



Carlton Trail

Economic Impact Assessment

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Executive Summary

Praxis Consulting (Praxis) was engaged by Carlton Trail Regional College to assess the economic impact of the College’s students, graduates, and operations on the region it serves and provincial economies for the 2016-2017 school year. Impacts were assessed across 4 dimensions: 1) student spending while enrolled 2) spending of salaries once students are graduated and in the workforce 3) productivity impacts of graduates working in their fields and 4) college operations.

The Saskatchewan Input-Output Model was used to measure the provincial economic impacts associated with students, graduates and operations and a regional-level economic model was constructed for the Carlton Trail region to assess students, graduates, and operations impacts at the regional level. These impacts were stated in terms of gross output, gross domestic product (GDP), employment and labour income.

Carlton Trail Regional serves a region having a population of over 66,200. The College offered 295 programs/classes to 2257 students in 30 communities during the 2016/17 programming year and has main campuses in:

- Humboldt
- Watrous
- Wynyard

A comprehensive economic impact study is a critical way to gain an understanding of how the student, graduates, and operations of the College benefit the regional economies with Carlton Trail campuses and the province as a whole.

Summary of Regional Level Results

Combining, student, graduate, and operational impacts provide the most complete picture of the importance of Carlton Trail Regional College to the province and region. In the 2016-2017 school year, at the regional level, Carlton Trail students, graduates, and operations added the following to the economy of the region served by the College (Carlton Trail Region) in millions of 2017 dollars and jobs:

Table 1: Carlton Trail Region Impacts - Summary

Carlton Trail Region Impacts	Gross Domestic Product (\$M)	Employment (Positions)	Labour Income (\$M)
Student and Operational Impacts*	16.3	185	10.8

*Includes student spending, graduate spending, graduate productivity, and College operation direct, indirect, and induced impacts.

Note: Gross Domestic Product (GDP) is the measure of the sum of all goods and services produced within a geographic area and is the measurement of the “size” of an economy.

Summary of Provincial Level Results

In 2016-2017 school year, Carlton Trail students, graduates, and operations added the following to the Saskatchewan economy in millions of 2017 dollars and jobs:

Table 2: Provincial Impacts - Summary

Provincial Impacts	Gross Domestic Product (\$M)	Employment (Positions)	Labour Income (\$M)
Student and Operational Impacts*	35.5	404	19.6

*Includes student spending, graduate spending, graduate productivity, and College operation direct, indirect, and induced impacts

Impacts on the Rest of the Province

A significant feature of the Carlton Trail regional economic impact model is the inclusion of estimated imports to the region from within the rest of the province. It follows that activity within the Carlton Trail region will have impacts on other areas of the province, notably those with industries providing inputs to Carlton Trail region businesses which cannot be sourced locally and where some degree of out-shopping occurs outside of the region but still within the province. An additional simulation was undertaken to estimate the impacts of Carlton Trail students, graduates, and operations on the rest of the province, outside of the Carlton Trail region:

Table 3: Rest of Province Impacts - Summary

Rest of Province Impacts	Gross Domestic Product (\$M)	Employment (Positions)	Labour Income (\$M)
Student and Operational Impacts	19.2	219	8.8

*Includes student spending, graduate spending, graduate productivity, and College operation direct, indirect, and induced impacts.

Impacts on the rest of the province totaled \$19.2 million in GDP and created or maintained 219 jobs.

Provincial Fiscal Impacts

At the provincial level, Carlton Trail Regional College generated the following fiscal impacts:

Table 4: Provincial Fiscal Impacts

Government Fiscal Impacts 2017	Personal Income Tax (PIT)	Corporate Income Tax	Taxes Unincorporated Business Profits	Sales and Excise Taxes	Total Revenue
Federal (\$M)	3.9	0.4	0.9	0.2	5.4
Provincial (\$M)	2.3	0.3	0.6	0.7	3.9
Total (\$M)	6.2	0.8	1.5	0.9	9.3

In total, Carlton Trail Regional College generated \$9.3 million in federal and provincial government revenues in 2017.

Note: these figures exclude resource revenues and are not adjusted for equalization payment impacts.

Conclusion

Carlton Trail Regional College students, graduates, and operations generated a significant economic contribution to the Carlton Trail region and provincial economies. Over the course of 2016-2017 school year, students, graduates, and operations maintained/added the following to the regional and provincial economies:

- 185 positions within the region;
- \$16.3 million in regional gross domestic product;
- \$10.8 million in new wages and salaries (included in GDP) in the region;
- 404 jobs within the province;
- \$35.5 million in provincial gross domestic product;
- \$19.6 million in new wages and salaries (included in GDP) in Saskatchewan;
- \$9.3 million in federal, provincial, and municipal government revenues; and,
- In the province outside of the Carlton Trail Region, Carlton Trail student and graduates added \$19.2 million to rest-of- province gross domestic product, including \$8.8 million in wages and salaries, and 219 jobs.

Approach and Methodology

Data Sources

Impacts were assessed across 4 dimensions: 1) student spending while enrolled, 2) spending of salaries once students are graduated and in the workforce, 3) productivity impacts of graduates working in their fields, and 4) college operations.

Student spending impacts were estimated using 2016-2017 Carlton Trail College student enrollments. Excluded from these figures were casual students and short courses of 1-5 days provided to industry because of the temporary nature of these programs. Total enrollment, less short courses and casual students, was 224 and included Institutional Credit, Basic Education, and University. Annual living costs per student were adapted from lower of the Ontario Securities Commission Student budget calculator and the lower bound of the latest Tuition & Cost of Living Estimates from the University of Alberta. These totaled \$9,600 for rent, \$3,000 for food, \$900 for entertainment, \$4,480 for utilities (including phone and internet) and \$880 for transportation. Excluded from these figures are tuition costs. These have already been included in the impacts of Carlton Trail College operations, once converted to Carlton Trail College revenues and re-spent in the Region and Province.

Student spending was multiplied by enrollment of 224 and converted to input-output industries: Finance, Insurance, Real Estate and Rental and Leasing (which includes rental dwellings) for rent, Manufacturing for food spending, Arts, Entertainment and Recreation for entertainment spending, Utilities for utilities (including phone and internet), and Transportation and Warehousing for transportation spending. It was assumed all expenditures could be met from local sources with the exception of food manufacturing in the Carlton Trail College region.

Data about the prevalence of paying rent was unavailable. Therefore, it is implicitly assumed that all students pay rent in some form, either real or imputed. Furthermore, for students that live rent-free, there are still costs that must be absorbed by the shelter provider (food, utilities, etc.) that would otherwise be spent elsewhere in the economy.

Graduate spending impacts were estimated by first deriving an estimated annual salary for Carlton Trail College graduates. Carlton Trail College conducted a survey of graduates' field of study, location of employment, industry employed in, and whether the graduate is employed in their field of study or not. The industry of employment was matched to annual average salaries by industry from the provincial IO model. Graduates employed but not in their field of study were assumed to be earning the average salary of the Accommodation and Food Service Industry. The survey also showed 147 graduates from institutional credit programs. Of these, 95% were employed with 78% of the employed working in the College region. Given employment, average salaries, and location, the amount of graduate spending was determined using the ratio of personal expenditures to personal income of just over 82% from the latest Saskatchewan economic accounts. This amount was allocated across components of personal expenditure based on the provincial average of expenditure by type after adjusting for leakages from imports and inventory withdrawals and used as the economic impact model input.

The productivity impact of employed Carlton Trail College graduates working in their field of study (71% of graduates) was estimated by converting positions into economic output. These were derived using industry averages of output per employee for Construction, Administrative Support, and the Government Sector in (Education and Health) times the numbers of graduates working in these industries and “shocking” the model in terms of the resultant output. Induced impacts of this incremental output were also used to calculate additional consumer spending in the region and province. Graduates not working in their field of study were assumed to have the average annual Accommodation and Food Service output per employee. ABE graduates were not included in this portion of the analysis. Instead, it is assumed that these students continue with additional education/training.

The operational impacts trace the revenue and expenses of operating the college campuses through the economy. Operational impacts were calculated by creating a mixed endogenous–exogenous model. This approach allows modification of the input structure of the expanding industry to reflect the output and input structure of a new development or event. This approach is appropriate when the input structure of the new development or event differs significantly from the input structure of the impacted industry. In this study, the labour income and employment coefficient in the model was adjusted to reflect actual employment and income paid to labour. A detailed account of the mixed endogenous–exogenous model methodology is available in Appendix C.

Under this approach, gross expenses are treated as industry gross output and expenses are assigned to either inter-industry purchases or final value-added (wages, amortization, and profits). Carlton Trail College provided budget data for 2016-2017 operating expenses. These total \$7 million including amortization. Incremental gross output was assigned to the “Government Sector”. In the provincial and national input-output accounts, the government sector, in addition to Public Administration and publicly funded health, also includes Universities, Government funded Elementary and Secondary Schools, Community Colleges and C.E.G.E.P.s, and Other Government Education Services. It should also be noted that the input-output industry “education services” includes private, for-profit educational services only.

Carlton Trail College also provided estimates of expenses sourced from within the region and from outside the region but within Saskatchewan. Locally sourced expenses were assigned to input-output model industries as incremental inputs. Annual expenses included salaries and wages, agency contracts, equipment expense, facilities expense, information technology, advertising, association fees and dues, financial services, insurance, materials and supplies, postage, freight and courier, printing and duplicating, professional services, telephone and fax, and travel. Also provided by Carlton Trail College was annual direct employment of 50 FTEs.

Wages and salaries totaled \$4.7M of total expenses. Remaining expenses were broken down into the following components: Finance, Insurance, Real Estate and Rental and Leasing, Professional, Scientific and Technical Services, Manufacturing, Other Services, Information and Cultural Industries, Utilities, Transportation and Warehousing, Administrative and Support, Waste Management and Remediation Services, and Supplementary Labour Income (benefits).

The region served is assumed to correspond to Saskatchewan Census Division 10 (which includes Wynyard) in addition to the larger centres of Humboldt, Southey, and Watrous.

Model Description

For provincial level impacts, Praxis's input-output model of the provincial economy was used. The provincial model is based on Statistics Canada's 2013 Saskatchewan input-output table, the latest available. The model is rectangular with 35 industries and 66 commodities. Please note that provincial model results were aggregated to 25 industries for this study to allow for industry to industry comparisons with regional results. A complete model description and definitions are available in Appendix A.

A separate economic impact model was developed to represent the economy of the Carlton Trail College region. This is based on a regional share of the 2013 provincial economy and is square in dimension with 25 industries. A detailed discussion on the development of sub-provincial input-output models is available in Appendix B.

Detailed Results

Direct, Indirect, and Induced Impacts

Direct Impacts typically represent total project expenditures, usually construction costs or, in this case, student and graduate spending, output attributed to graduates working their field, and locally spent operational expenditures. Indirect Impacts represent the secondary impact that includes inter-industry transactions and the purchases of inputs from industries that support directly impacted industries. Induced impacts are additional impacts from changes in household spending as incremental employees spend their wages in the region and province.

Direct, indirect, and induced regional impacts are below.

Table 5: Student Spending Impacts – Carlton Trail College Region

Student Spending Impacts-Carlton Trail College Region	GDP at Basic Prices Impact (\$M)	Employment Impact (Jobs)	Labour Income Impact (\$M)
Direct Impacts (\$M)	1.7	8	0.4
Indirect Impacts (\$M)	0.1	1	0.0
Induced Impacts (\$M)	0.0	0	0.0
Total Impacts (\$M)	1.8	9	0.5

Table 6: Graduate Spending Impacts – Carlton Trail College Region

Graduate Spending Impacts-Carlton Trail College Region	GDP at Basic Prices Impact (\$M)	Employment Impact (Jobs)	Labour Income Impact (\$M)
Direct Impacts (\$M)	0.10	0.73	0.05
Indirect Impacts (\$M)	0.01	0.06	0.00
Induced Impacts (\$M)	0.00	0.01	0.00
Total Impacts (\$M)	0.11	0.80	0.05

Table 7: Productivity Impacts – Carlton Trail College Region

Productivity Impacts-Carlton Trail College Region	GDP at Basic Prices Impact (\$M)	Employment Impact (Jobs)	Labour Income Impact (\$M)
Direct Impacts (\$M)	7.7	113	5.2
Indirect Impacts (\$M)	1.1	5	0.3
Induced Impacts (\$M)	0.2	1	0.1
Total Impacts (\$M)	9.0	119	5.6

Table 8: Operational Impacts – Carlton Trail College Region

Operational Impacts Impacts-Carlton Trail College Region	GDP at Basic Prices Impact (\$M)	Employment Impact (Jobs)	Labour Income Impact (\$M)
Direct Impacts (\$M)	4.8	50	4.5
Indirect Impacts (\$M)	0.4	5	0.2
Induced Impacts (\$M)	0.2	1	0.1
Total Impacts (\$M)	5.4	56	4.7

The identical procedure was repeated using the provincial impact model to derive impacts at the provincial level. With the calculation of imports to a sub-provincial region from within the rest of the province (intra-provincial imports), impacts at the regional level are, as expected, less than those occurring at the provincial level. Provincial impacts are summarized below:

Table 9: Student Spending Impacts - Province

Student Spending Impacts - Province	GDP at Basic Prices Impact (\$M)	Employment Impact (Jobs)	Labour Income Impact (\$M)
Direct Impacts (\$M)	1.7	8	0.4
Indirect Impacts (\$M)	0.5	4	0.2
Induced Impacts (\$M)	0.4	4	0.2
Total Impacts (\$M)	2.6	16	0.8

Table 10: Graduate Spending Impacts - Province

Graduate Spending Impacts - Province	GDP at Basic Prices Impact (\$M)	Employment Impact (Jobs)	Labour Income Impact (\$M)
Direct Impacts (\$M)	1.8	19	0.8
Indirect Impacts (\$M)	0.6	4	0.2
Induced Impacts (\$M)	0.6	6	0.3
Total Impacts (\$M)	3.0	30	1.2

Table 11: Productivity Impacts - Province

Productivity Impacts - Province	GDP at Basic Prices Impact (\$M)	Employment Impact (Jobs)	Labour Income Impact (\$M)
Direct Impacts (\$M)	10.4	170	7.1
Indirect Impacts (\$M)	4.4	34	1.7

Induced Impacts (\$M)	5.7	57	2.3
Total Impacts (\$M)	20.5	262	11.1

Table 12: Operational Impacts - Province

Operational Impacts Impacts - Province	GDP at Basic Prices Impact (\$M)	Employment Impact (Jobs)	Labour Income Impact (\$M)
Direct Impacts (\$M)	4.9	50	4.7
Indirect Impacts (\$M)	0.4	6	0.2
Induced Impacts (\$M)	4.0	40	1.6
Total Impacts (\$M)	9.4	96	6.5

Detailed Results by Industry

The following tables provide total impacts (direct, indirect, and induced) by industry of Carlton Trail College students, graduates, and operations on the Carlton Trail College regional economy. In the case of student spending, the bulk of impacts occur in the directly impacted industries of Finance, Insurance, Real Estate and Rentals, Transportation, and Arts, Entertainment, and Recreation. Graduate spending impacts are concentrated in the Retail and the Service sectors. All of the direct activity occurs within the Government Sector. Productivity impacts are concentrated largely in directly impacted industries (Construction, Administrative Support, Accommodation and Food Services, and the Government Sector in the form of Education and Health). There is also a smaller induced impact, which represents the additional impacts of consumer spending of wages earned, which is concentrated within the retail trade and service industries.

Table 13: Total Impacts Students and Operations – Carlton Trail College Region

Total Impacts (\$M) Students and Operations – Carlton Trail College Region	Gross Output Impact (\$M)	GDP @ Basic Prices Impact (\$M)	Employment Impact (Positions)	Labour Income Impact (\$M)
Crop and Animal Production	0.1	0.1	0	0.0
Forestry and Logging	0.0	0.0	0	0.0
Fishing, Hunting and Trapping	0.0	0.0	0	0.0
Support Activities for Agriculture and Forestry	0.0	0.0	0	0.0
Mining and Oil and Gas Extraction	1.1	0.7	1	0.1
Utilities	0.3	0.2	0	0.0
Construction	9.8	3.7	34	2.1
Manufacturing	0.2	0.1	0	0.0
Wholesale Trade	0.1	0.1	0	0.0
Retail Trade	0.0	0.0	0	0.0
Transportation and Warehousing	0.4	0.2	2	0.1
Information and Cultural Industries	0.1	0.1	1	0.0
Finance, Insurance, Real Estate and Rental and Leasing	2.2	1.5	5	0.3

Total Impacts (\$M) Students and Operations – Carlton Trail College Region	Gross Output Impact (\$M)	GDP @ Basic Prices Impact (\$M)	Employment Impact (Positions)	Labour Income Impact (\$M)
Professional, Scientific and Technical Services	0.5	0.3	3	0.2
Administrative and Support, Waste Management and Remediation Services	1.1	0.7	15	0.5
Educational Services	0.1	0.1	2	0.1
Health Care and Social Assistance	0.0	0.0	0	0.0
Arts, Entertainment and Recreation	0.2	0.1	2	0.1
Accommodation and Food Services	2.4	1.2	39	0.9
Other Services (Except Public Administration)	0.0	0.0	0	0.0
Operating, Office, Cafeteria and Laboratory Supplies	0.1	0.0	0	0.0
Travel, Entertainment, Advertising and Promotion	0.1	0.0	0	0.0
Transportation Margins	0.1	0.0	0	0.0
Non-Profit Institutions Serving Households	0.0	0.0	0	0.0
Government Sector	10.6	7.2	79	6.4
Total	29.6	16.3	185	10.8

Table 14: Total Impacts Students and Operations – Province

Total Impacts (\$M) Students and Operations – Province	Gross Output Impact (\$M)	GDP @ Basic Prices Impact (\$M)	Employment Impact (Positions)	Labour Income Impact (\$M)
Crop and Animal Production	0.8	0.4	2	0.0
Forestry and Logging	0.0	0.0	0	0.0
Fishing, Hunting and Trapping	0.0	0.0	0	0.0
Support Activities for Agriculture and Forestry	0.0	0.0	0	0.0
Mining and Oil and Gas Extraction	1.9	1.3	1	0.2
Utilities	1.2	0.8	1	0.2
Construction	12.7	4.8	44	2.7
Manufacturing	2.7	0.8	5	0.3
Wholesale Trade	1.2	0.8	5	0.3
Retail Trade	3.3	2.1	45	1.4
Transportation and Warehousing	1.3	0.7	6	0.4
Information and Cultural Industries	1.2	0.7	5	0.3
Finance, Insurance, Real Estate and Rental and Leasing	11.5	7.9	26	1.5
Professional, Scientific and Technical Services	1.4	0.9	9	0.5

Administrative and Support, Waste Management and Remediation Services	1.8	1.1	23	0.8
Educational Services	0.2	0.2	4	0.1
Health Care and Social Assistance	0.9	0.6	7	0.2
Arts, Entertainment and Recreation	0.7	0.3	8	0.2
Accommodation and Food Services	6.3	3.0	101	2.3
Other Services (Except Public Administration)	0.8	0.5	11	0.3
Operating, Office, Cafeteria and Laboratory Supplies	0.1	0.0	0	0.0
Travel, Entertainment, Advertising and Promotion	0.1	0.0	0	0.0
Transportation Margins	0.1	0.0	0	0.0
Non-Profit Institutions Serving Households	0.3	0.2	4	0.1
Government Sector	5.7	8.5	94	7.7
Total	56.4	35.5	404	19.6

Fiscal Impacts

Fiscal Module Description

An expansion in economic activity, especially when wages and salaries comprise a significant portion of incremental gross domestic product, is expected to generate incremental government revenues. The economic impact model's fiscal module is based on the latest federal, provincial, and municipal budgets and estimates government revenues as follows:

- Personal income tax is calculated by using the provincial and federal personal income tax rate that would apply to average industry annual income. This is applied to model-generated labour income.
- Corporation income tax is calculated by applying the provincial and federal corporate tax rates to incremental corporate profits before taxes calculated by the model.
- Unincorporated business income taxes are calculated by applying the small business tax rate to incremental unincorporated business profits calculated by the model.
- Sales tax calculation is based on the ratio of provincial and federal sales taxes collected to retail trade gross output applied to incremental retail trade output calculated by the model.
- Fuel and tobacco revenues are calculated as a fixed ratio (based on budget figures of tobacco and fuel tax revenues to total sales tax revenue) multiplied by estimated sales tax revenues.

Provincial government royalties from non-renewable resources are excluded from this analysis. Estimates are not adjusted for any reduction in equalization.

At the provincial level, Carlton Trail College generated the following provincial fiscal impacts:

Table 15: Government Fiscal Impacts 2017– Province

Government Fiscal Impacts 2017	Personal Income Tax (PIT)	Corporate Income Tax	Taxes Unincorporated Business Profits	Sales and Excise Taxes	Total Revenue
Federal (\$M)	3.9	0.4	0.9	0.2	5.4
Provincial (\$M)	2.3	0.3	0.6	0.7	3.9
Total (\$M)	6.2	0.8	1.5	0.9	9.3

Appendix A: Definitions and Model Description

Final Demand: sum of personal expenditure, government purchases of goods and services, business and government investment, and net exports.

Gross Output: total expenditures on local goods and services as well as payments to labour and business profits. Gross output includes double counting because it includes the value of inputs used in production rather than net value added alone.

GDP at factor cost: measure of net economic activity within a prescribed geographic area. It represents the payments made to final factors of production: labour, unincorporated business profits, and other operating surplus (corporate profits, interest income, inventory valuation adjustments, and capital consumption allowances). GDP at factor cost excludes the value of intermediate goods and services used in production.

GDP at market prices: GDP at factor cost plus indirect taxes less subsidies.

Employment: measured in positions.

Direct Impact: total project expenditure, usually construction or operating outlays.

Indirect Impact: the secondary impact that includes inter-industry transactions, purchases of inputs from supporting industries

Induced impact: the additional impact from changes in household spending as industries modify labour input requirements in response to altered levels of demand for output.

Industry outputs are calculated as $(I - D(I - \mu - \alpha - \beta)B)^{-1}D((I - \mu - \alpha - \beta)e^* + (I - \mu - \beta)X_d + (I - \mu)X_r) = X$

Where:

I = an identity matrix of industry by industry dimension

D = a matrix of coefficients representing commodity output proportions

B = a matrix of coefficients representing commodity input proportions (technical coefficients) by industry

μ = a diagonal matrix whose elements represent the ratio of imports to use

α = a diagonal matrix whose elements represent the ratio of government production to use

β = a diagonal matrix whose elements represent the ratio of inventory withdrawals to use

e^* = final demand categories of consumption, government purchases of goods and services, business and government investment, and inventory additions.

X_d = final demand category of domestic exports

X_r = final demand category of re-exports.

Employment is calculated as a fixed number of positions per dollar of industry output.

Appendix B: Developing Community Level Input-Output models

The latest available provincial input-output tables at the S-Level from Statistics Canada were used as the starting point. The table represents 25 industries and 18 components of final demand (based on the 2010 S-level aggregation). The tables were converted into industry-by-industry space.

In a square input-output table, each industry in the table can be represented as a column. For example industry 1 can be represented as follows:

Z ₁₁
Z ₁₂
·
·
·
Z ₁₂₅
W ₁
X ₁

z_{ij} = purchases by industry i of products from industry j . The transactions matrix consists of z_{11} to z_{2525} comprise the transactions matrix of 625 (25 x 25) elements.

W_1 = value added or gross domestic product component of industry 1's output which includes wages, salaries, supplementary labour income, unincorporated business profits, incorporate income profits, other income, and depreciation.

X_1 = industry 1's total output, which equals W_1 plus the sum of z_{11} to z_{25} .

To create sub-provincial models, four challenges must be overcome:

- 1) Allocation of provincial gross output by community/region
- 2) Estimation of technical coefficients by industry at a community/regional level
- 3) Estimation of components of gross domestic product by industry at a community/regional level
- 4) Allocation of provincial final demand output by community/region.

Census data on labour force by industry will be used to allocate gross output by industry for the region/community. Regional gross output for industry i is estimated:

$$X_i^R = \text{Labour Force}_i^R / \text{Labour Force}_i^{\text{SK}} \times X_i^{\text{SK}}$$

Where:

X_i^R = regional gross output for industry i

Labour Force_i^R = regional labour force for industry i

$\text{Labour Force}_i^{\text{SK}}$ = provincial labour force for industry i

X_i^{SK} = provincial gross output for industry i

To estimate items in each regional transaction matrix (z_{ij}) it will be assumed in all cases that the provincial input structure will apply to regional industries. The components of the regional transaction matrix are estimated:

$$z_{ij}^R = z_{ij}^{SK} / X_i^{SK} \times X_i^R$$

Where:

z_{ij}^R = an element of the regional transactions matrix.

z_{ij}^{SK} = the corresponding element of the provincial transactions matrix.

The same methodology is used for estimating the components of GDP.

$$W_i^R = W_i^{SK} / X_i^{SK} \times X_i^R$$

Where:

W_i^R = regional value added or gross domestic product component of industry i 's output

W_i^{SK} = provincial value added or gross domestic product component of industry i 's output

The components of final demand are estimated as follows. Personal expenditures are based on a per capita allocation of provincial spending.

$$PE_i^R = PE_i^{SK} / \text{Pop}^{SK} \times \text{Pop}^R$$

Where:

PE_i^R = Regional personal expenditure on industry i 's output

PE_i^{SK} = Provincial personal expenditure on industry i 's output

Pop^{SK} = Provincial population

Pop^R = Regional population

Gross capital formation (GFCF) or investment by industry is estimated applying the regional share industry to total provincial gross capital formation for each industry. The same approach is used to estimate exports (X_d), imports (M), and inventory changes by industry (VPC)

$$\text{GFCF}_i^R = X_i^R / X_i^{SK} \times \text{GFCF}_i^{SK}$$

$$X_d_i^R = X_i^R / X_i^{SK} \times X_d_i^{SK}$$

$$M_i^R = X_i^R / X_i^{SK} \times M_i^{SK}$$

$$\text{VPC}_i^R = X_i^R / X_i^{SK} \times \text{VPC}_i^{SK}$$

Where:

GFCF_i^R = Regional investment spending on industry i 's output.

GFCF_i^{SK} = Provincial investment spending on industry i 's output

$X_d_i^R$ = Regional exports of industry i 's output

$X_d_i^{SK}$ = Provincial exports of industry i 's output

M_i^R = Regional imports of industry i 's output

M_i^{Sk} = Provincial imports of industry i 's output
 VPC_i^R = Regional inventory changes of industry i 's output
 VPC_i^{Sk} = Provincial inventory changes of industry i 's output

Regional public administration employment is used to allocate provincial government current expenditures by region.

$$GCE_i^R = PAE^R / PAE^{Sk} \times GCE_i^{Sk}$$

Where:

GCE_i^R = Regional government current expenditures on industry i 's output
 PAE^R = Regional public administration labour force
 PAE^{Sk} = Provincial public administration labour force
 GCE_i^{Sk} = Provincial government current expenditures on industry i 's output

It is also necessary to adjust for leakages for intra-provincial imported factors of production. These are estimated residually: If the sum of the use (both Final Demand and Inter-industry sales) of industry i 's output is less than X_i then, intra-provincial exports are used to balance. Similarly, if use is greater than X_i intra-provincial imports are used the balance.

Intra-provincial exports/imports and exports due to out-shopping are estimated by calculating the marginal propensity to out-shop (the ratio of major community per capita retail sales to provincial per capita retail sales and multiplying by PE. Imports and exports are adjusted by this amount.

The estimation of intra-provincial imports into a region/community and incorporation of intra-provincial imports into the region/community model's leakages will constrain local multipliers to values not exceeding provincial level multipliers.

Developing Community/Regional Impact Models

Industry outputs in response to a shock in final demand are calculated as $(I - (I - \mu - \alpha - \beta)A)^{-1}((I - \mu - \alpha - \beta)e^* + (I - \mu - \beta)X_d + (I - \mu)X_r) = X$

Where:

I = an identity matrix of industry by industry dimension
 A = a matrix of technical coefficients representing inter-industry purchases (z_{ij}) divided by own industry gross output X_i .
 μ = a diagonal matrix whose elements represent the ratio of imports to use
 α = a diagonal matrix whose elements represent the ratio of government production to use
 β = a diagonal matrix whose elements represent the ratio of inventory withdrawals to use
 e^* = final demand categories of consumption, government purchases of goods and services, business and government investment, and inventory additions.
 X_d = final demand category of domestic exports
 X_r = final demand category of re-exports.

Employment is calculated as a fixed number of positions per dollar of industry output.

GDP components are calculated based on a fixed ratio of W_i to industry output.

Appendix C: Mixed Endogenous–Exogenous Input-Output Impacts

In a 3 industry x 3 industry input-output model with industry 3 exogenized, endogenous industry output and final demand X^M

$$\begin{pmatrix} X_1 \\ X_2 \\ Y^L_3 \end{pmatrix}$$

is calculated as follows:

$$X^M = M^{-1} Y^M$$

Where $M =$

$$\begin{pmatrix} (1-a^L_{11}) & -a^L_{12} & 0 \\ -a^L_{21} & (1-a^L_{22}) & 0 \\ -a^L_{31} & -a^L_{32} & -1 \end{pmatrix}$$

$$A^L = (D(I - \mu - \alpha - \beta)B)$$

$Y^M =$

$$\begin{pmatrix} Y^L_1 + a^L_{13}X_3 \\ Y^L_2 + a^L_{23}X_3 \\ -(1-a^L_{33})X_3 \end{pmatrix}$$

$$Y^L = D((I - \mu - \alpha - \beta)e^* + (I - \mu - \beta)X_d + (I - \mu)X_r)$$

Where:

I = an identity matrix of industry by industry dimension

D = a matrix of coefficients representing commodity output proportions

B = a matrix of coefficients representing commodity input proportions (technical coefficients) by industry

μ = a diagonal matrix whose elements represent the ratio of imports to use

α = a diagonal matrix whose elements represent the ratio of government production to use

β = a diagonal matrix whose elements represent the ratio of inventory withdrawals to use

e^* = final demand categories of consumption, government purchases of goods and services, business and government investment, and inventory additions.

X_d = final demand category of domestic exports

X_r = final demand category of re-exports.