BC STATS
Province of British Columbia
Ministry of Finance and Corporate Relations

THE BRITISH COLUMBIA HIGH TECHNOLOGY SECTOR:

Input/Output Analysis

A joint project of BC STATS and the Science and Technology Division
of the Ministry of Employment and Investment

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1. Introduction

The objective of this study is to assess the impact of the high technology sector on the economy of British Columbia. In this study, the high technology sector is defined in terms of a set of selected high technology commodities, and selected high technology industries classified according to the Standard Industry Classification 1980 (SIC). Since SIC industries vary in their high technology characteristics, corresponding high technology weights have been assigned. The procedure for defining the high technology sector (selection of high technology commodities and industries and their weights) is described in a separate study by Lawrance and Miller[1]. The list of 29 high technology commodities is provided in Table 1. High technology industries with their respective high technology weights are listed in Table 2.

The B.C. 1990 Input/Output model is utilized to measure the impact of the high technology sector in British Columbia. The procedure involves following three stages:

Stage 1- Definition of the high technology sector according to the procedure described by Lawrance and Miller.

Stage 2 - Concordance of the high technology industries classified according to the 1980 SIC to corresponding industries with the 1990 Input/Output classification. Re-estimation of high technology weights for the selected industries, using the Input/Output classification.

Stage 3 - Estimation of economic impacts due to inter industry linkages of the high technology sector within the provincial economy.

2. High Technology Sector Classification

2.1 SIC Classification

Selected SIC industries ("four digit" level) and their high technology weights are listed in Table 2.. The industries are divided into two sub-groups. Group one consists of industries with 100% weights, where 100% of the activities of industries in this group are deemed to have high technology characteristics. Group two consists of industries with high technology weights of less than 100%, where the activities of these industries

[1]Lawrance and Miller (1995). Defining the High Technology / Knowledge Sector in British Columbia, available on request from BC STATS

are not exclusively high technology. This list differs from that of Lawrance and Miller (1995) in that it does not include SIC 868, Health and Other Medical Laboratories. SIC 868 does not have a clear business sector equivalent in the I/O industry categories. Conversely the list includes SIC 3311, Small Electrical Appliance Industry which was dropped by Lawrance and Miller in the later stages of their work. Finally, the weights used here have been derived from export rather than production proportions. However, these differences are not expected to have a major effect on the application of the I/O results to those of Lawrance and Miller.

Table 1
High Technology Commodity Selection

2961	Machine tools
3291	Computers, video units, printers, etc.
3292	Office mach.,excl.photocopy&facsimile
3310	Aircraft engines
3320	Aircraft parts & equipment
3330	Aircraft service & repairs
3579	Radio, tv, stereo, vcr & unrec. tape
3580	Telephone & rel. equip, incl facsimile
3599	Broadcasting & radio comm. equip
3600	Radar & radio navigation equip
3619	Semi-conductors
3621	Printed circuits
3622	Integrated circuits
3623	Other electronic equipment comp.
3630	Electronic alarm & signal systems
3903	Optical fiber cables
4080	Pharmaceuticals
4332	Radioactive chemicals
4970	Aircraft&naut.navig.instr.,excl radio
4989	Lab & scientific instruments
4999	Measuring & control instruments
5001	Medical & dental equip & supplies
5003	Personal medical goods
5031	Optical & photo equipment
5032	Photocopy & microfilm equipment
5440	Telephone & other telecommunications
5661	Architect,engineering,scientific serv
5750	Computer services
5840	Laboratory equipment & supplies

Table 2
High Technology Industry Selection: SIC Classification

SIC	Industry	Weight (%)
3211	AIRCRAFT & AIRCRAFT PARTS	100
3351	TELECOMMUNICATION EQUIPMENT	100
3352	ELECTRONIC PARTS & COMPONENTS	100
3359	OTHER ELECTRONIC EQUIPMENT	100
3361	ELECTRONIC COMPUTERS & PERIPHERALS	100
3362	ELECTRONIC OFFICE, STORE & BUSINESS MACHINE	100
3369	OTHER OFFICE, STORE & BUSINESS MACHINES	100
3372	ELECTRICAL SWITCHGEAR & PROTECTIVE EQUIPMENT	100
3379	OTHER ELECTRICAL INDUSTRIAL EQUIPMENT	100
3741	PHARMACEUTICAL & MEDICINE	100
3911	INDICATING & RECORDING INSTRUMENTS	100
3912	OTHER INSTRUMENTS & RELATED PRODUCTS	100
772	COMPUTER & RELATED SERVICES	100
7752	OFFICES OF ENGINEER	100
7759	OFFICE OF SCIENTIFIC & TECHNICAL SERVICES	100
3192	CONSTRUCTION & MINING MACHINERY	13
3194	TURBINE & MECHANICAL POWER TRANSMISSION EQUIPMENT	42
3199	OTHER MACHINERY & EQUIPMENT, n.e.c.*	19
3271	SHIPBUILDING AND REPAIR	11
3311	SMALL ELECTRICAL APPLIANCE	40
3381	COMMUNICATIONS, ENERGY WIRE & CABLE	59
3711	INDUSTRIAL INORGANIC CHEMICALS, n.e.c.	7
3994	MUSICAL INSTRUMENT SOUND RECORDING	60
3999	OTHER MANUFACTURING PRODUCTS, n.e.c.	12

* n.e.c. : not elsewhere classified.

2.2 1990 Input/Output Classification

Many Input/Output (I/O) industries at the "worksheet level" correspond to SIC industries at the "four digit" level, while others represent aggregates (groupings) of SIC industries. In other words, there is not always a one to one correspondence between SIC and I/O classifications. Often two or more SIC industries are aggregated into one I/O industry. For example, SIC industries: 3912 Other Instruments & Related Products, 3913 Clock & Watch Industry and 3914 Ophthalmic Goods Industries are aggregated into one I/O industry, 145-Other Scientific & Prof. Equipment (Table 3 below). This creates a minor problem for this study, since there are cases where an I/O Industry is an aggregate of two or more SIC industries not all of which belong to the high technology sector. For example, in the above case, 3912 is a high technology industry (weight 100) while 3913 and 3914 are not defined as high technology industries (weights are zero). In these cases, I/O industries will have different high technology weights than SIC industries. To overcome this problem, new weights are calculated for high technology I/O industries. Table 3 lists high technology I/O industries along with their corresponding SIC industries. All the SIC industries having high technology weights greater than zero are printed in a normal font. Non-high technology industries have zero weights and are printed in italics.

The high technology weights for I/O industries are based on the number of establishments in and the high technology weights of their constituent SIC industries. For example, the high technology weight for I/O industry 145 Other Scientific & Prof. Equipment is

$$53.76 = ((100 \times 50) + (0 \times 7) + (0 \times 36)) \div (50+7+36)$$

Where 50, 7 and 36 are respectively the number of establishments for the SIC industries 3912, 3913 and 3914, and 100, 0, and 0 are the corresponding high technology weights for these SIC industries (see Table 3). The selected I/O industries with their corresponding high technology weights are taken as the high technology sector for the purpose of this study.

Table 3
High Technology Sector: I/O Classification

SIC	Industry	Weight SIC	Weight I/O	# of est.
3211	99 AIRCRAFT & AIRCRAFT PARTS	100	100.00	49
3351	117 TELECOMMUNICATION EQUIPMENT	100	100.00	19
3352	118 ELECTRONIC PARTS & COMPONENTS	100	100.00	50
3359	119 OTHER ELECTRONIC EQUIPMENT	100	100.00	74
3361	120 ELECTRONIC COMPUTERS & PERIPHERALS	100	100.00	58
	121 MISC. OFFICE, BUSINESS MACHINES	100	100.00	
3362	Electronic Office, Store & Business Machine	100		4
3369	Other office, store and business machines	100		11
	123 MISC. ELECTRICAL INDUSTRIAL EQUIP	100	100.00	
3372	. Electrical Switchgear & Protective Equipment	100		15
3379	Other electrical industrial equipment	100		34
3741	139 PHARMACEUTICAL & MEDICINE	100	100.00	30
3911	144 INDICATING & RECORDING INSTRUMENTS	100	100.00	34
	145 OTHER SCIENTIFIC & PROF. EQUIPMENT		53.76	
3912	Other Instruments & Related Products	100		50
3913	*Clock and Watch*	0		7
3914	*Ophthalmic Goods*	0		36
772	191 COMPUTER & RELATED SERVICES	100	100	
	192 PROFESSIONAL BUSINESS SERVICES		34.75	
7730	*Accounting and Bookkeeping Services*	0		267
7731	*Offices of Chartered and Certified Accounting*	0		927
7750	*Architectural, Eng. & Sci. & Tech. Services*	0		21
7751	*Offices of Architects*	0		465
7752	Offices of Engineer	100		1376
7759	Office of Scientific and Technical Services	100		736
7761	*Offices of Lawyers and Notaries*	0		2286
	96 COMPRESSOR & TURBINE		21.49	
3191	*Compressor, Pump & Industrial Fan*	0		21
3194	Turbine and mechanical power transmission equipment	42		22
3192	97 CONSTRUCTION & MINING MACHINERY	13	13.00	110
	98 SAWMILL & OTHER MACHINERY, n.e.c.		14.46	
3199	Other Machinery & Equipment, n.e.c.	19		153
3193	*Sawmill and Woodworking Machinery*	0		48
3271	111 SHIPBUILDING AND REPAIR	11	11.00	21
3311	113 SMALL ELECTRICAL APPLIANCE	40	40.00	11
3381	124 COMMUNICATIONS, ENERGY WIRE & CABLE	59	59.00	8
3711	135 INDUSTRIAL INORGANIC CHEMICALS, n.e.c.	7	7.00	28
3994	151 MUSICAL INSTRUMENT SOUND RECORDING	60	60.00	20
	152 MISC. MANUFACTURED PRODUCTS, n.e.c.		11.73	
3999	Other Manufacturing Products, n.e.c.	12		388
3991	*Broom, Brush and Mop*	0		6
3992	*Button, Buckle and Clothes Fastener*	0		3

3. Relative Size of the High Technology Sector

The size of the high technology sector is measured in terms of GDP (value added) at factor cost and paid employment. In section 3.1, the relative shares of GDP and paid employment in the high technology sector are compared with those of the other sectors. In section 3.2, further comparisons are made of the relative sizes of I/O industries within the high technology sector. In section 4, the economic impacts on the provincial economy of an exogenous increase in demand for the output of the high technology sector are estimated. Economic impacts are measured in terms of direct impacts, and secondary impacts due to backward and forward linkages. The terms "backward and forward linkages" are explained in detail in section 4.

The shares of GDP (factor cost) and paid employment[2] are calculated for high technology sector, other sectors and I/O industries in the high technology sector for the years 1984 and 1990, using data from the BC I/O tables. These shares are provided in Table 4a and Table 4b.

3.1 Comparison of the High Technology Sector with Other Sectors

The relative share of GDP (factor cost) of the high technology sector in the provincial economy has increased from 2.04 percent in 1984 to 2.20 percent in 1990. In 1984 and 1990, the share of GDP of the high technology sector was larger than Agricultural & Related Services, and Fishing & Trapping sectors. However, in 1990, the share of GDP of the high technology sector also became larger than the Food & Beverage sector. In 1990, the share of paid employment in the high technology sector was larger than the Agricultural & Related Services, Fishing & Trapping, Logging & Forestry and Mining & Quarrying and Oil Wells.

3.2 Comparison of Industries in the High Technology Sector

The service industries (I/O) in the high technology sector, 191 Computer and Related Services and 192 Professional Business Services, have approximately a 75 percent share of the GDP and a 65 percent share of the employment within the high technology sector (Tables 4a and 4b). The relative share of GDP within the high technology sector of 192 Professional Business Services has decreased between 1984 and 1990 reflecting increased shares of some of other high technology industries and particularly

[2] Different methodologies are used to estimate industrial employment for 1984 and 1990. Therefore, comparison of shares of employment between 1984 and 1990 are not made.

of 191 Computer and Related Services . Among manufacturing industries in the high technology sector, 98 Sawmill & Other Machinery, 99 Aircraft & Aircraft Parts, 119 Other Electronic Equipment, 120 Electronic Computers & Peripherals and 123 Misc. Electrical Industrial Equip. have the largest shares of GDP. Each of these manufacturing industries has at least a 2 percent share of the high technology sector's GDP. Among manufacturing industries, these industries also have the largest share of the high technology sector's employment. One other manufacturing industry, 118 Electronic Parts & Components, also has a significant share of employment, (2.5%) but has less than a 2 percent share of the high technology sector's GDP.

Between 1984 to 1990, shares of total GDP in the high technology sector for the following industries have decreased:

- 111 Shipbuilding & Repair,
- 117 Telecommunication Equipment,
- 120 Electronic Computers & Peripherals,
- 135 Industrial Inorganic Chemicals,
- 152 Misc. Manufacturing Products N.E.C., and
- 192 Professional Business Services.

However, GDP in absolute terms (1990 dollars, CPI adjusted) decreased only for 120 Electronic Computers & Peripheral Industries between 1984 and 1990.

Among significant industries (at least 4% share of GDP of high technology sector), 119 Other Electronic Equipment Industries has expanded the most between 1984 and 1990 followed by 99 Aircraft & Aircraft Parts and 191 Computer and Related Services.

Table 4a
High Technology: Relative Size-GDP

I/O *Industry*	I/O High Tech Weight	1984 GDP Per Cent of Business Sector	1984 GDP Per Cent of High-Tech	1990 GDP Per Cent of Business Sector	1990 GDP Per Cent of High-Tech	1984 to 1990 Percentage Increase High-Tech
96 COMPRESSOR & TURBINE	21.49	0.0122	0.5986	0.0145	0.6609	10.41
97 CONSTRUCTION & MINING MACHINERY	13	0.0225	1.1025	0.0246	1.1183	1.44
98 SAWMILL & OTHER MACHINERY, n.e.c.	14.46	0.0381	1.8644	0.0498	2.2644	21.45
99 AIRCRAFT & AIRCRAFT PARTS	100	0.0472	2.3095	0.0894	4.0673	76.11
111 SHIPBUILDING AND REPAIR	11	0.0313	1.5299	0.0106	0.4803	-68.61
113 SMALL ELECTRICAL APPLIANCE	40	0.0009	0.0447	0.0011	0.0508	13.65
117 TELECOMMUNICATION EQUIPMENT	100	0.1249	6.1112	0.0064	0.2927	-95.21
118 ELECTRONIC PARTS & COMPONENTS	100	0.0131	0.6411	0.0267	1.2156	89.61
119 OTHER ELECTRONIC EQUIPMENT	100	0.0214	1.0489	0.1038	4.7187	349.86
120 ELECTRONIC COMPUTERS & PERIPHERALS	100	0.0822	4.0188	0.0712	3.2374	-19.44
121 MISC. OFFICE, BUSINESS MACHINES	100	0.0068	0.3341	0.0121	0.5519	65.18
123 MISC. ELECTRICAL INDUSTRIAL EQUIP.	100	0.0370	1.8121	0.0651	2.9606	63.38
124 COMMUNICATIONS, ENERGY WIRE & CABLE	59	0.0261	1.2775	0.0318	1.4443	13.05
135 INDUSTRIAL INORGANIC CHEMICALS, n.e.c.	7	0.0138	0.6750	0.0084	0.3830	-43.26
139 PHARMACEUTICAL & MEDICINE	100	0.0066	0.3211	0.0117	0.5336	66.18
144 INDICATING & RECORDING INSTRUMENTS	100	0.0063	0.3104	0.0136	0.6167	98.68
145 OTHER SCIENTIFIC & PROF. EQUIPMENT	53.76	0.0098	0.4803	0.0158	0.7191	49.71
151 MUSICAL INSTRUMENT SOUND RECORDING	60	0.0003	0.0152	0.0007	0.0298	95.71
152 MISC. MANUFACTURED PRODUCTS, n.e.c.	11.73	0.0097	0.4758	0.0075	0.3399	-28.57
191 COMPUTER & RELATED SERVICES	100	0.4035	19.7373	0.5217	23.7253	20.21
192 PROFESSIONAL BUSINESS SERVICES	34.75	1.1304	55.2915	1.1124	50.5898	-8.50
Total High Tech		2.0444	100.0000	2.1988	100.0000	0.00
Rest of Industries *						
AGRICULTURE AND RELATED SERVICES	0	1.4555		1.1207		
FISHING AND TRAPPING	0	0.3836		0.6134		
LOGGING AND FORESTRY	0	2.8591		2.5196		
MINING, QUARRYING AND OIL WELLS	0	5.1685		2.9113		
FOOD AND BEVERAGE	0	2.4088		1.9111		
OTHER MANUFACTURING	0	13.7712		12.6579		
CONSTRUCTION	0	8.6227		9.1088		
TRANSPORTATION, STORAGE AND COMM.	0	10.7084		10.5638		
ELEC. POWER, GAS AND OTHER UTILITIES	0	3.4300		2.9624		
WHOLESALE AND RETAIL TRADE	0	14.3977		14.7814		
PERSONAL SERVICES	0	10.0562		10.3945		
OTHER SERVICES	0	24.6939		28.2561		
Total Rest of Industries		97.9556		97.8012		
Total B.C.		100.0000		100.0000		

*Based on I/O “Small aggregation”.

Table 4b
High Technology: Relative Size-Employment

I/O *Industry*	I/O High Tech Weight	1984 Paid-Empl. Per cent of Business Sector	1984 Paid-Empl. Per cent of High-Tech.	1990 Paid-Empl. Per cent of of Business Sector	1990 Paid-Empl. Per cent of High-Tech
96 COMPRESSOR & TURBINE	21.49	0.0140	0.6023	0.0158	0.5910
97 CONSTRUCTION & MINING MACHINERY	13	0.0246	1.0566	0.0310	1.1604
98 SAWMILL & OTHER MACHINERY, n.e.c.	14.46	0.0472	2.0245	0.0607	2.2699
99 AIRCRAFT & AIRCRAFT PARTS	100	0.0717	3.0762	0.1369	5.1162
111 SHIPBUILDING AND REPAIR	11	0.0509	2.1849	0.0185	0.6900
113 SMALL ELECTRICAL APPLIANCE	40	0.0029	0.1234	0.0046	0.1705
117 TELECOMMUNICATION EQUIPMENT	100	0.1844	7.9154	0.0110	0.4110
118 ELECTRONIC PARTS & COMPONENTS	100	0.0281	1.2065	0.0666	2.4889
119 OTHER ELECTRONIC EQUIPMENT	100	0.0335	1.4381	0.1316	4.9203
120 ELECTRONIC COMPUTERS & PERIPHERALS	100	0.1263	5.4231	0.1100	4.1098
121 MISC. OFFICE, BUSINESS MACHINES	100	0.0203	0.8714	0.0223	0.8335
123 MISC. ELECTRICAL INDUSTRIAL EQUIP.	100	0.0857	3.6778	0.0974	3.6412
124 COMMUNICATIONS, ENERGY WIRE & CABLE	59	0.0252	1.0816	0.0209	0.7818
135 INDUSTRIAL INORGANIC CHEMICALS, n.e.c.	7	0.0078	0.3364	0.0052	0.1957
139 PHARMACEUTICAL & MEDICINE	100	0.0245	1.0510	0.0336	1.2560
144 INDICATING & RECORDING INSTRUMENTS	100	0.0148	0.6339	0.0347	1.2982
145 OTHER SCIENTIFIC & PROF. EQUIPMENT	53.76	0.0182	0.7791	0.0306	1.1419
151 MUSICAL INSTRUMENT SOUND RECORDING	60	0.0004	0.0160	0.0035	0.1314
152 MISC. MANUFACTURED PRODUCTS, n.e.c.	11.73	0.0253	1.0865	0.0221	0.8277
191 COMPUTER & RELATED SERVICES	100	0.2619	11.2413	0.7387	27.6088
192 PROFESSIONAL BUSINESS SERVICES	34.75	1.2622	54.1740	1.0798	40.3557
Total High Tech		2.3298	100.0000	2.6756	100.0000
Rest of Industries*					
AGRICULTURE AND RELATED SERVICES	0	3.5700		1.6770	
FISHING AND TRAPPING	0	0.4843		0.5269	
LOGGING AND FORESTRY	0	2.3576		1.9627	
MINING, QUARRYING AND OIL WELLS	0	2.4705		1.3162	
FOOD AND BEVERAGE	0	2.2751		2.1594	
OTHER MANUFACTURING	0	12.6349		13.5678	
CONSTRUCTION	0	9.0615		8.7458	
TRANSPORTATION, STORAGE AND COMM.	0	8.5094		8.5602	
ELEC. POWER, GAS AND OTHER UTILITIES	0	0.9536		0.5756	
WHOLESALE AND RETAIL TRADE	0	22.8497		24.4379	
PERSONAL SERVICES	0	19.8189		18.9803	
OTHER SERVICES	0	12.6848		14.8145	
Total Rest of Industries		97.6702		97.3244	
Total B.C.		100.0000		100.0000	

* Based on I/O “Small aggregation”.

4. Linkages of the High Technology Sector to the Economy

This section deals with the estimation of the direct impacts caused by an initial change in the high technology sector and the secondary impacts which result as the initial direct impacts work through the economy. Secondary impacts occur because of the existence of inter-industrial linkages in the provincial economy. Secondary impacts can occur through backward linkages and also through forward linkages. Secondary impacts through backward linkages occur when industries in the high technology sector demand more intermediate inputs, which are produced by other industries in the provincial economy. Secondary impacts through forward linkages occur when the increased outputs of the high technology sector become intermediate inputs of other expanding provincial industries. Backward secondary impacts always exist because production requires inputs. Sectors providing these inputs will be affected in response to the initial increased production in the direct high technology sector. However, forward secondary impacts do not always exist, as will be discussed in the section below.

All economic impacts are measured in terms of change in GDP (value added) and employment.

4.1 Direct Economic Impacts

In this section, direct economic impacts resulting from an exogenous increase in demand for outputs from the high technology sector are estimated. The direct impacts affect the selected industries in the high technology sector and are estimated for a standardized one million dollar increase in demand for output from the high technology sector. The percent shares of GDP of industries in the high technology sector (Table 4a) are used to allocate the million dollar increase in output in the high technology sector. For example, there is an assumed increase of $505,898 and $237,253 of output from the service industries; 192 Professional Business Services and 191 Computer & Related Services respectively, corresponding to the total one million dollar increase in output of the high technology sector. GDP is used instead of total output of these industries to allocate the million increase in demand for high technology outputs. The assumption is that allocation based on GDP will be more reflective of the true importance of each industry.

Direct GDP and employment impacts obtained from the 1990 B.C. Input/Output model are provided in Table 5

4.2 Backward Indirect (Secondary) Impacts

Backward secondary impacts are measured in terms of increases in GDP and employment in other (non-high technology) industries. Backward indirect impacts exist since an increase in high technology output by industries in the high technology sector require intermediate inputs which are produced by other industries. Backward indirect impacts are provided in Table 5.

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Table 5
Simulation Results: B.C. Input/Output Model 1990
Direct and Indirect Impacts: In Dollars Per
$1 million Increase in High Technology Sector Output

Impacts	Direct	Indirect	Total
GDP @ Factor Cost	621,418	123,224	744,642
GDP @ Market Price	631,338	139,409	770,747
Jobs	12	2	14
Household Income	560,969	79,709	640,678
Average Income	45,971	35,717	44,386

- Household Income is the sum of wages and salaries, supplementary labour incomes, and the net income of unincorporated business.
- GDP at factor cost is the sum of Household Income plus other operating surplus (profits).
- GDP at Market Price equals GDP at Factor Cost plus Commodity Indirect Taxes, net of Subsidies.
- Average Income is estimated by dividing Household Income by the number of Jobs.

It should be noted that the total GDP at market price impact is less than $1,000,000 (increased high technology output demand) due to leakages (import and government production) from the economy (see section 4.3).

The following are the non-high technology industries (I/O classification) with significant indirect impacts. In other words, these industries provide significant intermediate inputs for the expansion of high technology sector. These industries will experience, backward indirect (secondary) impacts when the high technology sector expands.

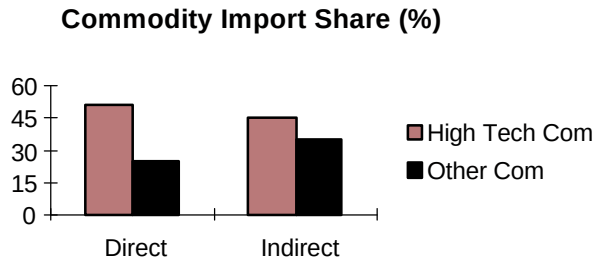
Industries with Significant Indirect Impacts: GDP @ Factor Cost

187 Other Finance & Real Estate Ind.	$ 29,396
177 Telecommunication Carriers & Other	$ 13,780
194 Misc. Business Services	$ 11,319
182 Wholesale Trade Industries	$ 9,173
184 Banks & Other. Deposit Accepting Inst.	$ 7,719
183 Retail Trade Industries	$ 5,539
208 Bus Associations/Machinery Leasing /Other Services, n.e.c.	$ 5,147
Rest of Industries	$ 41,151
Total Indirect GDP @ Factor Cost	$123,224

4.3 Leakages from the Economy

In order to increase output, the high technology sector requires some intermediate inputs which are imported and/or which are produced by government industries. These intermediate inputs represent leakages to the economy, because they are not produced by other business sector industries. Similar leakages also exist for industries affected through backward impacts. Estimates of leakages are provided in Table 6a.

Approximately, 50 % of high technology commodities demanded as intermediate inputs by the high technology sector (direct industries) and non-high technology indirect industries, are imported. This compares to a rate of import of 25% for other commodities demanded by the high technology sector (direct industries) and of 34% for non high technology (indirect) industries.



The following high technology commodities are significant from an import leakage perspective (Table 6b):

- 3291 Computer, Video Units, Printers, etc.;
- 3622 Integrated Circuits; and
- 3320 Aircraft Parts & Equipment.

At least 80% of the demand for each of these commodities by the high technology sector is met by imports. For each of these commodities, imports represent at least 5% of the total high technology commodities demanded by the high technology sector. Further, the imports for each of these commodities represent at least 1% of the total of all commodities demanded by the high technology sector. Also note that, total imports of high technology commodities are 13% of all commodities demanded by the high technology sector. This suggests that domestic industries producing high technology commodities, especially the above commodities, have significant potential for growth. It should also be noted that government leakages for all of the high technology commodities are insignificant.

Table 6a

Simulation Results: B.C. Input/Output Model 1990

Commodity Requirements

Per $1 million Increase in High Technology Sector Output

	Domestic	Import	Govt. Production	% Share of Imports
Direct Commodity Inputs				
High Tech Commodities	47,847	48,974	116	50.5
Other Commodities	200,870	65,451	5,406	24.6
Indirect Commodity Inputs				
High Tech Commodities	4,636	3,844	36	45.5
Other Commodities	94,731	50,506	2,091	34.3

Table 6b

High Technology Commodity Requirements

by the High Technology Sector

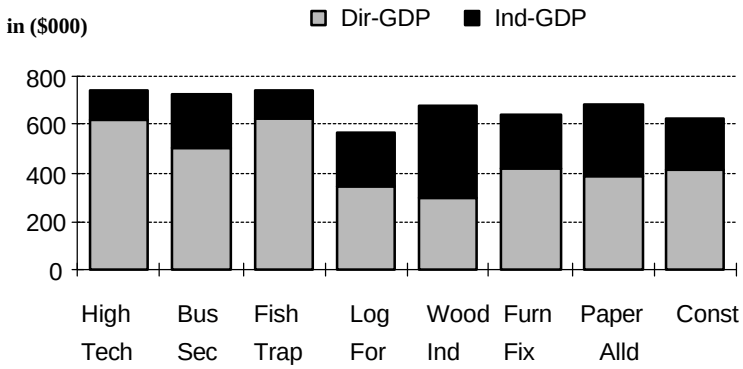
High Technology Commodity	Import as Percentage of:		
	Commodity Demanded (%)	All High Tech Commodities Demanded (%)	Total Commodities Demanded (%)
Computers, video units, printers, etc.	100.0	7.8	2.0
Integrated circuits	87.8	5.0	1.3
Aircraft parts & equipment	84.6	4.7	1.2
Telephone & oth telecommunications	31.5	6.9	1.8
Rest of High Technology Commodities	44.3	26.2	6.9
All High Technology Commodities	50.5	50.5	13.3

4.4 Economic Impacts of the High Technology Sector Vs. Other Sectors

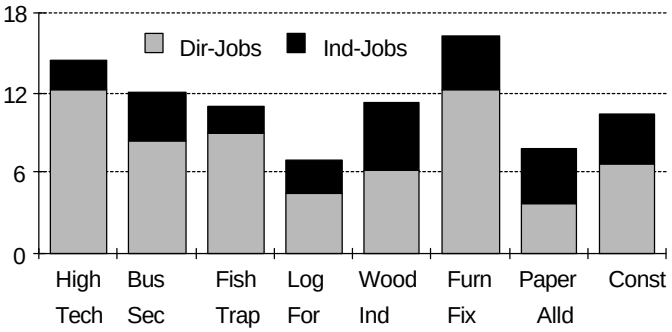
In this section, direct and indirect backward impacts of the high technology and other sectors are compared for a one million dollar increase in demand. The comparisons are made in terms of GDP (factor cost) and employment (jobs) impacts.

The estimated *direct* GDP impacts of a one million dollar increase in output from the high technology sector are larger than those for all other sectors compared here, save Fishing and Trapping. The direct number of incremental jobs (paid employment) is also greater than for any other sector except for the Furniture and Fixture Industry, where the impact is equal. However, the estimated *indirect* impacts on GDP and employment are much weaker, and only exceed those of the Fishing and Trapping Industry.

High Technology VS Other Sector: GDP



High Technology Vs Other Sectors: Employment



If the business sector can be assumed to represent the average sector, then it can be concluded that the high technology sector has relatively larger direct impacts and has relatively weaker (less than average) backward linkages in the British Columbia economy. The relative weakness of these backward linkages reflects the added emphasis in high technology on creating value through direct application of labour and capital, while using fewer purchased inputs. This is consistent with the importance of service industries within the sector.

Table 7

Comparison of 1990 Simulation Results

High Technology Sector vs. Other Selected Sectors

Sector	Direct		Indirect		Total	
	GDP	Jobs	GDP	Jobs	GDP	Jobs
High Technology	621,418	12.2	123,224	2.2	744,642	14.4
Business Sector	499,213	8.4	223,675	3.7	722,888	12.1
Primary Sectors:						
Fishing & Trapping	630,465	9.0	107,693	2.0	738,158	11.0
Logging & Forestry	342,756	4.5	228,629	2.5	571,385	7.0
Manufacturing:						
Wood Industries	296,199	6.2	378,939	5.0	675,138	11.2
Furniture & Fixture Industries	422,768	12.2	222,132	4.0	644,900	16.2
Paper & Allied Products	388,474	3.7	292,244	4.1	680,718	7.8
Construction	415,411	6.7	208,595	3.8	624,006	10.5

4.5 Forward Secondary Impacts

Forward inter-industry linkages occur if outputs from the high technology sector serve as inputs (intermediate use) to other industries. Such industries are referred to as ***forward industries***. The existence of forward secondary impacts depends on the potential for the forward industries to expand. If the availability of domestically produced high technology was not acting as a constraint, then such expansion would be unlikely. In addition, the potential for the expansion may not only depend on the domestic supply of high technology inputs but may also be constrained by government regulatory policies and market conditions[3].

Forward secondary impacts will not exist if the outputs of the high technology sector are only replacing (substituting for) imports used by the forward industries. If in fact forward industries do not have the potential for expansion, then increased output from the high technology sector may be exported, and/or may cause a decline in the domestic price of high technology products. These situations would lead either to null, or to insignificant forward impacts.

Forward secondary impacts exist because of the increased availability of high technology products for further intermediate use by domestic business sector industries. High technology products consumed by the categories of final demand; consumer, investment, export, and government consumption, will not produce any forward secondary impacts.

This analysis is not aimed at estimating the probability of the existence of forward secondary impacts nor their magnitude. To estimate the magnitude of the forward secondary impacts of the high technology sector, additional information would be required. Because of the absence of this information, the analysis in this study is limited to identifying and ranking the forward industries, based on their dependence on the high technology sector. This is done under two separate assumptions concerning how the high technology sector outputs are increased:

- the supply of high technology commodities (Table 1) is increased by one million dollars; or

[3] A detailed discussion of this topic can be found in Hamilton, J.R., N.K. Whittlesey, M.H. Robinson, and J. Ellis, 1991. "Economic Impacts, Value Added, and Benefits in Regional Project Analysis" *American Journal of Agricultural Economics*, 73(2): 334-344.

- supply of aggregate output of the high technology industries (Table 2 and Table 3) is increased by one million dollars.

These assumptions are based on whether forward industries are identified with respect to the high technology commodities (listed in Table 1) or to all the outputs (whether "high tech" or not) of the high technology sector (Table 2)
It should also be noted that increased consumption by the forward industries may cause further forward secondary impacts, but these are not considered here. In other words, only first stage forward secondary impacts are taken into consideration.

The sixteen major forward industries identified in this analysis are listed in the first column of Table 8 below. Columns two and three provide measures of the industry's relationship to the high technology sector based on assumption one, an additional supply of the high technology commodities. The last two columns provide measures based on assumption two, an additional supply of outputs by the high technology sector. For example for forward industry, 162 Air Transport & Services Incidental, the numbers in columns two to four mean:

- the industry would use 9.5% of an increase in supply of high technology commodities;
- 27.0% of the intermediate inputs used by the industry are high technology commodities;
- the industry would use 4.1 % of an increase in outputs from the high technology sector; and
- 51.4 % of its intermediate input use are from the outputs of the high technology sector.

Note that the high technology sector produces 205 commodities, most of which are also produced by non high technology industries. Therefore, a large percentage of intermediate use of high technology sector commodity outputs by forward industries (last column) does not necessarily mean that these commodities are exclusively produced by the high technology sector.

Table 8
Profile of Forward Industries

Major Forward Industry	Assumption One[1]		Assumption Two[2]	
	Share of High-Tech Commodities Use (%)	High-Tech share of Industry's Intermediate Use (%)	Share of High-Tech Outputs Use (%)	High-Tech share of Industry's Intermediate Use (%)
162 AIR TRANSPORT & SERVICES INCIDENTAL	9.53	26.95	4.14	51.41
187 OTHER FINANCE & REAL ESTATE IND.	8.43	8.21	12.53	35.44
155 NON-RESIDENTIAL BLDG. CONSTRUCTION	6.59	17.13	7.14	60.73
154 RESIDENTIAL CONSTRUCTION	6.28	6.77	6.99	47.60
192 PROFESSIONAL BUSINESS SERVICES	5.50	24.69	5.88	47.50
182 WHOLESALE TRADE INDUSTRIES	4.79	9.06	4.40	35.09
198 OTHER HEALTH AND SOCIAL SERVICES	3.84	27.30	1.45	54.46
184 BANKS & OTH. DEPOSIT ACCEPTING INST.	3.79	30.17	4.52	42.03
183 RETAIL TRADE INDUSTRIES	3.60	5.77	4.97	37.88
213 LABORATORY SUPPLIES	3.29	67.57	0.73	85.63
160 OTHER ENGINEERING CONSTRUCTION	3.17	25.03	3.21	59.51
210 OPERATING SUPPLIES	3.16	4.76	2.59	70.26
177 TELECOMMUNICATION CARRIERS & OTHER	2.93	24.83	2.31	44.46
157 GAS & OIL FACILITY CONSTRUCTION	1.63	10.99	1.57	46.58
188 INSURANCE INDUSTRIES	1.59	11.53	2.64	24.32
194 MISC. BUSINESS SERVICES	1.03	9.41	2.25	48.40
Total	69.15		67.32	

[1] **Assumption 1:** The supply of high technology commodities (Table 1) is increased by one million dollars.

[2] **Assumption 2:** Supply of aggregate output of the high technology industries is increased by one million dollars

Appendix
Assumptions and Caveats Respecting the Input/Output Model

Two Major Assumptions:

1: Allocations of commodity among producing sectors:
If the output of a commodity is increased, all industries (sectors) producing that commodity get a *fixed share* of the increased production.

2: Production function of industries (sectors):
For each dollar of an industry's output, certain *fixed* amounts of commodity inputs are required. In other words, an industry utilizes a *fixed proportions* of inputs and these fixed proportions do not depend on the level of its output.

There are additional assumptions regarding government production and imports. Government production and imports of a commodity constitute a fixed share of the domestic demand of the commodity. Exports of a commodity are supplied exclusively from the domestic industries, business sector.

The following issues should be considered when the estimates of economic impacts from an Input/Output model are translated into estimates of benefits and costs.

- **The British Columbia Input Output Model (BCIOM-90)** is based on data representing the economy of British Columbia for the year 1990. the High Technology Sector is a rapidly growing sector and its inter-industry relationships may be also changing rapidly.

- The Input/Output model assumes that there are no capacity constraints in any increased production. It assumes that no new capital investment is needed to increase production, which may not be true in the case of high technology sector.

- The assumption of industry's fixed proportions of inputs does not permit any substitution among inputs due to technological invention (change), relative price changes, or shifts in demand patterns.

- The model assumes that industries are operating at full employment. Any increase in production by domestic industries will require new proportionate labour (employment).

- Income impacts; wages and salaries, rents and profits earned by the factors of production do not take into account opportunity costs (alternative use) of these factor inputs. The opportunity cost of a factor input is the value of its best alternative use.

- The Input/Output model assumes (Assumption 2 above) that industries are operating at constant returns to scale. However, industries in the high technology sector may exhibit increasing returns to scale (early stages of development).

- Additional caveats for Forward impacts have been discussed earlier.