VERTICAL INTEGRATION TECHNOLOGICAL INNOVATION AND CROSS-SUBSIDY: THEORY AND METHODOLOGY

NPPS PROJECT

by

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Introduction

The purpose of this report is to obtain a more profound insight into the problem of technological innovation and cross-subsidy in the Canadian telecommunications industry. Since vertical integration is a very important characteristic of this industry, it is desirable to consider the question of technological innovation and cross-subsidy in relation to the high degree of vertical integration present in the sector. The project thus aims at analysing the issue of technological progress and cross-subsidy in telecommunications in the perspective of the vertically integrated firm, the industry, and the economy.

The structure of the report is subdivided into three parts. The first part (sections 1 and 2) outlines the main characteristics of the Canadian telecommunications industry in service production and equipment manufacturing. Emphasis is given to the regulated environment, the institutional context, particularly the existence of the Trans Canada Telephone System (TCTS), the ownership of the telecommunications companies and the extent of the concentration in the industry.

The second part (sections 3 and 4) constitutes a review of the theories of vertical integration and technological innovation. It concentrates on the incentives to vertical concentration, and its consequences for the industry and the economy as a whole. It also considers the impact of market structure on technological innovation and reviews empirical evidence concerning the influence on innovation of different factors such as firm size, monopolization, and regulation.

The third part (section 5 and 6) attempts to determine the impact of vertical integration on the Canadian telecommunications industry. The emphasis is directed at discovering some pattern in the purchasing policies adopted by the common carriers, and also attempts to define the cross-subsidization issue in the context of vertical integration, particularly when speaking of pricing policies and technological innovation.

Thus, the objective of the report is an examination of the issues of vertical integration, technological innovation, and cross-subsidization in the Canadian telecommunications industry, and the relation both from the viewpoint of the vertically integrated firm and the economy as a whole. This report must be considered as preliminary. The report is gathering up a bunch of information relative to the above-mentioned topics which may be judged somewhat disparate; however, we view that approach as the first step toward a clearer and deeper understanding of the relevant issues. In fact, that phase was mainly devoted to establishing the kind of information that could be available at both the theoretical and practical levels, and to attempt to determine in what direction attention should be focussed. In a second phase, we hope to get closer by some empirical measurement and to be more able to provide an indepth examination of several guidelines for effective regulatory policy.

1. Tour d'horizon institutionnel

1.1 Définition de l'industrie des télécommunications

La présente étude porte sur l'industrie des télécommunications canadiennes. Il convient donc, à prime abord, de la définir.

Une description par les services devient de plus en plus difficile, car, le téléphone deviendra vidéophone, les données seront transmises par téléphone et les émissions de télévision seront diffusées sur ruban magnétique. Ainsi, pour résister au temps, cette définition devra être reliée à la signification économique de l'activité des entreprises et non pas à la description du produit.

Le principe adopté stipule que les biens et services dont les ventes s'accroissent, lorsque le prix d'un produit augmente, font tous partie de la même industrie. De ce fait, nous sommes en présence de demandes à élasticités croisées positives. Ceci signifie que l'industrie englobe l'ensemble des substituts permettant de remplir les quatre fonctions qui lui sont assignées:

- transmettre les communications à longue distance
- fournir le système de commutation par lequel les communications sont distribuées
- rendre opérationnelles les boucles du service local
- produire l'équipement du terminal de base

Nous y retrouvons des compagnies de téléphone, de radiodiffusion, de télédistribution, de cablodistribution, et de manufacturisation d'équipement connexe aux télécommunications tels les centraux téléphoniques, le matériel de commutation, les appareils de transmission de données, les fils et cables électriques, les ordinateurs, les satellites, etc.

1.2 Description de l'environnement réglementé

Pour des fins d'équité et d'efficacité, les compagnies offrant le service téléphonique, bien considéré d'utilité publique, demeurent fortement réglementées. Trois d'entre elles se trouvent sous la juridiction du CRTC et possèdent une charte fédérale. Il s'agit des Télécommunications du Canadien National, de Bell Canada et de la Compagnie de Téléphone de la Colombie Britannique, lesquellles desservent 71.07% des consommateurs canadiens(1). Les autres, plus nombreuses, mais ne constituant que 28.93% du marché, possèdent une incorporation provinciale et sont réglementées, dans la majorité des cas, par le conseil d'utilité publique de leur province. Parmi les douze plus importantes nous y retrouvons:

- Newfoundland Telephone Company Limited
- The Island Telephone Company, Limited
- Maritime Telegraph and Telephone Company, Limited
- The New-Brunswick Telephone Company, Limited
- Québec-Téléphone
- Télébec Limitée
- Téléphone du Nord de Québec Incorporée
- Téléphone du Nord Limitée
- Ontario Northland Communications
- Manitoba Telephone System
- Alberta Government Telephones
- Okanagan Telephone Company

Edmonton Telephones, dont la réglementation provient des représentants élus de la ville d'Edmonton, et celle de Saskatchewan Telecommunications qui est soumise à un conseil de directeurs, désigné par le cabinet et constitué du ministre des téléphones et d'un comité siégeant à la législature du parlement de Saskatchewan, font exception à la règle.

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(1) Voir tableau 1

TABLEAU 1

Proportion du nombre total de téléphones canadiens offert par compagnie

Numéro associé	Nom de la compagnie	% de téléphones
1	Newfoundland Telephone Company Limited	1.14
2	Télécommunications du Canadien National	0.54
3	The Island Telephone Company, Limited	0.37
4	Maritime Telegraph and Telephone Company, Limited	2.99
5	The New-Brunswick Telephone Company, Limited	2.44
6	Bell Canada	60.03
7	Québec-Téléphone	1.65
8	Télébec Limitée	0.38
9	Téléphone du Nord de Québec Incorporée	0.52
10	Téléphone du Nord Limitée	0.47
11	Ontario Northland Communications	0.01
12	Manitoba Telephone System	4.35
13	Saskatchewan Telecommunications	3.21
14	Alberta Government Telephones	5.99
15	Edmonton Telephones	2.51
16	Okanagan Telephone Company	0.71
17	British Columbia Telephone Company	10.50
18	Autres compagnies	2.19

1.3 Propriété des installations

Certaines provinces ont préféré substituer des compagnies d'état à la réglementation d'entreprises privées. L'Alberta, le Manitoba et la Saskatchewan desservent de cette manière 17% du marché canadien de la téléphonie,(1) tout en possédant 21% de la valeur globale des installations(2) des neuf plus grandes compagnies opérant au Canada.

Nous retrouvons aussi deux entreprises importantes de propriété mixte. Une dans le domaine de la programmation, où le Canadien National, une corporation fédérale, et le Canadien Pacifique, une entreprise privée, constituent un consortium qui fournit des services de téléimprimeurs, de transmission de données et de transmission radio ou visuelle, et une autre dans l'exploitation du système national de satellites, puisque Télésat Canada est détenue conjointement par le gouvernement et les principales sociétés de télécommunications du pays.

Cependant, l'industrie canadienne des télécommunications demeure, dans une grande proportion, la propriété d'actionnaires. Cette caractéristique la différencie fortement du monopole d'état par lequel plusieurs pays d'Europe diffusent le service téléphonique. Aux Etats-Unis, par ailleurs, cette tendance à la possession privée des équipements est plutôt similaire, ce qui explique en partie pourquoi plusieurs études du cas canadien relatent souvent l'expérience américaine.

Il nous sera difficile de ne pas en faire un point de référence, puisque de plus, nos voisins du sud ont introduit une certaine forme de concurrence dans leur industrie des télécommunications, et plusieurs conséquences de cette libéralisation furent analyser empiriquement.

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(1) Voir tableau 2
(2) Voir tableau 3

TABLEAU 2

Neuf des plus grandes compagnies de téléphone au Canada

Compagnie*	Propriété	% de téléphones
4 (MTT)	Privée	2.94
5 (NBT)	Privée	2.44
6 (Bell)	Privée	60.03
7 (Québec Tel.)	Privée	1.65
12 (MTS)	Publique	4.35
13 (Sask. Tel.)	Publique	3.21
14 (AGT)	Publique	5.99
15 (Edmonton Tel.)	Publique	2.51
17 (B.C. Tel.)	Privée	10.50
TOTAL		93.67

Filiales et participation minoritaire de Bell Canada sur le marché de la téléphonie

1-	Newfoundland Telephone Company Ltd détenue à	78.2%
4-	Maritime Telegraph and Telephone Company Ltd détenue à	41%
5-	The New-Brunswick Telephone Company Ltd détenue à	41%
8-	Telebec Limitée détenue à	100%
9-	Telephone du Nord Limitée détenue à	99.8%

* Voir tableau 1

TABLEAU 2 (SUITE)

Nombre et pourcentage de téléphones par propriété

	Nombre de téléphones	% du total	% du secteur privé
Bell Canada*	7,888,581	64.09	77.35
Secteur privé	10,198,280	82.85	100.00
Secteur public	2,110,359	17.15	
TOTAL DES 9 PLUS GRANDES	12,308,639	100.00	

Pourcentage des téléphones mis en service par Bell Canada et ses filiales dans lesquelles il est majoritaire:

Dans tout le Canada	62%
Parmi les 9 plus grandes	64%
A l'est du Manitoba**	88%

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* inclut seulement les filiales dans lesquelles il est majoritaire

** parmi les 17 plus grandes

TABLEAU 3

Valeur et pourcentage du coût des installations par propriété

	Coût des installations	% du total	% du secteur privé
Bell Canada*	7,423,241,500	60.5	76.2
Secteur privé	9,740,798,000	79.4	100
Secteur public	2,530,449,000	20.6	
TOTAL DES 9 PLUS GRANDES	12,271,247,000	100	

Pourcentage du coût des installations de Bell Canada et de ses filiales pondéré par la proportion des actions qui appartiennent à la maison mère:

Parmi les 9 plus grandes	60.5%
A l'est du Manitoba**	90.2%

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* inclut la valeur pondérée des installations de ses filiales par le pourcentage de détention

** parmi les 15 plus grandes

TABLEAU 3 (SUITE)

Nombre et pourcentage d'employés en service par propriété

	Nombre d'employés	% du total	% du secteur privé
Bell Canada***	36,340	68.68	80.27
Secteur privé	45,274	85.83	100
Secteur public	7,475	14.17	
TOTAL DES 7 PLUS GRANDES	52,749	100	

Pourcentage des employés au service de Bell et de ses filiales dans lesquelles il est majoritaire:

Parmi les 7 plus grandes	68.68%
A l'Est du Manitoba****	91.58%

*** inclut que les filiales dans lesquelles il est majoritaire

**** parmi les 7 plus grandes

2. Organisation du marché

2.1 Organismes et associations

Comme nous l'avons préalablement souligné, le pouvoir omniprésent de réglementation est représenté par le Conseil de la Radiodiffusion et des Télécommunications Canadiennes (CRTC). Il s'agit d'une agence indépendante du gouvernement fédéral, mais qui relève de la responsabilité du Ministre des Communications. Cet organisme doit approuver les hausses de tarifs pour les rendre effectives, mais il n'a pas juridiction sur les procédures de division, parmi les compagnies, des revenus provenant des appels interurbains qui traversent plusieurs territoires.

Ces schémas de partage et l'existence d'un service téléphonique transcontinental canadien, véritablement national, sont assurés par le Réseau Téléphonique Transcanadien (RTT) formé de Télésat Canada et de neuf grandes firmes agissant au pays, en vertu d'une simple entente entre eux. Ce groupe informel, qui inclut toutes les utilités majeures du téléphone, coordonne les services longue distance des différents membres et résoud les conflits d'intérêt entre chaque entreprise et la collectivité. Grosso modo, la gestion, la surveillance, le contrôle et la maintenance du réseau constituent ses fonctions premières.

De plus, dans le but d'encourager le développement du secteur des télécommunications sous toutes ses formes, l'Association Canadienne des Entreprises de Télécommunications (ACET) fut établie en 1972. Elle regroupe la grande majorité des sociétés exploitantes sur une base volontaire.

Poursuivant le même objectif, des organismes gouvernementaux furent créés. D'une part, Téléglobe Canada qui assure les communications avec les pays étrangers, à l'exception des Etats-Unis où elles s'établissent par le truchement des entreprises de télécommunications concernées des deux côtés de la frontière. D'autre part, le Centre de Recherche sur les Communications (CRC) qui exécute un programme de recherche sur les nouvelles techniques de

télécommunications, qui accomplit des travaux de recherche fondamentale et appliquée et qui fournit au ministère conseil et assistance scientifiques en matière de gestion du spectre des fréquences.

2.2 Structure du marché de la téléphonie

Une vue d'ensemble du marché canadien nous porte à croire que les télécommunications du Canadien National et les membre du RTT, sauf Télésat Canada, doivent être considérés comme les maîtres d'oeuvre du marché de la téléphonie(1). Leur marché est délimité géographiquement par les frontières provinciales, sauf pour Bell Canada qui dessert le Québec et l'Ontario et le CN qui a force de loi dans le Yukon et les Territoires du Nord-Ouest.

Le pourcentage de téléphones mis en fonction par la compagnie de téléphone la plus importante, d'une région d'opération donnée, varie de 70% pour l'Alberta à 100% pour l'Ile du Prince Edouard et le Manitoba.(1) De façon concrète, nous ne pouvons parler de duopoles avec meneur qu'en Alberta, à Terre-Neuve et possiblement dans les Territoires du Nord-Ouest, car la présence de Québec-Téléphone au Québec et en Ontario, de même que celle d'Okanagan Telephone Company en Colombie Britannique, sont vraiment marginales, d'où la présence dans l'industrie canadienne des télécommunications de sept monopoles régionalisés(1).

Terre-Neuve	:	Newfoundland Telephone Company Limited
Yukon et Territoires du Nord-Ouest	:	Télécommunications du Canadien National
Ile du Prince Edouard	:	The Island Telephone Company, Limited
Nouvelle-Ecosse	:	Maritime Telegraph and Telephone Company Limited*
Nouveau-Brunswick	:	The New Brunswick Telephone Company Limited*
Québec et Ontario	:	Bell Canada*
Manitoba	:	Manitoba Telephone System*
Saskatchewan	:	Saskatchewan Telecommunications*
Alberta	:	Alberta Government Telephones*
Colombie-Britannique	:	British Columbia Telephone Company*

(1) Voir tableau 4
* Membres du RTT

TABLEAU 4

Proportion de téléphones offerts par compagnie par province (%)

Compagnie*	Terre-Neuve	Ile du Prince Edouard	Nouv. Ecosse	Nouv. Bruns.	Qué.	Ont.	Québec & Ontario	Manitoba	Sask.	Alberta	Colombie-Britannique	Yukon	Territ. du N.-O.	Yukon & Territ. du N.-O.
1 NFT	75.5													
2 TCN	21.9										0**	100	80	88
3 IT		100												
4 MTT			99											
5 NBT				99										
6 BC					89	95.2	92.7						20	12
7 QT					6.3		2.6							
8 T					1.5		0.6							
9 TNQ					2		0.8							
10 TN						1.2	0.7							
11 ONC						0**	0**							
12 MTS								100						
13 ST									89					
14 AGT										70				
15 ET										29				
16 OT											6			
17 BCT											92			
18 autres	2.6	-	1	1	1.2	3.6	2.6	-	11	1	2	-	-	-
TOTAL	100	100	100	100	100	100	100	100	100	100	100	100	100	100

*Voir tableau 1

** Ces compagnies sont présentes mais leur part est infinitésimale.

Comme nous pouvons le constater, en associant une entreprise téléphonique à chaque région du Canada comme précédemment, la principale entreprise téléphonique de chaque province ou de chaque région d'exploitation du service, à l'exception des Télécommunications du Canadien National, est aussi membre du RTT.

2.2.1 La place de Bell Canada dans l'industrie des télécommunications

La plus importante de toutes les entreprises de télécommunications au Canada demeure sans conteste, Bell Canada, qui détient 62% de tout le marché canadien et 64% du marché des neuf plus grandes firmes exploitantes au Canada, qui elles, composent 94% de l'ensemble de la téléphonie canadienne(1). Puisque les sept plus grandes y englobent 90%, nous pouvons dès lors extrapoler sans risque d'erreurs astronomiques. Entre autre, un fait intéressant à noter, Bell Canada et ses filiales, dans lesquelles il est majoritaire, contrôlent 88% des téléphones et 92% des emplois de cette industrie à l'est du Manitoba. Une autre constatation, la valeur des installations de Bell Canada et de ses filiales, pondérée par le pourcentage des actions détenues par Bell, totalise 90% de la valeur totale des plans situés dans la même région(2).

A première vue, il semble évident que Bell monopolise tout l'est du Canada. D'une part, cette impression tient au fait que l'importance du marché québécois et ontarien est considérable. En effet, 90% du nombre de téléphones installés à l'est du Manitoba s'y retrouve et Bell en contrôle 92.79%. C'est aussi grâce à eux que Bell peut prendre une si grande importance dans l'ensemble du Canada, puisque ces deux mêmes marchés soutiennent 65% de la téléphonie canadienne, tandis que Bell ne possède aucune compagnie à l'ouest de l'Ontario. D'autre part, Bell est propriétaire à 78.2% de Newfoundland Telephone Company Limited et détient ainsi 75.5% du marché terre-neuvien de la téléphonie(3). Cependant, les autres provinces de l'Atlantique ne sont pas, théoriquement, sous l'emprise de Bell, car il ne

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(1) Voir tableau 2
(2) Voir tableau 3
(3) Voir tableau 2

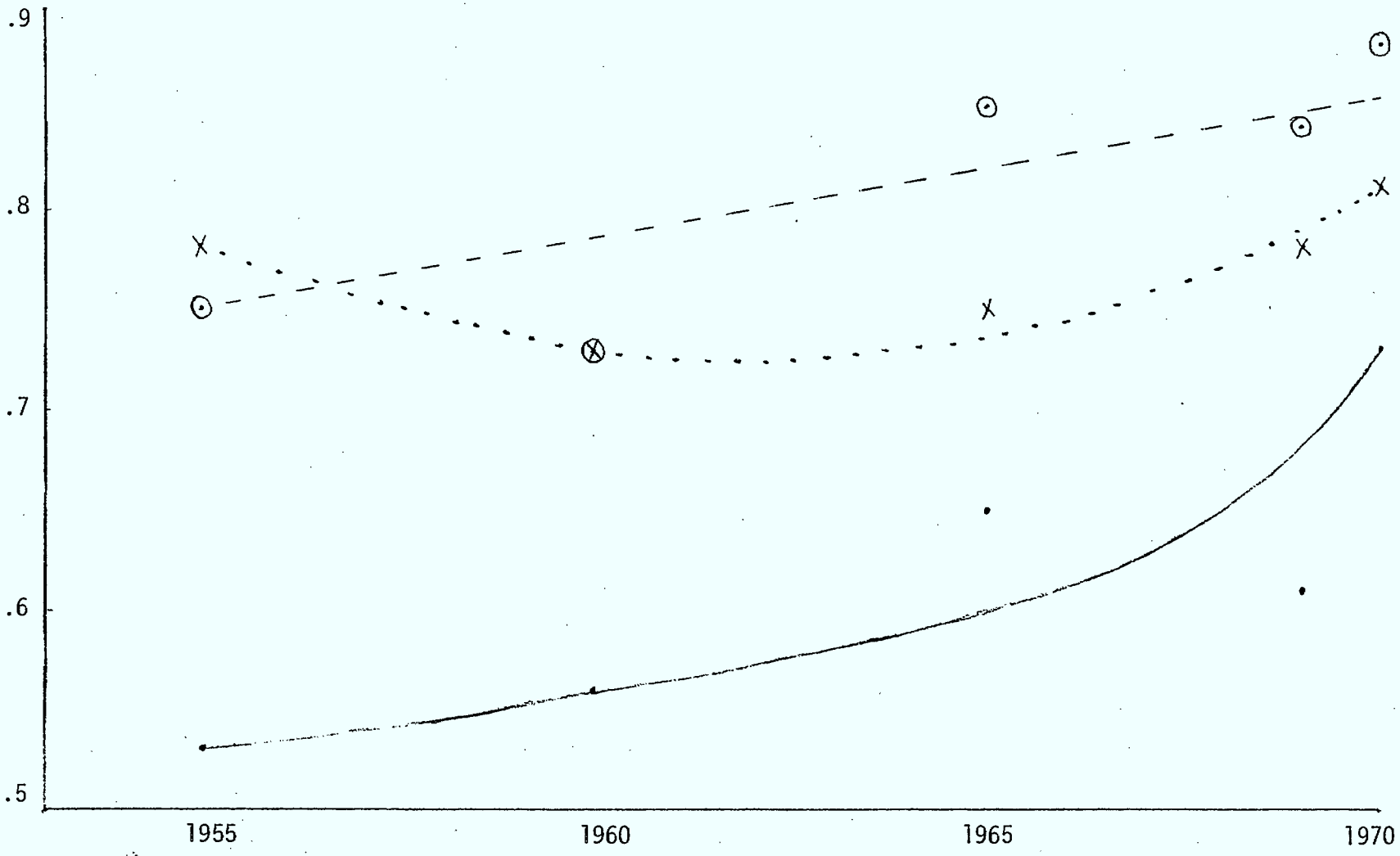
possède que 41% des actions de The New Brunswick Telephone Company Limited et de Maritime Telegraph and Telephone Company Limited et il n'est pas actionnaire de The Island Telephone Company Limited.

Malgré tout, il se pourrait que Bell ait une certaine influence ou un effet d'entraînement sur l'administration de ces compagnies indépendantes. Par exemple, le Contempra ou le téléphone à boutons-pressions (touch-tone) ont-ils été mis en service en même temps dans les Maritimes qu'au Québec et en Ontario? Le passage du "Step by Step" à la commutation électronique, en passant par le "Crossbar", a-t-il été entrepris au même moment et effectué avec la même rapidité dans ces deux régions? Le même phénomène pourrait se produire avec la venue de la transmission par fibres optiques. Les salaires versés par Bell Canada servent-ils de modèle au Nouveau-Brunswick, à la Nouvelle-Ecosse et à l'Ile du Prince Edouard?

Un élément de réponse à la dernière interrogation nous est fourni par le graphique 1. Nous y constatons en effet, que le rapport du salaire moyen de ces trois compagnies des Maritimes sur le salaire moyen des employés de Bell suit une fonction croissante du temps. Cette situation laisse croire que Bell représenterait un leader et que les syndicats des Maritimes s'en inspireraient lors de leurs revendications salariales. Il se peut aussi que la régie de service publique soit plus large en ce qui concerne les augmentations que l'est le CRTC. En ce qui concerne la force d'attration de Bell et son contrôle pratique de la situation, l'indice requis demeure la provenance des achats d'équipement de ces entreprises. Malheureusement, ces données ne sont pas facilement disponibles. En conséquence, pour les fins de notre étude, nous insisterons plus particulièrement sur la présence de Bell Canada au Québec, en Ontario et à Terre-Neuve.

Graphique I

Graphique du rapport du salaire moyen sur le salaire moyen des employés de Bell par compagnie par année



Terre-Neuve: Points: . Courbe :————————
Nouveau-Brunswick: Points: ⊙ Courbe :- - - - - - - - - - - -
Nouvelle-Ecosse: Points: x Courbe :.....

2.3 Structure du marché de la fabrication d'équipement de télécommunications

Une vue globale du marché canadien, parsemé de 95 compagnies en 1976, laisse sous-entendre que la concurrence y règne[1]. En effet, malgré l'importance de Northern Telecom, qui emploie 32% des travailleurs de l'industrie canadienne de fabrication d'équipement de télécommunications, il demeure que les 9 autres plus grandes en détiennent individuellement de 1.7% à 5.9%, alors que les 85 autres se partagent les 36.7% qui reste. Une fois de plus, il nous faut analyser les marchés provinciaux pour bien dégager le rôle de chacune d'elles.

Comme nous l'avons vu dans la section 2.2, le marché de la téléphonie est très régionalisé. Afin d'économiser du transport, du temps et d'épargner sur les coûts de transaction, pour ainsi devenir plus efficace, nous pouvons nous attendre à ce que les compagnies offrant le service téléphonique s'approvisionnent particulièrement chez les fournisseurs situés dans leur région d'exploitation. Ce qui corrobore l'instauration, par Northern Telecom, d'usines de fabrication dans les Prairies peut aussi provenir d'une politique d'achat chez nous puisque les compagnies téléphoniques sont possédées par les provinces dans cette région. Cette politique d'expansion lui permit de se tailler une place égale à sa moyenne nationale au Manitoba, en Saskatchewan et en Alberta[2].

Au Nouveau-Brunswick, où Bell possède à 41% le service téléphonique, Northern est le seul fabricant de produits de télécommunication et nous retrouvons une situation équivalente en Colombie Britannique, où General Telephone and Electronics, l'actionnaire majoritaire de British Columbia Telephone Company, garde à son service 83% des employés de la Colombie Britannique qui oeuvrent dans le domaine de la manufacturisation du matériel de télécommunications. En Nouvelle-Ecosse, en Saskatchewan et en Alberta nous faisons face à un duopole, car les deux principales entreprises de chaque province se partagent respectivement

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(1) Voir tableau 5
(2) Voir tableau 6

TABLEAU 5

Nombre et pourcentage d'hommes employés par fabricant d'équipement de télécommunications dans l'ensemble du Canada

Compagnies	Nombre d'employés*	% du total	% des 10 plus grandes
Northern Telecom	11,000	32.1	50.7
Canadian Marconi Company	2,000	5.9	9.2
GTE	1,785	5.2	8.2
CAE Electronics Ltd	1,250	3.6	5.7
Control Data Canada Ltd	1,250	3.6	5.7
Litton Systems Canada Ltd	1,250	3.6	5.7
RCA Limited	1,100	3.2	5.1
Collins Radio Company of Canada Limited	750	2.2	3.5
Marsland Engineering Ltd	750	2.2	3.5
ITT Industries of Canada Ltd	570	1.7	2.7
TOTAL DES 10 COMPAGNIES	21,705	63.3	100

Compagnies	Nombre d'employés par co.	% du total par co.
18 autres compagnies	350	1
67 autres compagnies	150 ou -	.4 ou -

Total Canada: 34,268 employés

* La médiane de leur tranche de taille

TABLEAU 6

Compagnies	Nombre d'employés par co.	% du total par co.
NOUVELLE-ECOSSE		
Hermes Electronics Ltd	350	70
Northern Telecom Canada Ltd	150	30
Total Nouvelle-Ecosse: 502 employés		
NOUVEAU-BRUNSWICK		
Northern Telecom Canada Ltd	75	100
Total Nouveau-Brunswick: 75 employés		
QUEBEC		
Northern Telecom Canada Limited	4,400	45
Canadian Marconi Co.	2,000	20
CAE Electronics Ltd	1,250	13
Central Dynamics Ltd	350	4
Farinon Electric of Canada Limited	350	4
RCA Limited	350	4
TOTAL DES 6 COMPAGNIES	8,700	90
23 autres compagnies	150 et -	1.5 et -
Total Québec: 9,871 employés		

TABLEAU 6 (SUITE)

Compagnies	Nombre d'employés par co.	% du total par co.
ONTARIO		
Northern Telecom Canada Limited	6,000	28
Control Data Canada Limited	1,250	6
Litton Systems Canada Limited	1,250	6
Collins Radio Company of Canada Limited	750	4
Marsland Engineering Limited	750	4
RCA Limited	750	4
ITT Industries of Canada Limited	500	2
TOTAL DES 7 COMPAGNIES	11,250	54
51 autres compagnies	35 et -	1.7 et -
Total Ontario: 21,155 employés		
MANITOBA		
Northern Telecom Canada Limited	150	49
Quality Communication Products Limited	75	24
ITT Industries of Canada Limited	35	11
GTE Lenkurt Electric Limited	35	11
Cook Electric Company of Canada Limited	15	5
Total Manitoba: 310 employés		

TABLEAU 6 (SUITE)

Compagnies	Nombre d'employés par co.	% du total par co.
SASKATCHEWAN		
GTE Lenkurt Electric Limited	150	58
Northern Telecom Canada Limited	75	29
ITT Industries of Canada Limited	35	13
Total Saskatchewan: 260 employés		
ALBERTA		
GTE Automatic Electric Limited	350	59
Northern Telecom Canada Limited	150	25
Reliable Communication and Power Products Ltd	75	13
Quindor Products Ltd	15	3
Total Alberta: 590 employés		
COLOMBIE-BRITANNIQUE		
GTE Lenkurt Electric Linited	1,250	83
Anaunda Cutv. Ltd	75	5
Anatek Electronics Ltd	75	5
Spilsburg and Tindall Limited	75	5
Sinclair Radio Laboratories Ltd	15	1
Synaptir Systems Ltd	15	1
Total Colombie Britannique: 1,505 employés		

100%, 87% et 84% des travailleurs affectés à ce marché, tandis qu'au Manitoba nous devrions opter pour un oligopole avec Northern Telecom comme meneur, puisque Quality Communications Products Ltd, ITT Industries of Canada Ltd et GTE Lenkurt Electric Ltd totalisent 46% du marché(1).

En Ontario, malgré les 6000 employés affectés aux usines de Northern Telecom face à un nombre global de 21,155 dans toute la province, le marché semble tout à fait concurrentiel. Pour appuyer cette anticipation, notons que la deuxième entreprise en importance ne représente que 6% de ce dernier et que les 51 compagnies de moins de 350 employés en réunissent 46%. Chacune d'entre elles n'exige que 0.9% en moyenne de la main-d'oeuvre totale associée à cette industrie, d'où une faible, voir une imperceptible influence sur les prix.

Au Québec la situation demeure plus ambigüe, car Canadian Marconi Company, malgré ses 2000 employés, ne représente pas vraiment le second vendeur de produits recherchés par la téléphonie. Sa production, quoique très diversifiée, s'adresse surtout à l'avionique, aux communications maritimes, aux diffuseurs et aux besoins militaires. L'importance de Northern s'en trouve rehaussée puisque CAE Electronics Ltd ne requiert que 28% des besoins en main-d'oeuvre de Northern Telecom. RCA, Farinon et Central Dynamics se font la lutte pour la troisième place; cependant ils peuvent difficilement espérer concurrencer Northern puisqu'ils ne fabriquent que des éléments de systèmes dont Bell a besoin. Alors, nous pouvons conclure que Northern a le contrôle au Québec aussi, d'autant plus que les 23 autres compagnies opérant au Québec n'embauchent que 10% des hommes disponibles.

Comme nous le constatons, la définition de l'industrie des télécommunications, qui varie d'une étude ou d'un tableau statistique à l'autre, nous rend la tâche encore plus difficile. Il importe, par exemple, de savoir quels biens d'équipement produit précisément une compagnie. Un autre feuillet de Statistique Canada nous donne une vision totalement autre du marché national. Nous y remarquons que la valeur des livraisons de produits d'équipement de télécommunications s'élevait à $1,368,086,[illegible]0

(1) Voir tableau 6

au Canada en 1975[1], alors que le revenu des ventes de Northern Telecom Limited atteignait $1,018,382,000, ce qui correspond à 74% de la production canadienne[2]. Cependant, notons qu'environ 10% du chiffre d'affaires de Northern Telecom provenait des Etats-Unis[3]. D'un autre côté, l'industrie canadienne de la téléphonie importe une partie du matériel qui lui est requis et ceci annule en partie l'effet dégongleur de la part de Northern dans la production canadienne soulevé dans l'affirmation précédente. Par ailleurs, la classification de Statistique Canada pourrait laisser de côté des entreprises dont la fabrication principale n'est pas destinée à l'industrie des télécommunications, mais à l'inverse elle pourrait inclure la valeur totale des ventes d'une compagnie sans la pondérer par la part qui est dirigée vers l'industrie qui nous concerne.

Tenir compte de ces éléments modifie à la hausse ou à la baisse la dépendance des compagnies canadiennes de téléphone vis-à-vis Northern. Quoi qu'il en soit, il demeure évident, d'une part, que Northern Telecom, avec ses 25 installations manufacturières au Canada, dont 15 sont situées au Québec et en Ontario, constitue le plus grand fournisseur d'équipement de télécommunications pour les entreprises canadiennes[4]. D'autre part, Northern Telecom est au sizième rang dans le monde en ce qui concerne la vente d'équipement de télécommunications et ce fait n'est pas sans influencer son développement.

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(1) Statistique Canada 1975, pp. 43-206.
(2) The Financial Post Corporation Service, 2 décembre 1976.
(3) "Northern s'implante de plus en plus aux Etats-Unis", Le devoir, mardi le 1er novembre 1977.
(4) The Financial Post Corporation Service, 3 avril 1978.
De façon plus précise, dans un article intitulé "Case for Splitting Northern Telecom from its parent has still to be made", paru dans le Financial Post du 11 septembre 1977, Robert Jamieson estime que 70% de la valeur des achats sur le marché canadien provient de Northern.

2.4 Interdépendance des deux marchés

Nous n'avons pas de données nous permettant d'établir la part précise de la valeur des achats annuels de Bell effectués chez Northern; cependant, il convient de considérer ce dernier comme son plus grand fournisseur. D'ailleurs, nous pouvons lire dans le Rapport Annuel 1975 de Bell Canada,..."la Northern Telecom reste toujours pour Bell Canada une source sûre d'approvisionnement en matériel de télécommunications de qualité". Cette assurance, ainsi que nous l'analyserons dans le prochain chapitre, se maintient plus facilement lorsque la compagnie de téléphone possède celle qui fabrique le matériel nécessaire à la diffusion des services de télécommunication.

Nous observons le phénomène inverse en Colombie-Britannique. En effet, General Telephone and Electronics, le cinquième plus gros fabricant d'équipement de télécommunications au monde(1), détient 50.82% des actions de British Columbia Telephone Company par l'entremise d'Anglo Canadian Telephone Company(2).

Notons qu'une analyse empirique plus approfondie de ce que nous sommes en droit d'appeler l'intégration verticale deviendrait réalisable si nous possédions les données permettant d'élaborer, entre autres choses, le tableau 7.

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(1) "Case for Splitting Northern Telecom from its parent has still to be made", Financial Post, 17 septembre 1977.
(2) Rapport Annuel 1977 de British Columbia Telephone Company.

TABLEAU 7

Valeur des ventes annuelles par compagnie de fabrication et par types de produits

Compagnie / Produit	A	B	C	D	ECT
Poteaux Fils Câbles Fibre-optique Micro-onde TOTAL TRANSMISSION					
Commutation manuelle Commutation pas à pas Commutation Crossbar Commutation électronique Terminaux TOTAL COMMUTATION					
   TOTAL MULTIPLEXAGE					
Téléphones réguliers Contempra Téléphones à clavier TOTAL RECEPTION					
TOTAL					

TABLEAU 7 (suite)

Valeur des achats annuels par compagnie de téléphone et par type de produits

Compagnie / Produit	A	B	C	D	ECT
Poteaux Fils Câbles Fibre-optique Micro-onde TOTAL TRANSMISSION					
Commutation manuelle Commutation pas à pas Commutation Crossbar Commutation électronique Terminaux TOTAL COMMUTATION					
TOTAL MULTIPLEXAGE					
Téléphones réguliers Contempra Téléphones à clavier TOTAL RECEPTION					
TOTAL					

3. Théorie de l'intégration verticale

3.1 Définition de l'intégration verticale

Plusieurs volumes, comme vous pourrez le constater en feuilletant la bibliographie, traitent des incitations, des avantages, des inconvénients et des conséquences de l'intégration verticale, mais aucun à notre connaissance nous en propose une définition claire et précise. Afin de bien savoir de quoi l'on parle, nous allons proposer une définition économiquement soutenue de l'intégration verticale. Ce n'est évidemment pas facile avec la multitude de facteurs qui peuvent l'entraîner, mais nous pouvons tout de même élaborer un comportement de base qui, dès qu'il est observé, justifie l'appellation d'intégration verticale. Il s'agit de la diversification des activités d'une firme par l'achat de facteurs exigés par un processus de production, lui permettant l'auto-suffisance ou une moindre nécessité de recourir au marché d'un bien intermédiaire.

Notons que ce phénomène sera présent que cette fusion se réalise en amont ou en aval puisque le résultat sera le même. Cette définition met donc en relief au moins deux étapes de la transformation de la production d'un bien ou de l'élaboration de l'offre d'un service, alors que l'intégration horizontale se fait par l'achat de processus de production (ou par la location de processus lors de sous-traitance) qui se situent au même stade de production. Dans ce dernier cas, nous constatons qu'à la limite, lorsque le nombre d'entreprises fusionnées tend vers l'infini, l'intégration horizontale équivaut à un monopole.

Discernons tout de suite, deux catégories d'intégration verticale. Il y a celle, plus visible ou plus palpable où les équipements, les immeubles, les formes d'énergie ou les autres produits qui entrent dans la fabrication du bien final ou de consommation sont disponibles chez le complexe intégré. Il y a l'autre, moins évidente où ce sont les différents services connexes à la production qui y sont intégrés. Prenons un exemple au hasard, le cas de l'industrie des télécommunications où Bell Canada produit lui-même ses équipements par sa filiale Northern

Telecom. Il ne faut pas croire qu'une entreprise téléphonique ou autre, qui emploie de façon permanente un comptable, un avocat ou un courtier, répond à la définition. Nous constatons, au même titre que les employés réguliers attitrés à la production, que tous s'affairent à la bonne, saine, loyale et rentable diffusion du service téléphonique. Cependant, le service de recherche et de développement de Bell Canada influence le mode de diffusion du service téléphonique par la découverte de nouveaux procédés de fabrications et par la création de nouveaux produits qui se concrétiseront par l'implantation de nouveaux équipements qui seront élaborés et confectionnés à une étape inférieure à la diffusion de ce service.

Les chercheurs renseignent les dirigeants de Bell-Northern sur les dernières innovations technologiques. Lorsque ce groupe décident d'en adopter une nouvelle ou d'ouvrir un nouveau marché ils modifient le processus de production des stades inférieurs. L'annexion à une entreprise d'un centre de recherche et de développement peut être considérer comme l'intégration verticale d'un service, car il s'agit vraiment d'un facteur de production prenant la forme d'un service qui pourrait être acheté en quantité variable de plusieurs centres indépendants.

Le plus hasardeux demeure la détermination du niveau ou des degrés d'intégration. Pour y parvenir, deux facteurs importants entrent en jeu:

- Le nombre d'échelons des multiples passages, entre la matière première et le produit final, qui sont sous la gouverne de la firme.

- Le pourcentage du bien (service) intermédiaire produit (offert) par la firme intégrée.

Le premier facteur démontre bien la puissance du complexe Bell-Northern en y attribuant, en 1975, cinq degrés d'intégration. En effet, la plus importante compagnie offrant le service téléphonique au Canada demeure, depuis 1962, l'unique propriétaire de Northern Telecom Limited,

le plus important fabricant d'équipement de télécommunications au Canada. En 1971, les deux compagnies se joignent pour former Bell-Northern Research Limited, afin de devenir largement auto-suffisant en dessin, plan et technologie. Déjà, en 1969, Northern contrôlait Microsystems International Limited qui produisait les composantes stables du matériel de télécommunications, tel les semi-consducteurs les circuits intégrés, les systèmes microélectroniques et les circuits électroniques incluant les transistors, les diodes, les résistances, etc... Finalement, en 1972, Medco Limited, filiale de Northern Telecom, permettait la distribution industrielle de l'équipement électrique et électronique sur une base nationale. En 1975, elle devenait le plus gros distributeur de produits de télécommunication au Canada.

Malheureusement, suite à une absence considérable de données, il semble impossible d'évaluer dans quelle proportion Bell s'autosuffit à chacun de ces échelons.

3.2 Incitations à l'intégration verticale

3.2.1 Considérations de failles de marché

Une des hypothèses de la théorie économique du comportement du producteur soutient que l'entrepreneur rationnel désire maximiser le profit qu'il obtient à partir de sa production et de la vente de ses produits. Puisque cette espérance de gain a toujours motivé les producteurs lors de la prise d'une décision, il en est de même lorsque l'intégration verticale devient une alternative envisageable. Par exemple, Bell Canada achète Northern Telecom si Bell y discerne la possibilité d'augmenter ses profits. Pour voir comment cela se présente dans la réalité, remontons quelques années en arrière.

Avant l'intégration, Bell se procurait le matériel nécessaire à la bonne diffusion du service téléphonique chez des fabricants d'équipement de télécommunications indépendants. S'il constate qu'il peut produire tous ses équipements à un coût inférieur au prix qu'il paie, incluant le taux de rendement sur le capital investi, Bell Canada sera incité à les fabriquer lui-même. Ainsi, il peut

1) soit faire concurrence aux producteurs existants en construisant une nouvelle usine, en y installant de la machinerie neuve et en recrutant du personnel qualifié,

2) soit, une solution souvent plus économique et moins risquée, devenir propriétaire d'une compagnie déjà opérante qui va lui vendre le matériel désiré au prix coûtant.

En résumé, l'intégration verticale se réalise lorsque l'achat d'un processus de production de biens intermédiaires permet au producteur du bien final, par la manipulation des prix de cession interne, de s'offrir ses facteurs de production à un moindre coût. Cependant, des analyses telles celles d'Allen, de Bernard, et de Williamson démontrent que seules des structures initiales de marché particulières engendrent cette possibilité de profit global plus élevé pour les deux stades de production.

a) Concurrence versus concurrence

Dans le cas où la compagnie d'exploitation et celle de fabrication d'équipement sont toutes les deux en concurrence dans leur marché respectif, la maximisation du profit global, lorsque les deux stades de production sont en possession d'un opérateur commun, nécessite que les prix de cession interne soient égaux au prix du marché[1]. Effectivement, s'ils sont différents, le profit sera supérieur pour l'une et moindre pour l'autre, mais, la somme sera inférieure à celle obtenue avant l'achat du fabricant par l'exploiteur, où le prix du marché prévalait.

Naturellement, une firme peut rechercher l'intégration verticale dans le but d'établir un pouvoir de marché ou de s'assurer une source d'approvisionnement; mais encore là, le mieux qu'elle puisse faire est d'ache-

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(1) Jean-Thomas Bernard en fournit la démonstration dans son article intitulé "L'intégration verticale dans l'industrie minière" paru dans la revue "L'actualité économique" de octobre-décembre 1977.

ter de sa filiale qui produit le matériel et d'offrir à ses clients son bien de consommation aux prix du marché. Par conséquent, il n'y a aucune incitation à l'intégration verticale lorsque les deux producteurs sont en concurrence puisque toutes les transactions doivent, pour permettre la maximisation du profit, s'effectuer au prix du marché.

b) Monopole versus concurrence

L'hypothèse qui veut que le service téléphonique soit offert par un monopole et les équipements de télécommunication par plusieurs compagnies concurrentielles colle assez bien, par exemple, au marché ontarien sectionné ou à la réalité ontarienne prise isolément du reste du Canada. Bell Canada, étant le seul à offrir le service téléphonique, est aussi le seul à acheter l'équipement nécessaire à cette fin. Alors, le monopole sur le marché de la téléphonie est aussi monopsone sur le marché de la fabrication. Cette situation autoriserait Bell Canada à rémunérer le facteur de production que forme le matériel de télécommunications en deçà de la valeur de sa productivité marginale, alors qu'en concurrence cette rémunération égaliserait la valeur de la productivité marginale. Si Bell décide de produire lui-même ses équipements, il peut faire mieux que la concurrence et il perd le loisir d'utiliser son pouvoir de monopsoneur. Ici, il n'y a certes pas possibilité d'augmenter les profits par la fusion.

L'établissement d'un pouvoir de marché ne peut pas non plus être invoqué pour justifier un désir de fusion chez Bell, puisqu'il possède déjà le marché en entier.

c) Concurrence versus monopole

Un exemple où l'on renverserait l'hypothèse, de sorte que la concurrence règne sur le marché de la diffusion du service téléphonique et qu'il n'y ait qu'un producteur de matériel propre à la diffusion, serait empreint d'une incitation au fusionnement, mais ce cas ne concerne pas l'industrie qui nous préoccupe.

d) Monopole versus monopole

Par ailleurs, lorsque les deux stades successifs de production présentent des imperfections de marché, ce qui consiste en une situation probable; par exemple, au Québec, avec la présence de Bell Canada et de Northern Telecom, le fournisseur de biens intermédiaires les vendra à un prix supérieur au coût marginal de production grâce à son pouvoir monopolistique ce qui forcera Bell à acheter une quantité moindre qu'optimale de ces inputs et ainsi à employer une quantité plus qu'optimale de main-d'oeuvre dans son processus de production. L'intégration verticale engendrera des profits plus élevés pour Bell Canada provenant de la baisse du coût du facteur de production fourni par Northern et de la réorganisation du processus de production de Bell, et bénéficiera aussi à Northern suite à la hausse de la quantité vendue de ce même facteur qui elle-même peut engendrer des économies d'échelle de production.

Le monopole bilatéral a fait couler beaucoup d'encre et tous se plaisent à dire que la somme des profits n'atteint pas le profit global que pourrait réaliser un opérateur commun. Il semble bien que sur le plan des structures initiales de marché et de ses imperfections, telles que décrites dans les sections 2.2 et 2.3 du présent rapport, l'analyse empririque favorise l'intégration verticale. Cependant, il n'y a pas que l'augmentation des profits qui justifie une action semblable.

3.2.3 Autres avantages recherchés par les protagonistes

a) Développer des intérêts communs

Offrir le service téléphonique avec efficacité requiert des équipements de longue durée de vie, d'où les conditions d'investissement optimal obligent la tenue de contrats de long terme avec les fabricants. Lors de failles de marché, ce type de contrats implique que les décisions optimales peuvent être contrecarrées par l'opportunisme des vendeurs qui profitent de "package deal" pour déguiser la vraie valeur du matériel. Ceci est d'autant plus vrai que le nombre potentiel de participants à la transaction est petit. Avec l'intégration verticale, les compagnies téléphoniques évitent ce dilemne par

la création d'intérêts communs. Des ajustements dans le temps s'effectuent en coopération pour remplacer ce marchandage opportuniste.

Cette harmonisation d'intérêts permet un usage plus sélectif des bénéfices non pécuniers et un accès direct à l'information. Cette mobilité de l'information objective, à coûts relativement bas, soutient la bonne poursuite des opérations. Les limites de l'intellect humain à recevoir, interpréter et conserver l'information, lacunes dues à la rationalité limitée, se voient contrer par ce besoin d'organisation. Ces économies de communication favorisent l'acquisition de données qui ouvrent la voie à des moindres coûts, puisque l'organisation interne peut plus facilement les compiler.

Etant donné l'importance et les coûts de la recherche, la grande coordination des activités facilitera la rationalisation des changements technologiques, ce qui entraînera sûrement des économies. Ainsi, il sera facile pour la firme monopolistique intégrée de combiner le temps d'utilisation d'un équipement jusqu'à l'obsolescence économique complète avec la mise en opération de la nouvelle technologie qui a pour but de tenir la firme à la fine pointe du progrès.

c) Minimiser l'incertitude

Un autre aspect non négligeable du regroupement réfère à l'impact sur le marché du capital. Lorsque deux firmes se fusionnent, elles mettent tout en commun, elles intègrent même l'incertitude. Dans certains cas, les difficultés du marché à distribuer le risque peuvent créer des incitations à l'intégration. Dans l'industrie des télécommunications,

1) les coûts élevés des équipements,
2) leur durée de vie variable suite à la technologie dévastatrice,
3) la dépendance de la téléphonie de quelques fabricants, laquelle apporte une insécurité d'approvisionnement,

constituent des éléments incitatifs d'importance, car ils sont générateurs de risque. L'organisation interne compresse cette incertitude puisque nous pouvons nous attendre à ce qu'elle fasse apparaître

1) un meilleur ajustement des capacités des différents stages du processus de production,

2) une synchronisation des flux d'entrée et de sortie.

Le risque s'atténuera aussi pour la firme de fabrication d'équipement suite à l'accès garanti au vaste marché de la compagnie exploitante. Ce marché assuré, en plus de diminuer les dépenses en marketing, admettra probablement un élargissement de la production, d'où l'apparition d'économies d'échelle dans la fabrication, car l'étendue du marché favorise la division du travail, et cette dernière favorise la baisse des coûts. Or, la baisse du risque attendu et l'anticipation à la hausse des profits engendrent une telle activité sur le marché des titres que la valeur globale des firmes s'élève. Ceci signifie que deux facteurs influençant la fusion se concrétisent en une autre incitation. Notons, en terminant, que la probabilité jointe de pertes suffisamment grandes pour causer la fermeture de la firme est inférieure à la somme des probabilités pour l'ensemble des firmes indépendantes.

3.3 Conséquences de l'intégration verticale

Ici, nous allons tenter de soulever les implications propres au fusionnement, en laissant de côté celles qui découlent de la monopolisation de l'industrie. D'ailleurs, le pouvoir de monopole est en relation avec le nombre restreint d'offreurs d'un service, tandis qu'une entreprise qui décide de produire ses équipements, sans acheter une compagnie déjà existante, en accroît le nombre.

3.3.1 Effets sur l'industrie

a) Hausse de la productivité

Les entreprises qui s'intègrent soulèvent souvent l'hypothèse stipulant que cette décision encourage la productivité des fac-

teurs de production. Il est vrai qu'une industrie dominée par un très grand établissement, où l'intime collaboration entre le manufacturier et la compagnie d'exploitation règne, conduit, par l'entremise d'une extrême efficacité de la direction des opérations,

1) à la rationalisation de la production réalisable,

2) à l'exploitation des économies externes,

3) à la spécialisation poussée des établissements, des employés et de la production.

Cependant, l'intégration verticale dans l'industrie des télécommunications occasionne une plus petite productivité de la main-d'oeuvre qu'à l'accoutumée, sauf si la demande prend une taille immense, car le produit est fabriqué sur mesure et la conception, la fabrication et l'installation relèvent du manufacturier. Alors, une ligne de production n'implique pas l'automatisation des tâches puisque le produit est hautement technique et requiert des ingénieurs, des dessinateurs et des scientifiques, d'où une méthode de fabrication non-routière. routinière

b) Elévation de barrières à l'entrée

Les effets sur l'industrie consistent en l'élévation des barrières à l'entrée, sinon en l'exclusion pure et simple d'offreurs. Le complexe intégré peut effectivement exclure les concurrents d'une juste compétition, en produisant ses propres biens intermédiaires et en ne permettant pas aux autres producteurs indépendants de lui vendre leurs produits.

3.3.2 Effets sur l'économie

a) Cas du monopole bilatéral

Les effets engendrés sur l'économie dépendent des structures de marché observées. Nous avons vu dans la section 2.2.1 qu'une seule situation particulière pouvant entraîner l'intégration peut représenter la réalité de l'industrie des télécommunications canadiennes. Nous nous

intéresserons donc aux effets sur l'économie de l'intégration verticale favorisée par le cas d) de cette section. Lorsqu'un monopole bilatéral se fusionne, la maximisation du profit global provoque une production plus élevée et un prix plus bas pour le service suite à la baisse du coût du facteur de production fournit par Northern et à la réorganisation de l'agencement des facteurs de la production de Bell. Le profit global plus grand qui en découle engendre aussi un revenu d'impôt plus considérable.

Le bien-être de la société s'en trouve rehaussé de deux façons:

1) les consommateurs de service téléphonique sont directement gagnants puisque la quantité produite augmente et, que le prix des services diminue.

2) Le bien-être de toute la population est indirectement augmenté puisque le revenu d'impôt du gouvernement est plus élevé et qu'il profitera à la population canadienne.

L'importance de la réallocation des ressources, qui constitue la clef du succès du fusionnement pour l'ensemble de l'économie, est liée

1) à l'élasticité de substitution des facteurs de production du bien final,

2) à l'élasticité de la demande pour le bien final.

Ceci signifie que l'importance de la baisse du coût de production du service téléphonique dépend de la facilité avec laquelle Bell peut substituer de la main-d'oeuvre pour du capital et que l'ampleur de la hausse de la production du service téléphonique est déterminée par la quantité supplémentaire de services demandés par les consommateurs suite à la baisse du prix de vente de Bell.

Cependant, Williamson considère que l'organisation interne d'un monopole bilatéral constitue un marchandage socialement improductif mais privément payant. Ce qui justifie la préférence pour de petites firmes en concurrence imparfaite serait l'assurance qu'elles constituent une protection contre une trop grande concentration de pouvoir politique et économique entre les mains d'un seul conseil d'administration d'entreprise.

b) Introduction de l'environnement réglementé

D'une part nous avons traité des résultats faisant suite à l'action d'une compagnie qui s'intègre uniquement dans le cadre de situation distinctes de marché. D'autre part, rappelons-nous que la réglementation s'applique au service téléphonique, mais, non pas à la fabrication d'équipement. En introduisant cet aspect, il existe une possibilité pour le complexe intégré, par le jeu des prix de cession interne, de siphonner des profits vers leurs filiales non-réglementées. D'ailleurs, chez nos voisins du sud, la monopolisation réglementée d'American Telephone and Telegraph associée avec Western Electric, fit ressortir, d'après Alfred Kahn, des coûts excessifs chez les compagnies exploitantes et un report des coûts réduits à l'innovation.

4. The Impact of Market Structure on Innovation

4.1 Introduction

Economics is defined as the allocation of scarce resources to satisfy unlimited wants. In the absence of externalities, increasing returns to scale, and uncertainty, a perfectly competitive market system yields an optimal allocation of the resources, which translates to mean that individual self-interests are compatible with society's interests. That this view of the economic system is quite static for the expansion of the resource base or the development of new technology seems to be forgotten. In fact, technology has been regarded, until rather recently, as a simple parameter influencing the allocation of resources but unaffected by it. The general agreement about the beneficial effect of technological advance on the economy, particularly its positive contribution to the growth in productivity, has necessitated a revision of this view.

The recognition of technical progress as a leading force in the economy, and the importance attached to research and development activity, have reopened the question regarding the allocation efficiency of the perfectly competitive market. Few economists contend that perfect competition efficiently allocates resources for technological change; the point is to what extent can we tolerate the several imperfections present in the market structure? We are thus led to ask the following thorny question:

- what is the effect of firm size on technological change, or are there economies of scale with respect to firm size in the invention process?
- are larger firms spending more on research and development relative to their size than smaller firms, or does the intensity of innovational effort increase with firm size?
- what is the relation between firm size and research output intensity?

- what is the influence of market structure (concentration, intensity of rivalry) on resources devoted to inventive activity and on inventive output?
- has vertical integration a beneficial effect on the inventive process, or do the disadvantages outweigh the benefits?
- what is the impact of regulation on technological change?

Although these issues are very complex, they are of primary importance because technological innovation is crucial to a nation's economy. New technology affects the rate of growth of productivity and the quality of consumption, competitiveness of Canadian products, nature and structure of particular industries, availability and nature of jobs, fortunes of individual firms, and successes obtained in attempting to manage with problems such as energy shortage, environmental pollution, generalized and accelerated communications, and many others. The U.S. Technology Policy, issued in 1977 by the U.S. Department of Commerce, credits technological innovation with 45% of the growth in the American economy between 1929 and 1969, while research and development is credited with increasing productivity by 40%.

These issues are also of paramount importance for the telecommunications industry, and in particular for electronic communications. Donald Cruickshank, President of the Canadian Telecommunications Carriers Association stated recently: "This is a very critical time for the industry. There are some huge technological changes coming. They will bring with them the potential for significant social change. We'll have to proceed cautiously because we don't want to jam things down people's throats." (The Financial Post, June 17, 1978). Some of the new developments in telecommunications he refered to were the electronic transfer of funds, the cashless society, the electronic delivery of mail, and the generalized access to computer data banks via telephone. He continued: "We have to decide what society wants and go from there to decide what will be the shape of our industry of the future".

Another reason that makes these issues critical for the industry is the current round of hearings of the Restrictive Commission on vertical

integration in the telecommunication industry. This Commission is a response to a report issued in December 1976, by the Director of Investigation and Research, under the authority of the Combines Investigation Act, recommending that Bell Canada divests itself of Northern Telecom by offering its shares in the company to its own stock-holders. The report claimed that Northern Telecom has been able to gain 70% of the telecommunications equipment market in Canada because of Bell Canada's captive market. The Director's report attacked the foreclosure of the Canadian market to other suppliers and noted that lack of competition has stifled innovation, reduced the choice of equipment, and raised equipment costs. Moreover, the report noted that the ties between the two companies have hurt the vitality and profitability of Northern Telecom, and have raised insurmountable barriers to new competition.

The remainder of the report analyses the inventive process more carefully in order to make explicit the different states of this activity, and to define the relevant concepts; the various factors influencing the rate of technological innovation and current measures of it are specified. The theoretical and empirical grounds concerning the impact of firm size, market power and regulation on the inventive activity are also reviewed. Finally, all these concepts are applied in order to analyse the influence of vertical integration on technological change in the telecommunication industry.

4.2 Theory of Technological Change

4.2.1 Technological Change: Concepts, Determinants and Measurement

The pool of knowledge pertaining to industrial and agricultural arts is called technology. Given the technology existing at a certain moment in time, there exists a number of different ways of producing an industry's product. The amount of goods produced from a given amount of inputs is limited by the existing technology. The production function shows the maximum output which can be obtained from a fixed amount of inputs, given existing technology.

Technological change is the advance of technology, and results in a change in the production function. Of course, the change in the production function may follow from various types of improvements - lower price of equipment, improved material, new method of producing existing goods, new technique of organization, marketing or management, or new product. The problem of defining technological change this way is that production functions are not readily observable. Thus, there is no way to measure the rate of technological change directly, although indirect measures do exit.

It is worthwhile to distinguish between a technological change and a change in technique. A technological change is an advance in knowledge, while a change in technique is a change in the utilized method of production. Of course, these two concepts are related to one another because the economic impact of a technological change cannot be significant unless it entails a change in technique. The distinction is also important since many changes in techniques do not result from technological advance, but are the consequence of changes in input prices. Further, technological change should be distinguished from scientific advance since many technological innovations do not imply new scientific principles.

What are the major factors determining the rate of technological change in an industry? In addition to knowledge of existing technology, the first factor that appears to influence the rate of technological change markedly is the amount of resources devoted by firms, independent inventors, and government to improve industrial technology. The inventive effort made by the government depends on how closely the industry's output is related to social needs fulfilled by government's activity, the existence and magnitude of externalities produced by relevant research and development, and on other political factors. The amount of resources devoted by firms and independent inventors depends heavily on the expected profitability of their use [15].

If the quantity of resources invested by private sources to improve the industry's technology is influenced by the expected profi-

tability of the investment, this implies that the rate of technological change will be governed by the usual demand and supply factors. Thus, returns obtained from effectuating a technological change will likely be higher if the new technology can reduce the costs of a product whose demand is increasing and if the costs incurred for developing the technology are not too large. Similarly, a technological change has some chance to be realized, even if the development costs are high if there is a chance for any payoff. We can thus argue that technological change is an economic activity pursued for gain, that anticipated gains vary with anticipated sales of goods embodying the innovation, and that expectations of sales for improved capital goods are largely based on present capital goods sales.

Another factor which determines the rate of technological change is the amount of resources devoted by other industries to the improvement of their goods and the other inputs it employs. A technological advance in an industry supplying some material can stimulate technological change among its customers. There is also the possibility of a spillover effect i.e. technology invented for a particular industry can turn out to be useful in many other sectors. Furthermore, the availability and usefulness of foreign technology may be an important determinant of the rate of technological change.

Other factors which influence an industry's rate of technological change are the accessibility to the capital market and the ease of funding. These determinants are of primary importance. Especially if the technological change necessitates high development costs; nevertheless, they are so intimately related to firm size that we shall delay their discussion. (The same can be said about the impact of market structure on technological change. The influence of firm size, concentration and monopolization will be explicitly treated in the following sections).

A final important determinant of the rate of technological change is the presence and extent of basic knowledge, also called technological opportunity. It is possible to argue that high technological

innovation rates occur only over a period of time where there is related, but exogenous scientific progress. If progress in science slows or moves in directions leading to fewer opportunities, it is then likely that technical advance in the industry will slaken.

How technological change can be measured? Probably the simplest and most commonly used measure of the rate of technological change is the variation in output per man-hour of labor. It is a very incomplete index because it is affected by many other factors such as increases in the amount of capital per worker, economies of scale, changes in the proportion of the productive capacity used, and the rate of diffusion of best-practice techniques.

A more adequate measure of the rate of technological change is the so-called total productivity index, which relates changes in output to changes in both labor and capital inputs. Formally, this index is written as follows:

$$\frac{Q}{wL + vK}$$

where Q is the quantity of output (as a percent of output in some base period),

L is the quantity of labor (as a percent of labor input in some base period),

K is the quantity of capital (as a percent of capital input in some base period),

w is labor's share of the value of output (in the base period),

v is capital's share of the value of output (in the base period).

This index has many deficiencies. It must however be emphasized that even the most sophisticated measures of the rate of technological change suffer from several limitations because technological change is measured by its effects, and effects are in turn measured by the increase of output unexplained by other factors. All productivity measures should be used only as rough proxi.

In order to meet particular needs, specific indices can be constructed. Robert Babe [1] did this to test whether vertical integration in the Canadian telecommunications industry entails substantial cost savings. If this were true, greater productivity increases should accrue to vertically-integrated firms than to non-integrated ones. His productivity index took into account growth in real output, the effects of rate increases, and inflationary pressures with respect to costs of labour, capital, and other expense items. More precisely, the constructed index distinguishes between increased revenues due to real growth and increased revenues due to rate increases, and also between increased costs due to increased factor utilization and increased costs due to higher wages, salaries and returns to capital.

4.2.2 The Innovation Process

The previous section has pointed out that the basic determinant of technological change is the amount of resources devoted to improving technology. Thus, the rate and direction of technological change depends on the nature and the magnitude of the research and development carried out. Research and development includes three broad areas: basic research aiming entirely at the creation of new knowledge; applied research, expected to have a specific payoff, and development whose goal is to reduce research findings to practical results. The distinction between research and development often is not well-defined. It depends primarily on the purpose of the work being undertaken, the nature and extent of the uncertainties involved, and the length of time the work can be expected to continue without having any practical return. The bulk of money spent by firms on research and development ends up in development, not research. The private industry is responsible for roughly 20% of all basic research, 65% of all applied research, and 85% of all development performed in the economy.

Research and development activity is characterized by considerable uncertainties, particularly when projects attempt to realize sufficiently large technological advances. There are three kinds of risks associated with R and D programs: the risk of technical non-completion,

the risk of commercial failure (given technical completion), and the risk of economic insuccess (given commercialization). In general, most of the R and D projects carried out by firms seem to present a fairly high probability of technical completion. This appears to result from the fact that, in general, most of the R and D projects financed by the private sector are desired to make fairly modest advances in the state of the technology. This behaviour contrasts with government-financed projects which are more ambitious. In addition, the variations in the percentage of R and D expenditures devoted to research by firms can be an indication of the variation between entreprises of the average estimated probability of technical success of R and D programs and the actual probability of technological completion. Thus, R and D expenditures assigned to research is a quite acceptable surrogate for the riskiness of a firm's R and D program, at least from a technical point of view [17].

Finally, it is worthwhile to recognize that the effectiveness of a firm's R and D department depends heavily of its relations with other parts of the firm, particularly with production and marketing. There is much evidence suggesting that the probability of commercialization and economic success are directly related to the degree to which R and D and marketing functions are paralleled. More precisely, it seems that the probability of commercialization can be, on the average, about 10 percent higher, if marketing and production are able to properly grasp the potential of the projects. Also the probability of commercialization can be approximately 20-30 percent higher, and the probability of economic success can be around 10-20 percent higher, on the average, if marketing and production do a good job in exploiting them properly [16].

Thus far, we have focussed attention on research and development. Despite the obvious importance of these activities, it must be recognized that R and D is only one ingredient in the process leading to the introduction of a new product or process. In fact, empirical findings indicate that R and D expenditures account for about half of the total costs associated with activities bringing in new products or

processes [17]. The amount of resources therefore devoted to innovative activity is considerably greater than indicated by the statistics on R and D expenditures. Moreover, when analysing R and D budgets, care must be taken because the ratio of R and D expenditures to the total costs of innovation can vary among firms of different sizes, industries, countries, or periods of time. Hence, we see that R andD statistics are only one facet of the innovative activity and may be an inadequate measure for differences in the costs of innovation.

These facts have led economists to decompose the process of technological change in three distinct steps: invention, innovation, and diffusion. Invention is the act of conceiving a new product or process and solving the purely technical problems associated with its application, while innovation involves the entrepreneurial functions required to convert a new technical possibility into practice; diffusion is the stage at which a new product or process comes into widespread use.

There are three main reasons why economists have stressed the distinction between invention and innovation: first, an invention has little or no impact on the economy until it is applied as an innovation; second, the inventor and the innovator may be quite different people or organizations; finally, the size of the investment required for innovation is often assumed to be much greater than for invention. However, it must be emphasized that such a three-step model, while serviceable for many purposes, may be too crude an approximation when we want to characterize the entire process of technical change with a deeper insight. For example, the distinction between invention and innovation becomes somewhat blurred in cases where a single firm does both the inventing and innovating. Furthermore, the process of technical change contains several stages including applied research, preparation of product specifications, prototype plant construction, tooling and construction manufacturing facilities, manufacturing start-up and marketing start-up, which may have advantage to be recognized and sorted out in many situations. Although a richer model might be beneficial, the actual availability of relevant data means that we have to confine ourselves to the previous three-step model.

Once than invention is commercially introduced, the diffusion process begins. Like the earlier stages of the activity of creating and assimilating new products and processes, the diffusion of an innovation is a learning process which takes place among the producers of the innovation, as well as among its users. What are the determinants of the diffusion process? Econometric studies indicate that the rate at which a new product or process will be initiated is dependent on the profitability of producing the innovation, the existence and duration of patents for the innovation, and the size of the investment required to produce the innovation; it also depends on the number of rivals the innovator has, and on the relative size of the innovating firm with respect to other producer or customer firms [17].

More specifically, the probability that a firm not using an innovation will adopt it in the next few months is influenced by the proportion of firms in the industry that already are utilizing it. Moreover, the probability that a nonuser will adopt the innovation is higher for more profitable innovations than for less profitable ones, if holding constant the proportion of firms in the industry that are already using it. Finally, the probability that a nonuser will imitate an innovation is higher for innovations requiring fairly small investments, if holding constant the proportion of firms in the industry already using it and the profitability of the innovation. On the other hand, if the assumption is accepted that firms consider themselves unable to determine rival schedule decisions by their own decisions, and if producers are not restrained from penetrating into the new product's market by barriers to entry or capacity bottlenecks, then an increase in the number of rivals or a reduction in the relative size of the innovator can accelerate the pace of imitation.

Another factor influencing the diffusion process is the market structure of the industry. In general, the rapidity with which an innovation spreads throughout the economy increases with the number of firms, and sellers with small market shares are more likely to trigger a rapid pace of imitation than dominant firms, though the latter may retaliate vigorously if their market shares are endangered (preemptive innovation).

Tight oligopoly generally is less conducive to innovation than loose oligopoly, and both are better than pure monopoly.

Another determinant of the diffusion of an innovation which is quite relevant for the telecommunications industry is the tacit collusion or coordination among the firms of the industry. The existence of the TCTS group and the way it operates can have a decisive influence on the innovative process since its main function is to ensure that facilities are available to meet the growing demand for long-distance services, and that the revenues from such services are equitably distributed among the member companies. That influence may be quite important if we remember that most of the firms that are not affiliated to an equipment producer company make most of their purchasing decisions, not through competitive bidding, but rather through negociated contracts. However, the impact of this intercorporate structure may be fairly difficult to identify since very little information is available.

4.2.3 Measurement of Innovative Activity

The consideration of technological change as an economic variable has led us to analyse the process of innovation. Thus, we would be interested in having some measure of the innovative activity, either as innovational output or innovational input. Output measures are still in the experimental stage and do not lend themselves readily to any standardization, while input measures have now often become official statistical series, although there are still severe problems of definition and comparability.

The usual input measures are R and D spending, current and deflated; R and D payrolls, current and deflated; R and D employees; scientists, engineers and technical aides employed; R and D outlays per man, R and D outlays per assets, and R and D outlays per sales. Each of these, as well as other indices of innovational effort, has recognized deficiencies. For instance, technical improvements may not only be developed in the R and D department but also in operating and other divisions. The use of scientific personnel as measures accomodates this phenomenon, but also includes employees with no R and D function or contribution. We can

also utilize modified indices or R and D employment which make a distinction between total and professional R and D personnel.

Other deficiencies of input measures may be attributed to institutional or social distortions. For example, a change in the tax treatment of research expenditures may provide an incentive for firms to classify additional activities as "research". Another possibility is the situation where R and D becomes more fashionable, either because the stimulus of a remarkable advance in technology, or because R and D is viewed more favorably by stockholders. These two cases will both result in significant increases in reported R and D outlays without necessarily implying commensurate increases in R and D activity.

Innovational output usually has been measured by patent applications, patents awarded, important patents awarded, inventions or innovations, important inventions or innovations, estimated sales associated with the introduction of new products. Recognized deficiencies of patents as an output measure include the fact that a patent recipient need not have been responsible for the invention, that patented inventions are of unequal importance, and that some inventions are not patented. However, systematic studies of patenting behaviour have led most economists in the field to conclude that the number of patents received by a firm is an acceptable, usable surrogate for innovative output.

Given these several measures for the inputs and outputs of research activity, we can now ask whether there is a relationship between inventive effort and inventive output. Several econometric studies have revealed many correlations between these two types of series, particularly between the number of scientists and engineers and the number of patents, R and D expenditures in any year and the number of patents issued a firm four years later, the rate of R and D spending and the total number of important inventions forthcoming (given firm size). There seems little doubt that, on the average, a direct, positive relation between innovational effort and innovational output exists. Nevertheless, it is likely true that the transformation may depend on factors other than effort, and it may probably not be linear.

4.2.4 Technological Innovations in Telecommunications

The telecommunications industry has become one of the most technology-based of all industries, and the technology available for supplying Canada's telecommunications needs is undergoing dramatic changes. By changing the methods for meeting various technological constraints, invention and innovation have opened up numerous new possibilities for providing telecommunications services at lower costs and will play an important role in shaping the structure of the industry in the future.

On the other hand, it is often stated that Canada's industrial research effort and its capacity for technological innovation are sagging badly. By almost any measure, the total Canadian expenditure on research and development is deplorably weak, despite the availability of top-notch scientific talent. For example, while R and D spending in Canada almost doubled between 1970 and 1976, it actually accounted for a smaller proportion of gross national product. In 1970, when R and D expenditures totaled $1.1 billion, it was 1.24% of GNP; six years later, spending reached $1.9 billion, but accounted for only 1.03% of GNP. These proportions are quite low if we remember that for United States, West Germany, and Japan, the corresponding figures are a bit higher than 2% of GNP. (The Financial Post, "Our Manufacturing in Jeopardy", November 5, 1977).

How does the industry of telecommunications perform with respect to this abysmal funding for Canadian research and development? Many questions can be raised and several points of comparison could be advanced. However, being constrained by the limited amount of available data, we will restrict ourselves to the following problems:

- what are the major centers engaged in research and development in the Canadian Telecommunications industry?
- what amount of resources is involved in the R and D process?
- what are the most important successes of their innovative activity?

In 1977, the private sector spent $360 million on research and development in Canada; 35% of this amount, i.e. around $130 million, may be credited to the telecommunications industry. The public sector and the universities added another $50 million, which sum to a total amount of $180 million devoted to research and innovation in telecommunications (Journal des Télécommunications, vol. 44, 3, 1977). The bulk of these works and studies was made by two important, specialized bodies, one private, and the other public. The first is Bell-Northern Research Limited, a well-known institution, the most important of all Canadian entreprises engaged in any kind of research; the second is the Center for Communications Research of the Department of Communications of Ottawa.

If we look only at the private sector, we have the following partial table.

Table 1

R and D Leaders in the Private Sector

Companies	Research and Development in Canada	
	1977 spending	Staff
Bell Canada	$112.9 million	2,800
Canadian Marconi Co.	$ 4.9 million	180
Litton Systems Canada Ltd	$ 3.1 million	59
GTE Lenkurt Electric Canada Ltd	$ 2.8 million	107

Source: The Financial Post, June 10, 1978.

The R and D budget for Bell Canada includes R and D spending by Bell Canada and its subsidiaries; the R and D staff for Bell Canada includes R and D staff for Northern Telecom and Bell-Northern Research only. We must also note that the R and D budget and staff for Canadian

Marconi Co. and Litton Systems Canada Ltd are not devoted entirely to telecommunications activities. Despite these remarks, it is clear that Bell Canada is the only company engaged in extensive research and development in telecommunications; most of this activity is carried on within Northern Telecom and Bell-Northern Research Ltd. British Columbia Telephone Co. utilizes the results of research and development activities undertaken in the General Telephone and Electronics System; this research is principally realized in the American territory.

Bell's and Northern Telecom's research and development expenditures have grown rapidly in the past twenty years or so. Estimates provided by Bell indicate that in 1955 Bell Canada spent about $240 thousand and Northern Telecom an additional $500 thousand on activities classified as research and development, for a total of $740 thousand. By 1968, Bell's spending had risen to about $4.0 million, and Northern Telecom's to $36.7 million, for a total amount of $40.7 million. In 1977, the R and D expenditures for all Bell System totalized $112.9 million. Thus, during the first period of 13 years R and D expenditures by Bell-Northern increased 55 times their 1955 level, while in the subsequent period of 9 years R and D spending tripled their 1968 level (Stat. Can.).

One of the main reasons for this fast growth is that, as recently as 20 years ago, Northern Electric Co. (now, Northern Telecom) relied almost entirely for its research and development on Bell Labs through Western Electric Co. Following a consent decree reached in 1956 as an outgrowth of antitrust proceedings, Western Electric agreed to divest itself of subsidiaires not primarily serving the American Bell System. While Bell Canada still has service contract with Bell Labs for obtaining AT and T patents on a royalty-free basis, it has become more and more difficult to get equipment from Western or assistance in the establishment of manufacturing facilities for innovations made on the American territoty. Northern has found it necessary and desirable to foster its own R and D capability in order to facilitate the way it can

meet needs and conditions specific to Canada. It had begun to do research in 1957, and by 1971 the then-large unit became the newly formed Bell Northern Research Ltd.

In 1977, Bell-Northern Research had spent around $70 million for research and development, and had 1,800 employees, of which approximately 1,200 were researchers, engineers or technical aides. The split of revenues between the two parents works out to an expected 62.5% from Northern and 32.9% from Bell; the ownership was recently modified to reflect the new position, being now 70% to Northern and 30% to Bell. Although R and D spending of $70 million is an impressive figure for the Canadian economy, it is only about one tenth that of the giant Bell Laboratories in the U.S. which spent about $700 million in 1977. With such a disproportionate scale of operation, it is hardly probable that Bell-Northern Research will end up with an innovation so important as the transistor or the laser. Some fundamental work is done in its laboratories, but it just cannot be expected to be of the same scope as the work done at Bell in New Jersey.

Bell Northern Research has a string of successes to its credit, many of them modest but they sum up to a total that makes Canada more or less self-sufficient in telecommunications. Its innovations cover a wide variety of new products or services. The major ones are as follows:

- The MDS is a digital central-office switching system processing phone calls. These machines are computer controlled switching systems making numerical multiplexing. They use computer technology and are run by computer programs. Their processing speed, 350,000 phone calls per hour, exceeds that of most commercial computers on the market. Their reliability is many years ahead of their rivals while the average computer may be down several times during the year, DMS can meet the incredibly strict standard of being down no more than two hours in a period of forty years. This sophisticated line of machines has demonstrated Bell-Northern Research's expertise in the computer area since it was the first time a telecommunications entreprise offered a complete

range of equipment for a totally computerized digital switching system. Research and development on this line will have cost a total of $200 million, and the first complete exhibit was ready June 1976.

- The SP-1 is a computer-controlled electronic central telephone office. This electronic telephone switching system has necessitated $80 million of development costs. The payoff, however, has been big. Thus far, $720 million of orders for the system have been received.

- The SL-1 is a private automatic branch exchange that uses digital technology. It was the first time that a reduced volume and a high degree of flexibility in usage are both associated in a fully electronic business communication system. The computer-based SL-1 system automatically places long-distance calls on the most economical route available, and keeps a detailed recording of all calls. It thus provides complete business telephone services in only one package. The success of this innovation is reflected in some lucrative licensing agreements which already have been negotiated with Sweden's Televerket, England's General Electric Co., and France's Thomson - CSF. Typically, Northern receives a straight fee of $1 million for each license, plus some additional royalties.

These three innovations stressed the fact that Bell-Northern has taken a leading role in computerizing and digitizing the telecommunications industry. The introduction of computers and digital networks in telecommunications represents a whole new way of doing business. Digital devices render all signals (voice and data messages) in the same electrical format in which they can be indiscriminately intermixed by time-division multiplexing without entailing increased costs, nor incurring reduced performance or fidelity. The digitized system is readily adapted, as a whole, to new uses simply by changing the terminal equipment, which signifies much more flexibility in the future telephone system. However, we observe that this technological change may involve a noticeable cost disadvantage to users with requirements confined to voice messages, since currently these are most economically carried on an analog transmission system. Finally, it is worthwhile to mention

that Bell-Northern's great interest in the computer field raises again the problem of boundaries for regulation since one has to face the disappearance of the boundary between the telecommunications and computer industries.

- The LD-4 is a coaxial-cable link for long-haul distance and with a high potential capacity. It permits the simultaneous transmission of 20,000 two-way communications, or a combination of television signals, data messages, and voice communications. LD-4 is already a great advance on other carrier systems, including microwave, and puts nearly Bell-Northern a quantum leap ahead in fibre optics. But what BNR researchers essentially are doing is seeking to perfect all the components that go to make a fiberoptics system, i.e. the tiny laser inputs, the output devices, and the small amplifiers required at intervals. At this time, the costs are the main obstacle, but the company seems confident that they will be reducing significantly.

- The "Contempra" and the "Bell 747" are two decorative models of the receiving terminal which may bring in any home the latest refinements of industrial esthetics. There are other decorative models like "1920", "Script", "Imagination", and "Mickey Mouse", but all these were patented by American companies while the first two were created by BNR in 1969 and 1978 respectively. The great success of these sophistications (Contempra is sold in 37 countries) indicates that telephone companies are becoming more and more marketing entreprises.

Finally it should be noted that Bell is working on an electronic telephone whose dial assembly has only 12 components relative to 110 for the current electromechanical telephone.

A last qualification: Bell-Northern Research does some research for clients other than Bell and Northern Telecom. About 42% of its revenues in 1976, i.e. $3 million, were expected from contracts of this kind.

In addition to the activities of Bell and Northern Telecom, research and development in Canadian telecommunications is undertaken by in-

dependent manufacturers. Most of the larger independents, however, are subsidiaries of American companies (R.C.A., General Electric, Westinghouse, Motorola, etc...) and their R and D spendings in Canada are limited and quite specialized.

GTE Lenkurt Electric Canada Ltd is another Canadian entreprise whose production is important and of high quality standard. With a staff of 100 engineers and technicians, its laboratories regularly produce new analog multiplexing systems, hyperfrequency devices, and various control units. One of its last product which has already gained a widespread fame is called System 52. It is a computerized control and command device utilizing large-scale integration technology, and presenting the information in eight colours on a cathodic screen. Before that, an analog multiplexing system, called 46A3-C, had been a big success due principally to its high transmission capacity of 600 circuits, its small volume, and its low cost.

4.3 Firm Size and Innovation

In this section, we will ask whether large firms are, in general, more effective than small firms in making technological innovations and introducing them into commercial practice. We will then review the literature on this subject looking for empirical evidence in a broad sense; that is we shall refer to econometric studies performed on the whole set of industries and whose results which are applicable in general for all the economy. Later, we will inquire whether these conclusions are yet pertinent for the particular case of the Canadian telecommunications industry.

More particularly, the questions to which we will pay close attention to are the following:

- what is the effect of firm size on technological change or are there economies of scale with respect to firm size in the invention process?

- Are larger firms spending more on research and development relative to their size than smaller firms, or is the intensity of innovational effect increasing with firm size?

- What is the relationship between firm size and research output intensity?

The exploration of links between firm size and technological progressiveness were necessitated given that (a priori) hypotheses in favor of bigness were propounded, particularly by J.A. Schumpeter and J.K. Galbraith. The major alleged advantages of size were the following. First, the costs of technological innovation in modern times are so important that they can be supported only by large enterprises. Second, R and D projects are risky as well as expensive and businessmen and investors are generally risk averters which will discourage technical pioneering by small firms. Third, economies of scale may exist in the R and D process, and R and D projects may benefit from scale economies realized in other sectors of the large corporation. Finally, large producers have an obvious advantage in making process innovations since they will imply larger total savings.

Of course, the defenders of bigness admit that there are also disadvantages associated with size. Although large corporations have the ability to average out losses and gains resulting from risky R and D programs, decisions to bear the risks of R and D projects are made by individual managers, not by impersonal enterprises. Moreover, these decisions must filter through a whole chain of command, and the larger the firm, the longer the chain. So, large corporations may curb imaginative innovation, which may drive many of the most creative persons out of a big firm to go at it alone in their own ventures. A related disadvantage of bigness is the propensity for research in large institutions to become over-organized.

To make a global, serious cost-benefit analysis of the impact of firm size on innovation is an unrealistic task. We must therefore gather the information obtained from partial views of the problem. If large firms have an advantage, it is primarily because they can choose R and D program portfolios that include both modest and ambitious projects. Small firms are not necessarily excluded from this approach but they have to face the risks of incomplete hedging. In general, neither insufficient

size nor inadequate funding restrains small enterprises from pioneering the early stages of the innovation process. However, troubles may appear at the development stage, once the time for purely creative thought and small-scale testing is over. The main disadvantage of small firms in the early inventive stages is then the possibility of deficient bargaining power when and if a passage to the development phase becomes necessary.

In general, small firms and independent inventors play a key role, sometimes a disproportionate one, in generating the new ideas and concepts which constitute the necessary base for technological advances. To bring these ideas into economic practice normally requires a significant investment of resources, although not so high that it cannot be met by medium-sized and small firms. There are relatively few advances which necessitate heavy private developmental investment that they can be undertaken with some chances of success only by very large corporations or by medium-sized firms having a particularly high risk tolerance. Thus, we can consider that there is no single firm size which is particularly conducive to technological innovation.

The empirical evidence suggests that innovational effort (for example, R and D expenditures per sales, or the ratio of R and D employees to total employment) tends to increase more than proportionately with firm size up to some point that varies from industry to industry. Beyond that point, innovational intensity appears to be constant or to decrease with firm size [11]. Thus, there appears to be no general tendency for R and D spending per sales to be higher among the giants than among their somewhat smaller competitors, although the size of the enterprise must often exceed a certain minimum for research and development to be profitable [16]. However, large firms spend more on R and D per patent pending than do smaller enterprises [11].

What about innovational output? The available data do not indicate that the inventive output per dollar of R and D is greater among the giants than among their smaller competitors [16]. In addition, when the size of R and D spending is held constant, increases in the size of

the firm are associated with a decreasing inventive output [17]. Furthermore, the number of significant inventions per dollar of R and D expenditures is lower in the largest firms than in the small and medium-sized firms, and patent intensity varies inversely with firm size and increases with R and D effort but shows diminishing returns [11]. So the largest firms barely hold their own in the receipt of invention patents despite their disproportionate share of both government and private R and D spending [22].

Among the largest industrial enterprises, increases in size are not in general associated with a positive intensification of R and D inputs or inventive outputs, and in more cases than not, giant scale has a modest stultifying effect. Sales volumes are consistently more concentrated among the largest firms than R and D employment, which in turn, tend to be lightly more concentrated than invention patents [11]. That is, small firms are responsible for a higher relative share of inventive activity than sales, and the number of patents usually increases less than proportionately with sales among large enterprises.

Up to some point, larger firms tend to devote a larger proportion of R and D spending to basic research, to commit themselves in more technically ambitious projects, and to have longer expected completion time. However, the difference between behavior of the largest firms and that of firms half as large is small [11]. Moreover, small firms contribute more than their proportionate share of innovations in industries characterized by low entry costs, and low capital intensity and development costs. They contribute little, either absolutely or relatively, to innovations in industries of high capital intensity. Thus, the views of Schumpeter, Galbraith, and others, seem difficult to defend. There is little evidence that industrial giants are necessary in most industries to ensure rapid technological innovation and rapid utilization of new techniques. Giant corporations do not, in general, seem necessary to ascertain that the existing amount of fundamental, technically risky, and long-termed R and D is carried out.

Finally, research and development and technical progress can be barriers to entry, particularly in those industries with high technological opportunities. At a minimum, an enterprise must have a strong development and engineering capability to assimilate, imitate, and improve upon the inventions of others. This minimum R and D capacity to maintain a defensive market position, associated with needed marketing and technical service facilities, constitutes a minimum size for entry.

4.4 Monopolization and Innovation

The links between monopoly concentration and technological advance may be seen along two different lines of causation. First, the expectation of reaching a monopoly status with accompanying supranormal profits through successful innovations may instigate enterprises to invest more heavily in research and development. Thus, anticipated monopoly may be an incentive to innovation. Second, the possession of monopoly power may be a favorable inducement for businessmen to tolerate more risky R and D projects, and to be more inclined and able to support the costs of innovation. Hence, the existence of monopoly power may lead to a more rapid technological change. Though the first causal connection is very important, particularly when considering patent policies, we will focus our attention in this section on the impact of monopoly concentration upon inventive activity.

Schumpeter and Galbraith have claimed that, if we consider the economy in a dynamic perspective, a perfectly competitive economy is likely to be inferior to and less desirable than an economy including several imperfectly competitive industries such as monopolies and oligopolies. Members of the Schumpeter-Galbraith school propound many hypotheses to uphold the view that a monopolistic market structure favors innovation. First, enterprises facing perfect competition have less resources to devote to research and development than do firms under imperfect competition. The profitability of monopoly power makes it easier to assemble funds for investment in new technological change than if fresh capital had to be tapped from the outside. Second, the organizational slack characterizing

monopoly concentration may be associated less with supra-normal profits, important cash-flow or liquidity, than with ample R and D staff and substantial salaries attracting high talented persons. Third, corporations protected against short term competitive pressures may be more apt to manage long-range research projects which may require several years before bearing fruits. Finally, firms possessing a sufficient control over the market may be capable of reaping most of the benefits from their innovations. They can internalize the rewards of their technological advances.

Defenders of perfect competition reply to these arguments that enterprises in imperfect markets are likely to meet less pressure to introducing new techniques and products since such firms have fewer competitors or rivals. They contend that innovation is the result of a conscious quest for new and better solutions to pressing problems, and such search activity is quite stimulated by the pressure on profits resulting form a competitive environment. These critics charge that a monopoly position entails lethargy and complacency toward the innovative process. They also claim that monopolistic firms are better able to drive out new entrants who, uncommitted to present technology, are likely to be relatively fast to adopt new techniques. Finally, they stress that to have a large number of independent decision-making units in the economy is a real advantage, particularly because it lessens the potential perturbations.

These two diametrically opposed views have led to such hard controversy about the influence of market structure on technological change. Several econometric tests were realized by different authors but they have resulted in divergent results [11, 16, 17, 21]. The differences between the findings of these studies are explainable because none of them have been entirely satisfactory methodologically (for instance, poor data and insufficient distributed lag techniques). Moreover, almost no correlation among the several tests performed was very significant statistically. For example, the correlations between patents per dollar of sales and profits as a percentage of sales, between patents per dollar of sales and liquid assets as a fraction of total assets, and

between R and D spending per sales and cash flow per sales were not significantly different from zero [11, 21]. The correlation between the ratio of R and D expenditures to sales and an index of market concentration was positive, though not very strong [11].

Maclaurin [14] studied the effect of market structure on technological change, comparing a ranking of industries by their important innovations during 1925-1950 with their ranking given by the extent of monopolization, considering the size of industry price leaders on the ease of entry. The two rankings revealed a difference. He concluded that while some degree of monopoly power is necessary for technological advance, it is not sufficient; ease of entry, entrepreneurial leadership, and a competitive spirit were considered as nearly essential. He also stressed the importance of the underlying engineering art and the scientific base in the inventive process.

The quantitative evidence given by the whole empirical literature concerning the impact of market on innovation forces the conclusion that no simple, one-to-one relationship between concentration and technological change is discernable. Indeed, it seems reasonable to believe that the influence of market concentration on the rate of technical innovation is less important than other variables. Hence, the weak agreement on a relation between research efforts or inventive outputs and concentration has led to the assumption that the relation may vary with the richness of opportunities opened up by progress in sciences and technological knowledge. A second factor influencing the rate of innovation, although much more elusive, is an attitude of receptiveness on the part of businessmen to adapting modern science to industrial purposes. One possible way market structure might affect the process of innovation is through a demonstration effect; however, it is worth noting that several industries have acquired a research conception largely by historical accident.

The importance of the technological opportunities has been stressed by empirical studies. The magnitude of R and D efforts made by industries was strongly correlated with an index of technological opportunity. After taking into account various classes of technological

opportunity, the correlation between R and D intensity and market concentration continued to be positive, but was much weaker. Also, in many cases it became statistically insignificant, and in some instances the relation changed its sign [5, 11, 21]. Consideration of opportunity classes helps to avoid imputing to concentration a bias toward technological innovations which is not warranted. High market concentration is less essential for important R and D investment in industries which have rich technological opportunities compared to low opportunity sectors. A modest degree of oligopoly seems then beneficial in fields of limited technological prospects [22].

Another variable affecting directly the rate of technological change is entry barriers. Comanor [5] discovered that industries with moderate barriers to new entry have much higher R and D employment relative to their size than industries with either high or low entry barriers, all other things equal. This may be explained conceivably by saying that high entry barriers entail lethargy, while low entry barriers make actual the threat of rapid imitation. There exist numerous case studies showing the key role played by new entrants in stimulating the rate of technological change. They are themselves direct sources for innovation, and provide real incentives to other firms. Thus, moderate entry barriers permit innovators to reap some benefits from the advances they have pioneered, while allowing new entrants to act as positive factors of technical progress. "The major economic force leading to innovation is not any particular structural form in the industry, but the conditions regarding entry to that industry". [25]

The evidence gathered from different sources appears to cast doubt on the allegations of Schumpeter, Galbraith, and others, assessing that industrial giants are required in all or most industries to insure a rapid pace of innovational output and a quick utilization of the new technologies. Moreover, there is likely no statistically significant, stable relationship between the degree of concentration and the rate of technological change in an industry. In sum, if structural market power has a beneficial effect on the inventive output, it is indeed a very modest effect. It is conceivable that existing monopoly power is a favo-

rable structure only for investment in basic and the most fundamental applied research, where the risks are high and externalities are important. What seems required to permit a rapid technological progress is a subtle blend of competition and monopoly, putting more emphasis in general on competition than on monopoly, and with the role of monopolistic elements diminishing when rich technological opportunities exist [22].

4.5 Regulation and Innovation

The impact of regulation on the pace and pattern of technological change is a very important and complex question. Although regulation is often considered to have a negative effect on technological progress, the regulatory forces do not all operate in the same direction, and the results are unclear and challenging. Moreover, the structure of the telecommunications industry dominated by a large firm which is both horizontally and vertically integrated, may have a great influence on the impact of regulation on innovation. Very few studies have tried to attack this problem through a systematic analysis [24, 26], probably because the complexity of this multivariate reality, and the lack of objective data. Thus, the evidence is rather anecdotal, limited to specific markets or to particular innovations. Nevertheless, an outline of the different effects that various aspects of regulation appear to have on the pace and pattern of innovation is useful [24].

In general, competition is more conducive to innovation than monopoly if the benefits of technological change can be internalized by the firm. Since innovations seem appropriable in the telecommunications industry, at least as much as in other industries, we can expect that the pace of technological change will be diminished wherever regulation creates or tolerates a monopolistic position which does not look necessary. Many analysts of the industry contend that Bell Canada's preference as a monopolist for Northern Telecom's equipment has slowed the adoption and the diffusion of several technical progresses such as terminal equipment for the public dial-up network, particularly automatic dialers which would have reduced Bell's long distance revenues (The Financial Post:

"Northern Telecom could live without Bell", October 29, 1977). If a carrier behaves as a protected monopolist, it is probable that R and D spendings and innovations will be reduced.

Regulation based on a cost-plus-profit basis relaxes all cost constraints and, in particular, tends to increase the expenditures for inventive activity. Nevertheless, the added spending on R and D will not necessarily materialize in actual innovations if the regulated carrier has incentives to delay the implementation of its inventions in practical technical advances. On the other hand, cost-plus-profit regulation may have a negative effect on technological change since it tends to lessen the incentive to realize cost reducing innovations. By preventing firms to make monopolistic profits, rate of return regulation has yet another important influence on innovation: it reduces the potential profitability of high risk ventures. In general, the regulated carrier will choose a selection of R and D projects away from high risk, high return innovations. On the other hand, rate of return regulation gives the carrier protection against the risks that are always associated with technological change. Regulation appears to eliminate the upper and lower portions of the risk (and profit) distribution that a firm must face when it is deciding to invest in R and D. The net impact of all these forces is unclear.

There is yet another way regulation can affect the pace and pattern of innovation; it is through the Averch-Johnson effect. It is asserted that the usual mode of regulation systematically provides an incentive for regulated enterprises to investing more heavily in plant and equipment than they would without a regulatory constraint. Moreover, regulated firms may also be induced to develop and to use more capital-intensive production processes than unregulated enterprises. The extent to which regulated firms have in fact behaved according to the Averch-Johnson effect is still waiting for a clear proof, though the bias towards more capital intensive technologies seems to be manifest, in particular, in slow depreciation policies and in the fact that regulated carriers are more prone to buy capacity rather than to lease it. Some contend that the Averch-Johnson effect may stimulate techno-

logical change since the introduction of new technology often necessitates large capital investments and/or an addition to the stock of plant and equipment. Such an argument has yet to be demonstrated.

Regulated industries are insulated from outside pressures; they are, to a certain extent, closed systems. Even in the absence of real economic barriers to entry, such as large economies of scale, regulation gives regulated firms a protected environment. These enterprises not have to face aggressive new firms trying to compete through service-improving or cost-reducing innovations, and this may favor the status quo. Related to this conservative bias is the concept of system integrity, often acknowledged in the telecommunications industry as crucial for the public interest. Though system integrity may be perceived to be in the interests of consumers, it could be used as an argument for upholding and extending monopoly power, and for deterring or forestalling new entry and innovation. This may give the carrier direct control over the access to the system and the pace and the pattern of new technology adopted in the industry. The result might probably be a greater technical exclusivity. This propensity for technical exclusivity is perhaps best indicated by the vertical integration in the Bell System (Bell-Northern Research, Bell Canada, Northern Telecom). Without denying the potential benefits of vertical integration, it is clear that it hinders any objective comparisons or tests of Bell Canada's production performance and innovative effort or output. System integrity may lead to extreme technical exclusivity, which makes very difficult the task of analysing seriously other alternatives like partial integration, long-term contracting, leasing, or joint ventures.

In certain circumstances, the pace of innovation may be accelerated by a regulated firm whose objective is to impede freer competition and further entry. If a new competitor threatens a regulated firm's traditional markets or attractive new ones, it is likely that the firm will try to oppose new entry by augmenting inventive efforts and outputs. The threat of more rivalry leads to preemptive innovation through an extensive, costly crash program. Such an investment may reach the point of negative social returns. On the other hand, a firm's

known ability to preempt an opportunity field may prevent or discourage any inventive activity by others, which results in little or no technological change.

A final factor influencing innovation is provided by the regulatory lag. It is well known that a commission's response to a changing situation of a regulated firm is slow. It is possible that between two rate adjustments a regulated firm can increase its net income by introducing a cost-reducing innovation. Thereby it can reap higher earnings until its rate structure is reexamined by the commission. Thus, it may be argued that the regulatory lag is conducive to more cost-reducing innovations. This effect will likely be particularly strong in periods of important inflation if we admit that enterprises are reluctant to go before regulatory agency. Practical and sound evidence for this argument is not available.

5. The Relationship between Common Carriers and Their Suppliers

The objective of this report in an indepth examination of the issue of technological innovation and cross-subsidy in the Canadian telecommunications industry as these are affected by vertical integration. Thus, it would appear to be quite important to have a clear vision of the structural and informal relationships existing between the telecommunications carriers and the several related telecommunications equipment markets. These links are said to be structural when they result from the existence of a vertically integrated structure or of a partial ownership relation. But other factors can create links of a more informal nature. For example, the presence of multiple suppliers of equipment and their geographic situation can have a decisive influence on the kinds of equipment used and purchased in the industry. In addition, the procurement policies of the common carriers may be an important determinant of the pace and diffusion of technological change throughout that sector. Finally, the very existence of the TCTS consortium should not be underestimated; through its sharing schemes, its technical standards, its construction activities, and the many policies it defends concerning issues such as interconnection, its influence can be of paramount importance.

Another reason which motivates the examination of the relationship between common carriers and their suppliers is the unique position of the industry in the economy. During the 1970's, the telecommunications equipment market reached growth rates that are envied by all sectors of the economy, and this warm-up is expected to continue so into future decades. On the side of common carriers, their expenditures on telecommunications equipment is now running more than $ 1 billion, and analysts think they will increase substantially into the eighties. Such a high level of investment has a great impact on the economy as a whole, and its pressure on the industry can modify drastically the environment that concerns the regulatory authorities.

The rapid pace of technological change, particularly digital switching and fibre optics, and the possible liberalization of the interconnect market may permit new opportunities in the telecommunications markets for existing and new firm. Knowledge of the actual links between carriers and suppliers, and the evaluation of their relative weights would appear necessary to assessing whether or not these opportunities are real and to whom they will benefit.

Thus, the purpose of this section is to portray the current state of the Canadian telecommunications industry, mainly on the supply side, in order to try to identify the impact and the extent of vertical integration in this sector of the economy, as well as to see whether technological innovation and a more liberalized view of regulation and competition could change the current market positions occupied by existing firms. This information is important to assess since if market shares are expected to change in the future, the strategies adopted by existing firms will probably be modified in order to secure or increase their relative position. It is conceivable that enterprises might be tempted to enlarge some cross-subsidy flows or to create additional ones to accomodate the new environment. Even if firms' strategies are not significantly modified with changing market shares, the knowledge of the anticipated relative importance of the many submarkets of the industry may be helpful when attempting to determine on which portions of the ket the regulatory policies must focus their action.

There are many ways to classify the equipment used in the telecommunications industry. Telecommunications equipment manufacturers usually group the equipment they produce in five broad categories:

1. Subscriber apparatus, telephone sets, etc...
2. Business communications systems, PABX, data communications.
3. Central office switching equipment.
4. Wire and cable, including terminals, connections, etc...
5. Transmission equipment (microwave, multiplex).

Common carriers, on the other hand, break out their equipment into three broad categories:

1. Central office equipment (installed on carrier premises).
2. Station equipment (installed on customer premises).
3. Outside plant (connection between 1 and 2).

The three main categories chosen for discussion are the following:

1. Wire, cable, and transmission equipment (including multiplex devices, line carrier systems, microwave, satellite).
2. Central office switching equipment.
3. PBX and subscriber apparatus (including key telephone systems, telephone sets, telephone accessories, mobile telephones, intercommunicating systems).

We then present, for each of these submarkets, the main suppliers together with their share of the market and their most important product lines. Also given are current sales and anticipated growth rate for the next decade for each product line of the submarket. The amount the telecommunications carriers spent in 1977 in each of these submarkets and where each product line was purchased is also shown.

The main source of information used in this section is a report made by Northern Business Intelligence entitled "Telecommunications Equipment Market in Canada", May 1978. For each submarket cited above, we use the projections made by NBI to forecast the growth of each product line. Though these growth rates will be utilized to give an indication about the future importance of these submarkets, the method used to obtain these figures is not discussed. Another source of information is the Restrictive Trade Practices Commission. These documents provided price comparisons for certain kinds of equipments and also information relating to common carriers' procurement policies. A final source of information was a working paper prepared by the National Telecommunications Branch, Industrial Resources Development, entitled "Canadian Telecommunications

Carriers and their Suppliers", June 1974.

5.1 Wire, Cable and Transmission Equipment Submarket

The transmission equipment submarket is the section of the telecommunications market where competition prevails the most widely, although it cannot be stated that this is a competitive area. In fact, some suppliers believe that the transmission market is plagued by fragmentation, both because of the number of manufacturers and by the wide range of different equipment standards imposed by the carriers. Tables 1 and 2 provide information on the main suppliers of transmission equipment and wire and cable.

The transmission equipment submarket in Canada (see Table 1) is dominated by two companies, Northern Telecom and GTE Lenkurt, whose share of the market together is estimated to be 75%. However the six following suppliers sum up to around 23% of the market, which represents for each of them a tangible, though in general small, portion of the business. In addition, six out of these eight suppliers provide at least two product lines of the submarket.

Northern Telecom, with about 55% of this market, offers a wide range of analog multiplex (MA-5) and line carrier systems, as well as analog microwave radio systems of high capacity (RA-3, with capacity ranging from 1200 to 1800 voice channels per RF channel). Northern Telecom also has two digital line carriers systems (LD-1, LD-4) and an extensive series of digital multiplex systems (DMS-1, DMS-10, DMS-100, 200, 300).

GTE Lenkurt is the only other supplier which provides a broad line of carrier and microwave systems, although its products are of smaller capacity. Lenkurt also makes several analog and multiplex systems which can compete with those made by Northern.

Table 1

TRANSMISSION EQUIPMENT SUPPLIERS

	Company	Transmission market share (%) 1977	Equipment supplied			
			Multiplex	Line Carrier	Microwave Systems	Satellite
c	Northern Telecom	55	X	X	X	
a	GTE Lenkurt	20	X	X	X	
c	Spar Aerospace	11	X		X	X
a	Farinon	3	X		X	
a	Hughes Aircraft	3				X
a	TRW Vidar	3		X		
a	ITT	2	X	X		
a	Ragtheon	2	X		X	X
a	CGE	ε	X			
e	Canadian Marconi	ε	X		X	
	Transcom	ε	X	X		
a	Wescom	ε	X	X		

Note: the symbol ε indicates a share less than 1%.

The small letter before the name of a supplier indicates if the company is canadian (c), american (a), or european (e).

Source: "Telecommunications Equipment Market in Canada", Northern Business Intelligence, 1978.

Farinon has carved out a good niche of the market particularly around its light capacity microwave systems for short haul, low to medium density routes. It is then a tough competitor to Lenkurt in that field; in fact, Farinon has a good business with CNCP and all the large carriers, except B.C. Tel. For high density, long haul microwave systems, the main competition that must face Northern Telecom arises from Raytheon and Spar who have succeeded to obtain good portion of the market, principally with the Prairie and the Maritime telcos and with CNCP. Thus, it seems that the microwave equipment in Canada is principally dominated by the three following companies (in that order): Northern Telecom, Farinon, Raytheon.

TRW Vidar has had some successes in the digital carrier systems submarket with its D-3 digital channel bank selling essentially in British Columbia and in the Prairies. With these sales to western telcos, Vidar competes directly with Northern Telecom and GTE Lenkurt.

In the subscriber carrier submarket, ITT has taken the lead (before Northern Telecom and Farinon) for a particular T-1 carrier system. Its DM 32 S digital carrier system has been sold to every major carrier in Canada. Wescom also produces T-carrier digital systems, but appears to have difficulties finding markets for its products. However, it has been able to market its conditioning equipments and repeaters all over the country by filling in the gaps in the corresponding family of line conditioning equipment offered by Northern.

The satellite submarket is dominated by three companies. The leading place is occupied by Hughes Aircarft, but Spar is not far behind, while Raytheon is the major supplier of small aperture ground stations. It is worth nothing that the two leaders in the transmission market, Northern Telecom and GTE Lenkurt, are not present in that field.

The wire and cable submarket (see Table 2) is a small, compact oligopoly represented by three suppliers. Northern Telecom, Phillips Cables, and Canada Wire and Cable together cover about 95% of the market.

Table 2

WIRE AND CABLE SUPPLIERS

	Company	Wire and Cable market share (%) 1977	Products supplied		
			Wire	Cable	Coaxial Cable
c	Northern Telecom	59	X	X	X
e	Phillips Cables	26	X	X	
c	Canada Wire and Cable	10	X	X	X
	Belden	ε	X		
e	Pirelli	ε	X		

Note: the symbol ε indicates a share less than 1%.

The small letter before the name of a supplier indicates if the company is Canadian (c), or European (e).

Source: NBI, 1978.

It is interesting to note that wire and cable products are quite homogeneous and compatible, and that these three suppliers offer a wide range of products, though Phillips Cables does not manufacture coaxial cables. Finally, only Northern Telecom is involved in the production of other telecommunication equipment.

Table 3 shows the importance (in $ million of shipments 1977) in the wire, cable, and transmission equipment market for each of the main product lines. It also gives anticipated growth rates for the whole market as well as for each product line. It should be noted that in 1977, wire and cable occupied the largest part of the market (53%), followed by multiplex (19%), microwave (12%) and line carrier (11%). In ten years from now, if the estimates are accurate enough, the situation could be slightly but significantly modified. The lead could be jointly shared by wire and cable and by multiplex (30%), followed by microwave (13%), line carrier (12%) and fibre optics (9%). Thus, in the next decade, wire and cable share of the market may significantly reduced, while multiplex and fibre optics are anticipated to greatly expand (in volume, the increase of multiplex would be even greater since its prices are expected to decrease with the digital technology).

Table 4 indicates the amount spent by major telecommunications carriers in 1977 for transmission equipment and for wire and cable. It is interesting to note that the two main Albertan carriers (AGT and Ed Tel) spent slightly more than B.C. Tel. for wire, cable and transmission equipment.

Tables 5 and 6 present from which suppliers each major carrier is believed to mainly purchase its necessary equipment for each product line (there are many blank spaces, particularly in table 5, but this is all the information we have successfully gathered). These two tables give us some information, albeit sparse, on the influence and importance of vertical integration.

Table 3

WIRE, CABLE AND TRANSMISSION EQUIPMENT MARKET

Equipment	Shipments 1977 ($ millions)	Anticipated growth/year 1977-1982	Anticipated shipments 1982 ($ millions)	Anticipated growth/year 1982-1987	Anticipated shipments 1987 ($ millions)
Microwave	51 (12%)	6.2 %	69	8.2 %	102 (13%)
Line Carrier	45 (11%)	4.8 %	57	10.0 %	92 (12%)
Multiplex	76 (19%)	8.8 %	116	15.0 %	233 (30%)
Satellite	17 (4%)	20.5 %	41	6.8 %	57 (7%)
Wire and Cable	216 (53%)	2.4 %	241	- 1.0 %	229 (29%)
Fiber Optics	1 (—)	74.8 %	21	29.35 %	75 (9%)
Total	406 (100%)	6.1 %	545	7.7 %	788 (100%)

Note: the figures between parentheses are the percentage of the total market represented by the corresponding product line.

Estimates are given in constant 1977 dollars.

Source: NBI and Restrictive Trade Practice Commission.

Table 4

WIRE, CABLE AND TRANSMISSION EQUIPMENT SPENDINGS

1977, ($ millions)

Carrier	Transmission	Wire and Cable	
Atlantic	8	15	
Bell	90	102	
Q Tel	5	7	
Prairies	32	62	(about two-thirds in Alberta)
BC Tel	20	28	
CNCP	14	3	
others	20	—	
Total	189	217	

Source: NBI.

Table 5

TELCO TRANSMISSION PURCHASING POLICIES

Telco	Microwave		Line Carrier		Multiplex	
	Main suppliers	Others	Main suppliers	Others	Main suppliers	Others
Nfld Tel	Northern	Farinon	Northern		Northern	
NBT	Northern	Lenkurt, Farinon, Raytheon	Northern		Northern	ITT
MTT	Northern, Lenkurt	Farinon	Northern, Lenkurt	Transcom	Lenkurt	ITT
Bell	Northern	Farinon	Northern		Northern	
Q Tel	Northern	Lenkurt, Farinon	Northern	Lenkurt	Northern	Lenkurt
MTS	Northern	Spar, Farinon	Lenkurt	CGE, Vidar		ITT
Sask Tel	Northern	Spar, Raytheon	Northern	Vidar		ITT
AGT	Lenkurt	Spar	Lenkurt	Vidar, Transcom		ITT
Ed Tel			Northern			
BC Tel	Lenkurt		Lenkurt	Vidar	Lenkurt	ITT

Source: NBI and RTPC.

Table 6

TELCO WIRE AND CABLE PURCHASES, BY MAIN SUPPLIERS

Telco	Supplier, per cent of purchases, 1975		
	Northern Telecom	Phillips Cables	Canada Wire and Cable
Bell	97.0 *	*	*
Nfld Tel	97.0	1.0	
MT and T	62.0 *	36.0 *	
NB Tel	54.0	5.0	17.0 *
BC Tel		99.0 *	
Quebec Tel	5.0 *	90.0 *	
MTS	0.1	24.0 *	66.0 *
Sask Tel	16.0 *	13.0	53.0 *
Edmonton	47.0 *	33.0 *	18.0
AGT	34.0 *	43.0 *	22.0

Note: An asterisk (*) indicates the supplier has a cable plant in the province in which the Telco operates.

Source: RTPC.

It was noted that the transmission equipment market was characterized by a vivid competition in all product lines. However, it appears quite difficult for the supplier to carve out a good share of market, despite aggressive marketing and specialization (see Table 5). Bell and Newfoundland Telephone (still under the control of Bell) purchase virtually all their transmission equipment from Northern Telecom. The only major exception is Farinon which has succeeded to penetrate that closed market with its excellent reputation and specialization in low-density, short-haul microwave systems (not produced by Northern). New Brunswick Telephone relies heavily on Northern Telecom, though it also purchases microwave systems from Lenkurt, Farinon, and Raytheon. Maritime Telegraph and Telephone is the telco in eastern Canada which has the most diversified purchasing policy. Two tentative reasons for this diversification of purchases may be because MTT uses selective competitive bidding, and because Bell Canada is not allowed to exercice its control over MTT.

As expected, B.C. Telephone makes nearly all its purchases from GTE Lenkurt, but Quebec Telephone, though it is also affiliated with GTE, relies mostly on Northern Telecom, while GTE Lenkurt is only the second supplier. We may ask whether this behavior is dictated by a preference given to the supplier manufacturing in the same region?

It is in the Prairies that we find the carriers having the most diversified procurement policies. For example, it is only in the Prairies (and with CNCP) that Spar and Raytheon, which compete with Northern Telecom for high density, long haul microwave radio systems, have succeeded to take a sizeable portion of the market. Also, it is only in the Prairies that Vidar, which competes with Northern Telecom and GTE Lenkurt for digital channel banks, has been able to sell its product. Moreover, it is only with a Prairie telco, namely AGT, that GTE Lenkurt has succeeded to take the lead to Northern Telecom for microwave and line carrier systems (except, of course, in its GTE market). Finally, it maybe interesting to note that there are only the four Prairie carriers which generally have competitive bidding on equipment (except for extensions).

Table 6 shows yet more precisely the importance and influence of vertical integration. The strict oligopoly situation existing in the wire and cable submarket is shown to be fragmented when we look at the regional level. Northern Telecom dominates the market (more than 50% of the market) which is associated with Bell Canada, Phillips Cables leads in the market controlled by GTE, and Canada Wire and Cable dominates only in the Prairies. In fact, Northern Telecom and the Maritime carriers are all owned partly by Bell Canada. We then observe that Bell Canada and the Maritime telcos all buy more than 50% of their needs in wire and cable from Northern Telecom. MTT and NB Tel are the only two telcos in this group that make a significant part of their purchases outside of Northern, and these purchases are in both cases made from the only supplier installed on their territory.

B.C. Telephone and Quebec Telephone have both the same parent as GTE Automatic Electric, which was a distributor for Phillips Cables until 1976 (it is worth noting that here, Quebec Telephone follows a purchasing policy quite close to that of B.C. Tel., in constrast with its divergence in the transmission equipment market).

Again it is in the Prairies that the smaller supplier, Canada Wire and Cable, was able to penetrate the most significantly the market. Moreover, it is only in the two Prairie provinces where it has plants that it has succeeded to reach more than 50% of the regional market. Note also that there are five regions (defined by a telco) where the two main suppliers, Northern Telecom and Phillips Cables, have plants. There are only two regions out of these five where the two suppliers do not have a sizeable share of the market; these are regions where each supplier has a captive market (Northern with Bell, Phillips with Quebec Telephone).

Finally, how does the future look for the wire, cable and transmission equipment market? For the microwave systems submarket, we have to distinguish between the high-capacity microwave equipment and the low-

capacity microwave equipment. Into the high density, long haul microwave market, it will be very hard to Spar and Raytheon to stay in competition with Northern Telecom since this supplier is engaged very actively into the long haul digital business and has already obtained the first contracts for the heavy route microwave equipment. Thus, the leading role of Northern Telecom is not at all threatened in that part of the market; Raytheon is expected to remain a distant second. In the light density, short haul microwave market, GTE Lenkurt and Farinon are both expected to retain their leading positions.

For line carrier equipment, let us consider the demand for T-carrier and subscriber carrier systems. The competition into the T-carrier submarket is anticipated to be strong. Northern Telecom enjoys a secure position into the Bell market, but the competition will be more intense in the rest of the market. Although GTE Lenkurt has now a good position outside of the Bell territory, new American suppliers like Vidar, Transcom, and Wescom are fighting hard to carve out a share for themselves. The subscriber carrier submarket is also expected to have fierce competition. Northern Telecom (with its DMS series) has already faced competition from ITT and Wescom, and Vidar is also anticipated to enter the market.

5.2 Central Office Switching Equipment Submarket

The central office switching equipment market represents the largest portion of the telecommunications equipment market (about 40% of total value shipments) and is also the section of the market which is the most concentrated. There are switching equipments for telephone and for message and data. Telephone switching equipment is classified according to its generation of equipment: manual, step-by-step, crossbar, electronic switching systems (electromechanical and digital switches). This part of the market is quite concentrated. The submarket for message and data switching equipment is much smaller in terms of shipment value, but is much more open to competition.

Table 7 presents the main carriers together with their product lines. Northern Telecom is believed to control around 75% of the switching market and is the only supplier which provides a complete line of products. The second rank belongs to GTE Automatic Electric, with 11% of the market, although this supplier manufactures only step-by-step equipment and electronic switching systems. Siemens is in third position (3% of the market) but it is the leader for message and data switching equipment. AEI Telecommunications has gained its small share of the market by providing equipment serving to expand the capacity and improve the efficiency of switching systems already installed.

Table 8 indicates the actual shipment value for 1977 for each product line together with their anticipated growth rates for the next decade. We observe that digital ESS is expected to increase rapidly during the decade so that ten years from now, it will represent more than two-thirds of the market. This growth will be made at the expense of analog ESS and of step-by-step and crossbar systems.

Table 9 gives the amount each of the main common carriers spent on switching equipment in 1977, and table 10 indicates from which supplier the major telcos purchased their required switching equipment. It is not surprising to observe that Northern Telecom is the main supplier of switching equipment of nearly all major telcos (except of course to B.C. Tel.). However, competition exists for the second place, and even for the first place in the Prairies.

The Atlantic telcos depend very heavily on Northern Telecom's production, and only small and sporadic purchases are made elsewere. Bell Canada purchases virtually all its switching equipment from Northern Telecom, while B.C. Telephone relies almost entirely on GTE Automatic Electric. Quebec Telephone, though its link with GTE Automatic, is believed to split more or less equally its purchases between Northern Telecom and Automatic Electric. In the Prairies, only Edmonton Telephones is highly dependent on Northern Telecom. For the three other Prairie telcos Automatic Electric offers intense competition to Northern Telecom. For example,

Table 7

SWITCHING EQUIPMENT SUPPLIERS

	Company	Switching Market share (%) 1977	Equipment supplied			
			S x S	Crossbar	ESS	Message/Data
c	Northern Telecom	75	X	X	X	X
a	Automatic Electric	11	X		X	
e	Siemens	3				X
e	AEI	2	X			
a	ITT	1			X	X
e	Canadian Marconi	ε				X
	Collins Radio	ε				X
e	L.M. Ericsson	ε		X		
j	Fujitsu	ε		X		
e	Philips	ε				X
	Plantronics	ε				X
e	Plessey	ε	X	X		

Note: the symbol ε indicates a share less than 1%.

The small letter before the name of a supplier indicates if the company is canadian (c), american (a), european (e), or japanese (j).

Source: NBI.

Table 8

CENTRAL OFFICE SWITCHING EQUIPMENT MARKET

Equipment	Shipments 1977 ($ millions)	Anticipated growth/year 1977-1982	Anticipated shipments 1982 ($ millions)	Anticipated growth/year 1982-1987	Anticipated shipments 1987 ($ millions)
Digital ESS	0	—	200	36.6 %	875 (68%)
Analog ESS	281 (61%)	2.4 %	316	- 5.6 %	236 (18%)
Crossbar/S x S	156 (34%)	0.8 %	162	- 8.5 %	104 (8%)
Message/Data	24 (5%)	11.3 %	41	10.6 %	68 (5%)
Total	461 (100%)	9.3 %	719	12.4 %	1283 (100%)

Note: the figures between parentheses are the percentage of the total market represented by the corresponding product line.

Estimates are given in constant 1977 dollars.

Source: NBI and RTPC.

Table 9

SWITCHING EQUIPMENT SPENDINGS

1977 ($ millions)

Carrier	Expenses on Central Office Equipment	
Atlantic	37	
Bell	227	
Q Tel	10	
Prairies	112	(more than one half in Alberta)
BC Tel	61	
CNCP	12	
Teleglobe	2	
Total	461	

Source: NBI.

Table 10

TELCO SWITCHING PURCHASING POLICIES

Telco	S x S/Crossbar		ESS		Extensions	
	Main suppliers	Others	Main suppliers	Others	Main suppliers	Others
Nfld Tel	Northern		Northern		Northern	
NBT	Northern		Northern		Northern	
MTT	Northern	AEI, LME	Northern	Automatic	Northern	
Bell	Northern	LME	Northern		Northern	
Q Tel	Northern, Automatic		Northern, Automatic		Northern, Automatic	
MTS	Northern, Automatic	AEI	Northern, Automatic			
Sask Tel	Northern, Automatic	AEI	Northern, Automatic		Northern	
AGT	Northern		Northern, Automatic	ITT	Automatic	
Ed Tel	Northern	Automatic, AEI	Northern	Automatic	Northern	
BC Tel	Automatic	AEI	Automatic		Automatic	

Source: NBI and RTPC.

AGT purchases large ESS from Northern Telecom and recently from ITT, and small ESS from Automatic Electric. It is interesting to note that AEI Telecommunications has succeeded in marketing its products essentially in the Prairies and on a smaller scale to MTT.

Due principally to its nearly complete dominance of the market, Northern Telecom is expected to remain the major supplier in the central office switching market. Its full line of DMS devices runs from the smallest rural office to the largest city center; Northern Telecom however will face very fierce competition in the local digital office submarket. Companies such as North Electric, Vidar, and Stromberg Carlson could augment substantially their sales in that portion of the market, reason being that independent telcos did not wish to depend heavily on Northern Telecom when technology, particularly digital switching, is characterized by such a fast evolution.

5.3 PBX and Subscriber Apparatus Submarket

The PBX and subscriber apparatus submarket is an attractive telecommunications equipment market since it is the area where the interconnection problem has its essential roots. However, it represents the smallest part of the telecommunications market with only 23% of the present value shipments. Its degree of concentration varies widely with the different product lines. Table 11 indicates the main suppliers of private branch exchanges, key telephone systems, telephone sets, telephone accessories, mobile phones and intercommunicating systems.

While there are many suppliers present in the PBX submarket, Northern Telecom's share of the market is estimated to be approximately 66%, while the next three following suppliers have almost all of the remainder of the market. The principal PBX product of Northern Telecom is the SL-1 which covers the 100 to 3000 line range; Northern has also a small electronic PBX, named Pulse, which is now six years old. GTE Automatic Electric has two main digital PBXs, one for 120 lines, the other for 1000 lines; a 4600-line model is supposedly coming soon. Thus,

Table 11

PBX AND SUBSCRIBER APPARATUS SUPPLIERS

	Company	Subscriber Apparatus Market share (%) 1977	Equipment supplied					
			PBX %	KTS %	Telephone Sets %	Intercomes	Accessories	Mobile phones
c	Northern Telecom	63	66	74	74		X	
a	Automatic Electric	13	13	14	14		X	
a	ITT	7	X	12	12	X		
e	L.M. Ericsson	2	5			X		
	International Systems	2						X
a	CGE	1						X
a	Motorola	1						X
j	Nippon Electric	1	5					
e	Pye	1						X
a	Wescom	1	X			X		
e	Philips	ε	X			X	X	
e	Plessey	ε	X					
	Western Radio	ε						X

Note: the symbol ε indicates a share less than 1%.

The small letter before the name of a supplier indicates if the company is canadian (c), american (a), european (e), or japanese (j).

Source: NBI.

though Northern Telecom is believed to sell to all major telcos, GTE Automatic can supply nearly the full range of PBX requirements and it can do better than Northern Telecom in the hotel market. Nippon Electric's offerings cover particularly the medium and large range for crossbar and electronic PBXs, while L.M. Ericsson's strength has been mainly in crossbar switches. This market is highly concentrated, with some gaps to be filled in by small competitors.

The key telephone systems submarket is controlled completely by three suppliers, with Northern Telecom representing around three-quarters of the market. The two other suppliers are GTE Automatic and ITT, both having almost equal share. These three companies offer the same KTS design which comes from Western Electric. A noteworthy fact about this submarket is that ITT has innovated in this field by offering the new type of two cable pair microprocessor based KTS. Northern Telecom and GTE Automatic are expected, in response, soon to introduce their own similar system.

In the telephone sets submarket, it is also Northern Telecom, GTE Automatic and ITT that control between them the whole market, with sales distribution similar to that of the KTS submarket. These three manufacturers offer the same basic phones designed by Western Electric. Recently, Northern Telecom has produced its own new designs like the Contempra, the E-phone, the Centurion, and the Logic key telephones. ITT also is making a key phone of its own design.

Table 12 shows value shipments for 1977 in each product line. together with their anticipated growth rates for the next decade. From this table, we see that the relative weight of each product line in the total value shipments is expected to be fairly stable over time, while the total value of the submarket is anticipated to increase markedly during the next ten years.

Table 13 indicates expenses made by the major telecommunications carriers for PBX and subscriber apparatus equipment, and Table 14 presents the main suppliers from which carriers purchased most of PBXs, key tele-

Table 12

PBX AND SUBSCRIBER APPARATUS MARKET

Equipment	Shipments 1977 ($ millions)	Anticipated growth/year 1977-1982	Anticipated shipments 1982 ($ millions)	Anticipated growth/year 1982-1987	Anticipated shipments 1987 ($ millions)
PBX	75 (28%)	8.0 %	110	14.0 %	212 (28%)
Key Telephone Systems	55 (20%)	6.7 %	76	12.4 %	136 (18%)
Telephone, Sets	107 (39%)	7.7 %	155	13.2 %	288 (38%)
Telephone Accessories	10 (4%)	13.8 %	19	16.1 %	40 (5%)
Intercoms	8 (3%)	10.4 %	13	3.0 %	15 (2%)
Mobile Telephones	17 (6%)	13.5 %	32	13.1 %	59 (8%)
Total	272 (100%)	8.3 %	405	13.1 %	750 (100%)

Note: the figures between parentheses indicate the percentage of total value shipments represented by each product line.

Estimates are given in constant 1977 dollars.

Source: NBI and RTPC.

Table 13

PBX AND SUBSCRIBER APPARATUS SPENDINGS

1977 ($ millions)

Carrier	Expenses on subscriber apparatus	
Atlantic	18	
Bell	123	
Q Tel	4	
Prairies	57	(about two-third in Alberta)
BC Tel	35	
Total	237	

Note: these figures do not include purchase of mobile phones, accessories or intercoms, because much of this type of equipment is sold directly to users.

Source: NBI.

Table 14

TELCO PBX AND SUBSCRIBER APPARATUS PURCHASING POLICIES

Telco	Telephone Sets		Key Telephone Systems		PBXs	
	Main suppliers	Others	Main suppliers	Others	Main suppliers	Others
Nfld Tel	Northern		Northern		Northern	Wescom
NBT	Northern		Northern		Northern	Wescom
MTT	Northern		Northern		LME	Northern, Automatic
Bell	Northern		Northern		Northern	LME, Automatic, Nippon
Q Tel	Northern	Automatic	Northern	Automatic	Northern	LME, Automatic
MTS	Northern	ITT	ITT		Northern	Plessey
Sask Tel	Northern	ITT	ITT		Northern	Automatic, Nippon
AGT	Northern	ITT	ITT		Northern	Nippon, Wescom
Ed Tel	Northern	ITT	ITT		Northern	Nippon, Plessey
BC Tel	Automatic		Automatic	Northern	Automatic	LME

Source: NBI and RTPC.

phone systems, and telephone sets they require. We see that the Maritime telcos and Bell Canada rely heavily on Northern Telecom, and that B.C. Tel. purchases nearly all its equipment from Automatic Electric while Quebec Telephone buys primarily form Northern Telecom followed by Automatic Electric. It is principally in the Prairies that smaller manufacturers (particularly ITT and Nippon Electric) have succeeded to carve out a sizeable share of the market for themselves.

Since Northern Telecom controls 75% of the telephone set submarket, it is not a surprise to consider that it is the main supplier to all telcos except B.C.Tel. However, it is a bit more surprising to see that GTE Automatic was able to sell its products only to B.C. Tel. and Quebec Telephone, while ITT has succeeded to penetrate that market only into the Prairies. The dominance of Northern Telecom is probably due to its wide range of telephone sets, particularly its new broad line of decorator phones and its Logic key telephone. Nevertheless, ITT offers a product line nearly as broad as that of Northern, except for some decorator phones, and this does not seem to be a sufficient reason to explain why ITT is confined to a second place, and only into the Prairie market.

In the key telephone systems submarket, although Northern Telecom's share of the market is the same as that for the telephone set market, it is no longer the main supplier for all telcos; ITT has taken the lead before Northern with the four Prairie carriers. GTE Automatic, however, has again the same market as previously with B.C. Tel. and Quebec Telephone. So, the key telephone system and the telephone set markets are both highly concentrated and clearly divided between the three manufacturers. The only possible threat lies in the key telephone systems market because Northern Telecom does not manufacture a low cable KTS (systems now produced by ITT).

The PBX submarket looks more competitive from tableau 14, but this is a kind of illusion. We must remember that Northern Telecom, GTE Automatic, Nippon Electric and L.M. Ericsson control between them 99% of this market. Northern Telecom is the main supplier for most of the car-

riers, and L.M. Ericsson has taken the lead for MTT. GTE Automatic is again the major manufacturer of B.C. Telephone, but it has also succeeded to sell out of its captive market. Some other manufacturers have also made some sales in that submarket, principally because they fill in some gaps in Northern Telecom's production; this is the case particularly for GTE Automatic with its GTD-120 H-M digital PBX which is well suited for hotel applications, for L.M. Ericsson's large cross-bar switches, and for Wescom's advanced hotel PBX.

5.4 Conclusions and Further Remarks

What has been learned, until now, from the precedent paragraphs? We have looked at the Canadian telecommunications equipment market at a level somewhat disaggregated to see how large are the different portions of this market, to estimate the future growth of these submarkets, and finally to evaluate the importance of competition in each of them. This portrait of the telecommunications equipment market was then related to the telephone operating industry. Essentially we indicated how much each major telephone company invested in the different submarkets, and we also tried to trace out the profile of the purchasing policies adopted by the main carriers. This information is interesting since it gives us a way, though very scanty as it is, to appraising the impact of vertical integration in that industry. It is also valuable for attempting to forestall where could be the next important moves in these submarkets, and thus anticipate the reactions of the concerned suppliers and carriers vis-à-vis these changes.

The major telephone companies can be divided into three main categories: the vertically integrated companies (Bell Canada, British Columbia Telephone, Quebec Telephone), the Atlantic carriers (Maritime Telegraph and Telephone, The New Brunswick Telephone), and the Prairie telcos (Manitoba Telephone System, Saskatchewan Telecommunications, Alberta Government Telephones, Edmonton Telephones). Bell Canada and B.C. Tel. purchase nearly all their telecommunications equipment from their affiliated supplier(s), and permit competitive bidding only for products not made by their manufacturing companies. This is not surpris-

ing, but that behavior may have the disadvantage to not consider costs necessarily as of prime importance. In that group, Quebec Telephone is slightly different. In nearly all submarkets, Quebec Telephone's main supplier is Northern Telecom, although GTE's associated manufacturers are solid second. There are reasons to this: Quebec Telephone is small, and Anglo-American Telephone Co. tolerates less control on it; Northern Telecom is closer to Quebec Telephone's market which is inside the Bell territory, or prices proposed by Northern are advantageous to Quebec Tel. Although we do not have mentioned Newfoundland Telephone, that telco could have been included in the class of integrated companies since it is owned at 78% by Bell Canada and relies almost exclusively on Northern Telecom.

The two main Atlantic carriers are now owned by Bell Canada at approximately 40%, but they were still subsidiaries of Bell in 1976. These companies have selective competitive bidding policies, but Northern Telecom is always the first supplier of N.B. Tel. although significant purchases are made elsewhere. MTT has a more diversified procurement policy. For example, GTE Lenkurt is the main supplier of multiplex and is as important as Northern for providing microwave and line carrier, and L.M. Ericsson has the lead in the PBX market. It may be noteworthy to say that Bell Canada, despite its large share in ownership, has no voting rights and has been prohibited by provincial law since 1966 to exercise control over MTT.

The four Prairie telcos are all government or municipally owned and can be said to be independent of the integrated companies. They all rely generally on competitive bidding. They make a large part of their purchases from Northern Telecom, and to a lesser extent, from GTE Automatic or Lenkurt, but they are much more open to outside suppliers than other carriers. For example, ITT has succeeded in becoming their main supplier of key telephone systems and is second (after Northern) in the telephone set market. This seems to be the area in Canada where serious new-comers can penetrate successfully the telecommunications equipment market (Is it significant that these carriers are government-owned? For example, can we pretend that government

authorities are more pervious to outside suppliers than are business managers?).

Thus, the telecommunications equipment market is highly dominated by Northern Telecom which enjoys a share greater than 50% in each submarket. Though competition seems possible in nearly all submarkets, and in many regions of the country, Northern's portion of the business is quite stable, and will be so as long as Bell Canada and its affiliates will rely so heavily on it. This large captive market may be a possible explanation for the fact that Northern can take a chance in the switching market by utilizing the European transmission speed, which is different from the one used on this continent. Northern Telecom could augment its share of the market if the carriers accept the change, or it can otherwise see its share diminish. However, even with this last possibility, Northern is certain of the Bell market.

As a final remark, we would only note that although GTE Automatic and Lenkurt have generally a less secure position in the market than Northern Telecom, B.C. Tel. seems interested in diversifying its purchases of equipment and reducing its dependance upon the GTE affiliated manufacturers. The situation appear quite different for Bell Canada (see Table 15). The Restrictive Trade Practices Commission requested Bell Canada to estimate its construction expenditures for the five next years. Bell does not plan to reduce its percentage of spendings in materials and services coming from Northern Telecom or subsidiaries. Recent investigations on vertical integration and concentration, and the bruising wind of competition that blows over the industry do not appear to be an incentive for Bell Canada to broaden its range of suppliers.

Table 15

CURRENT ESTIMATES FOR BELL CANADA'S CONSTRUCTION EXPENDITURES

	Actual 1976 ($ M)	Estimated 1977 ($ M)	Estimated 1978 ($ M)	Estimated 1979 ($ M)	Estimated 1980 ($ M)	Estimated 1981 ($ M)
Materials and Services from Northern Telecom and subsidiaries	487 (54%)	532 (53%)	626 (57%)	652 (55%)	692 (54%)	718 (54%)
Materials and Services from other suppliers than Northern Telecom	205 (23%)	226 (22%)	203 (18%)	246 (21%)	263 (21%)	273 (21%)
Bell Canada Labour	179	215	235	250	267	277
Other Components	30	37	39	42	48	52
Total	901	1010	1103	1190	1270	1320

Source: RTPC, exhibit no. B-76-204.

Note: The figures between parentheses are the percentage of total expenditures for the corresponding items.

6. Cross-Subsidization Issue

6.1 Introduction

As we have seen in the preceding sections of this report, the Canadian telecommunications industry is characterized by a high degree of vertical integration manifested mainly at three stages of the production process: the operating company, the manufacturing suppliers, research and development activities. The two most prominent examples are the Bell system, involving Bell Canada, Northern Telecom and Bell-Northern Research, and the GTE group with British Columbia Telephone, Automatic Electric and Lenkurt. The last section has shown up clearly that vertical integration influences the carriers' purchasing policies. It has also a tangible impact on innovation. A question is immediately raised by these relationship: are such behaviors detrimental to someone?

The social benefits (or harms) of a vertical structure are a matter of discussion, and the regulatory authorities appear to be leaning to the view that, in some cases, vertical integration may result in abuses to the detriment of at least some services or subscribers. Moreover, the would-be harmful consequences of vertical concentration are probably enlarged by the new and accelerated blurring of the line between regulated and non-regulated activities, and between the telecommunications and the computer industries.

Those who identify the possibility of positive gains arising from a vertical structure see those benefits mainly in terms of cost economies (searching, transaction, marketing...), risk reduction (less fluctuations in supplies, smaller interest rates...), greater market power, and accelerated technical innovation. Those who question the merits of vertical merger do so in terms of reduced efficiency, controlled market entry, and slower technological change. Many of these contended drawbacks might be seen as resulting from a monopolistic situa-

tion. But particularly in the presence of regulation, vertical integration can extend both the degree of monopolization and the ability to reap resulting monopoly rents. Vertical integration thus is pushing in the same direction as monopolistic power. Thus, some cross-subsidies that might, at first glance, be imputed to monopoly elements, cannot be discarded thoughtlessly when we are studying the impact of vertical concentration. The most crucial issues raised by vertical integration are then internal pricing, price discrimination, barriers to entry, diversification, and technological innovation. It is principally from the standpoint of these special themes that, in the following paragraphs, we will look for the existence of potential cross-subsidy flows.

Vertical integration is a phenomenon which can be looked at from different points of view. The approach consisting in the determination of the possible sources of cross-subsidy allows the definition of where and how much market mechanisms are distorted by vertical concentration. It is worthwhile to recall that cross-subsidization results from market imperfections. To understand this, suppose a manufacturer who subsidizes product A by selling B at higher prices than necessary. If firms are free to enter the market, another manufacturer could produce the commodity B at lower prices that the first producer and force him to quit the industry or to produce more efficiently. The presence of cross-subsidization thus reflects some restriction on the entry into the industry.

It is also important to note that cross-subsidy issue is a problem of economic efficiency, and not a question of equity. For example, to ask whether each service of a multiproduct firm pays some "fair" share of the common costs of the business is an important question but, strictly speaking, it should not be confused with a possible source of cross-subsidization. Consequently, when we want to determine the presence, and possibly the extent, of a cross-subsidy, this cannot be made on a fully allocated cost basis, which explicitly implies a sharing of the common costs according to some arbitrarily constructed allocation procedure (it is possible that a cost allocation formula

leads to the absence of cross-subsidy, for example the Shapley value with zero cross-elasticities, but nonetheless the concept of cross-subsidization must remain oriented to efficiency). Economic efficiency argues strongly against subsidization. However, in many cases, government think equity is more important than efficiency and decide to introduce subsidization; this is quite another problem, though fundamental.

Furthermore, if one service or customer is being subsidized by another, then both has to be identified. Cross-subsidization occurs when those who receive the benefits of an economic process differ from those who bear the costs. It is simply not sufficient to determine where the recipient of a subsidy is without also identifying the source of this subsidy. In cross-subsidization there is a loser and a winner, and these two must be different. With this scheme of reference, we have to show who wins and who losses, and this may be made in terms of costs to be beared, reduction of quantity or quality of production, etc... A measure of the extent or the magnitude of such a transfer thus can reveal the direction and the importance of one possible impact of vertical integration on the allocation of resources. There are many situations where these potential cross-subsidy flows could appear: inside a firm belonging to an integrated system, between two companies of the same integrated system, between one integrated group as a whole and some independent companies, and between an integrated system and the society in general. Finally, although the TCTS consortium is not generally taken into explicit consideration when we speak of vertical integration in the Canadian telecommunications industry, its role in this context may be important in some instances, and it is meaningful to consider it.

6.2 Pricing Policies

Under this heading, we will speak of internal pricing policies and price discrimination. Though internal pricing is specifically related to vertical integration, price discrimination is not. Moreover, we must be very cautious with price discrimination since it is a phenomenon quite accepted in the economic theory and not necessarily harmful. We say that price discrimination occurs when quantities Q_A and Q_B of a same product (or of products slightly different) are being sold to the same buyer (or several ones) at different prices P_A and P_B, and if this price discreapancy is not warranted by differences between the corresponding costs of production C_A and C_B, i.e. if $PA/CA \neq PB/CB$. Several conditions are required to make price discrimination a possibility: the seller must have some market power, i.e. he must be able to distinguish between buyers according to their different elasticities of demand, and there must be no opportunity for arbitrage between the segmented parts of the market. All these conditions are satisfied in the case of the telecommunications industry. The right problem is then with "undue" price discrimination which has to be correctly identified.

The last preliminary remark worth noting is the following question. If we suppose that vertical integration does not affect the real costs at each stage of the production process, and if the relevant firms are profit maximizers and demand conditions are not modified, then is it possible for the integrated firm to have an influence on prices? There are three known cases where the answer is negative.

1) if the integration is between two firms, each one meeting competition at its respective stage of production;

2) if the integration occurs between a monopoly at one level of the production process and a competitive firm at another stage;

3) if the integration is between a monopoly at one production level and all the firms facing competition at another stage.

Although these three cases are not necessarily exhaustive, none of them is relevant for the situation prevailing in the Canadian telecommunications industry. It thus must be admitted that an integrated firm may have a tangible influence on its prices.

6.2.1 Internal Pricing

Bell Canada is a monopoly regulated through a permissible rate of return on a financial capital rate base; Northern Telecom is not. Bell Canada's rate base contains the original investment made by Bell in Northern; that portion of Northern's earnings that come back to Bell Canada as dividends are also included in the net income of Bell Canada for calculating its rate of return on employed capital. It might thus be to Bell Canada's benefit to pay excessive prices on purchases it makes from Northern Telecom, and thereby circumvent the effect of the regulatory constraint. Moreover, Bell Canada could further increase the profitability of its consolidated business if Northern Telecom constains its dividend pay-out ratio. This double strategy, though possible only in the short term, results in higher rates for telephone subscribers while permitting Northern Telecom to reap the monopolistic profits that regulation had entended to eliminate. Hence, "natural" monopoly that is supposed to prevail at the common carrier level is shifted to the supplier level, rendering regulation ineffective. Telephone customers then may be subsidizing Northern Telecom's activities.

Henceforth, if Bell Canada purchases its equipment from Northern at higher prices than supposed, there is a monetary transfer from Bell Canada's customers to Northern Telecom. Bell Canada increases the necessary capitalization required to finance its inflated plant and equipment, and through the permissible rate of return it will reap more money from its customers by higher tariffs. This behavior will also augment Northern's rate of return since the increase of its sales has not required any increase of its costs of production.

To know whether this policy of internal pricing between two affiliates might lead to cross-subsidization depends essentially on

the way Northern Telecom could utilize this supplement of funds. For example, if the company invests this monetary surplus in research activities which result in a cost reduction innovation whose benefits are passed to the customers through lower prices or increased quality, then cross-subsidization is an uncertain issue. In fact, it is possible that the customers who will pay higher tariffs are the same who will benefit from the advance in technology. In its case, there is no cross-subsidy. However, even in the situation of an investment in research and development by Northern Telecom, there is yet a possibility of cross-subsidy if the rates that were permitted to be increased correspond to consumers different from those who will enjoy the innovation. In any case, there is always the problem of timing since the burden and the benefits are not necessarily coincident. This part of the problem is difficult enough to tackle because internal pricing involves monetary funds whose distribution between the relevant customers must be determined.

The problem is much clearer if we imagine that Northern Telecom follows another strategy. Suppose Northern uses the supplementary funds generated by its higher prices to Bell Canada to lower prices of one of its competitive product. In that case, the situation is simpler because the two groups are clearly identified: the customers whose rates will be increased are the losers, the consumers who will buy Northern's competitive product are the winners.

The line of reasoning we have followed in the last three paragraphs would be concertually interesting if the required information were available, since it would permit to precisely identify who will benefit and will support the burden. However, this approach appears quite difficult to implement since it seems unlikely that we could determine which service(s) will see its rates increased because of higher prices of purchased equipment, and its dubious that we could evaluate what Northern will do with its supplement of revenues. It is probably one reason why the commissions have, up to now, looked at the problems of cross-subsidy resulting from internal pricing from just one side of the test. They have tried to estimate and control the size of the pos-

sible burden that may be imposed on ratepayers, or they attempted to reckon the extra benefits that an affiliated, non regulated supplier could gain through higher prices. This is the purpose of the many price comparisons concerning equipment purchased by Bell from its subsidiary, and the many rate of return calculation designed to evaluate the profits gained by Northern on the different markets where it sells.

Price comparisons and rate of return calculations are not, strictly speaking, cross-subsidy tests for the internal pricing problem; they are only one-sided tests. Many versions of the rate of return tests can exist. One can claim there is no subsidy if:

a) the rate of return earned by Northern Telecom on capital it has dedicated to Bell business is less than or equal to Northern's over-all rate of return (see Board of Transport Commissioners);

b) Northern's rate of return on Bell business is not greater than Northern's rate of return on non-Bell business;

c) Northern's rate of return on Bell business is less than or equal to some weighed rate of return constructed from some chosen electrical equipment producers considered as comparable with respect to Northern's activities;

d) Bell's rate of return through dividends on its investment in Northern is higher than Bell's permissible rate of return (see CTC).

It is obvious that all these tests are vitiated by arbitrariness. Their main purpose is always to find out whether Northern's prices are set too high when it sells to Bell Canada. They all implicitly assume that there may be a potential subsidy flow from Bell Canada to Northern Telecom. Thus, they all suppose that Bell's customers might be burdened by the existence of vertical integration. None of them, however attempts to determine who will receive the benefit of this would-be transfer. We

have seen earlier that it is a very difficult task to try to determine both the gain and the burden of such a transfer.

Finally, many price comparisons might be utilized to check whether payments for goods and services purchased by Bell Canada from Northern Telecom were reasonable. We will not elaborate here on such methods since the F.C.C., for example, has rejected price comparison methodology for evaluating whether prices charged by Western Electric to Bell Operating Companies were just and reasonable. The main factors that have eroded the validity of these tests are:

a) rapid technological change,

b) intense short run competitive entry on the equipment market,

c) long run market foreclosure,

d) affiliated supplier's degree of monopoly or oligopoly in certain product lines.

Moreover, since the internal pricing problem is quite difficult to assess precisely, in such situations the best approach is usually to rely as much as we can on economic principles, so as to minimize, if possible, unwarranted vagaries. Thus, we believe the true test for a subsidy-free internal pricing policy must reveal whether or not the unit supplementary equipment costs (including the associated research and development expenses) are covered by the prices charged to the operating company. The ultimate issue is then an incremental cost test.

The case we studied in the preceding pages was the following: an integrated system comprising an operating company and its affiliated supplier. Taking into account the form of regulation (a permissible rate of return), it was stated that the profit of the system could be increased if the carrier is paying higher prices to the supplier than usually.

Thus, we expect a subsidy flow from the carrier to the supplier. In practice the situation seems to be the opposite. On surveys of prices of plant and equipment required by CRTC or RTPC, Bell Canada has constantly been able to show that "Northern Telecom's price levels on sales of communication equipment to Bell Canada were consistently lower than price levels of other major North American suppliers, except for sales by Western Electric to members of the Bell System in the United States" (RTPC, exhibit no. B-76-424). This would not necessarily mean that the monetary subsidy flow is inverted (from Northern to Bell) and that Bell Canada's customers are receiving the benefits of the subsidy. The situation is quite possible, for example, if Northern Telecom enjoys important cost savings (economies of scale, of scope, and of integration). This shows clearly that price comparisons not established on current incremental cost basis cannot fully appreciate the subsidy issue in internal pricing.

6.2.2 Price Discrimination

Northern Telecom's dual role as member of the Bell System and competing seller to a variety of other customers might be expected to give rise to some price discrimination between these different markets. To be successful, such discrimination must be accompanied by some procedure preventing arbitrage of the intermediate product between downstream firm; however, rate-of-return regulation itself lessens the incentives for such an arbitrage.

Thus, one possible cross-subsidy flow that we might expect is that Northern Telecom could charge an excessive price for sales to Bell Canada and earn a nonremunerative price on sales to other customers. Such a cross-subsidization signifies that Northern Telecom might use its captive relationship with Bell Canada to engage in unfair competition in noncaptive (or less captive) markets. It is not unrealistic to consider as possible such a behavior if we remember, from section 5, that although Northern Telecom enjoys a very good position in the telecommunications equipment market, there are several submarkets where competition is important.

In fact, this unfair competition in noncaptive markets has much resemblance with the preceding problem of internal pricing. By saying that a possible strategy for Northern Telecom is to charge higher prices to Bell Canada with the objective to compete more agressively in other markets, we only spell out the internal pricing problem in specifying exactly who wins and who losses in that cross-subsidy game. The criterion usually used to estimate that cross-subsidization flow is the rate of return test, but again we think that the best criterion would be an incremental cost test executed at the required level of disaggregation so as to focus as much as possible on the source of cross-subsidization.

A particular problem of price discrimination is as follows. Price comparisons exhibited before the Restrictive Trade Practices Commission indicate that the price paid by Bell Canada to Northern Telecom for telecommunications equipment, for example, the 500 type telephone set, is always smaller than Northern Telecom general trade level. This means that Bell Canada pays less for telecommunications equipment from Northern than other carriers are usually paying for the same equipment from the same supplier. In other words, Northern Telecom is discriminating between different carriers.

We know from economic theory that a producer maximizes its profit in selling its product on two fragmented submarkets by pricing lower on the market with the greatest demand elasticity. If we admit that this principle of economic theory is undisputable, and since Northern very often offers lower prices to Bell Canada when compared to other carriers, it would be interesting, if possible, to try to estimate whether Bell Canada so often exhibits a higher elasticity of demand.

6.3 Technological Innovation

High technology is a characteristic feature of the telecommunications industry. The interaction of vertical integration and technology is a characteristic feature of the telecommunications industry. The interaction of vertical integration and technological innovation

demonstrates many situations where cross-subsidization may intervene. Of course, these problems often flow from the high degree of monopolization and the existence of regulation, but they are usually greatly amplified by the vertical structure. These pretented evils seem to resist any effort of quantification; it is then possible that their study has to concentrate on a qualitative analysis. The methodology thus might be confined to case studies.

Though innovational output has been, in general terms, highly impressive, the relationship between Northern Telecom's integration in the Bell System and technical progress may be questioned in three ways:

a) the slowness of an integrated system in adopting technological advance originating outside of it;

b) the existence of possible delays in the introduction of cost-reducing technical changes;

c) the foreclosure of competitive innovation.

In all three cases, telephone subscribers might have to pay for Bell's preference of technological exclusivity. The same could also be true for B.C. Tel.

Bell Canada does have a bias toward equipment produced by Northern Telecom, and may delay adopting new technology or new facilities stemming from outside firms, at least to the extent of waiting first to determine whether Northern Telecom may be successful in developing its own alternatives. If the effort does not succeed, delays are not infinite; Bell prescribes and Northern begins to buy the outside equipment. There are some examples indicating that what Bell Canada calls "technological self-sufficiency" is not only a kind of stimulus for innovational output, but may also be considered another facet of the vertical structure organization.

For example, the controversy created by the vertically integrated telcos (Bell Canada, B.C. Tel.) over the choice of the right switching technology is quite meaningful. Western Electric tried to develop its own automatic exchange switching equipment, the "Panel dial type", and lost much money with it. Its purpose was to attempt to circumvent the patents on the much more efficient step-by-step switch made by Automatic Electric. More recently, B.C. Tel.'s great resistance to introduce the cross-bar switch (manufactured by Northern) and to stay with the technology produced by its affiliated suppliers, is certainly a burden to the detriment of its subscribers. Conversely, it seems that Bell Canada introduced substantial cross-bar equipment on its territory, a move that might have been too large. In the cross-bar case, only the Prairie telcos (which are free of any affiliation) seem to have adopted the right pace.

Many other similar case studies should be followed in the near future to evaluate the impact of vertical innovation upon technical change. For example, in many submarkets (quoted in section 5) experiencing fierce competition, it might be fruitful to observe suppliers' and carriers' moves when confronted with new products. Three main markets where such reactions will be interesting to follow are fibre optics, digitized equipment, and PBXs.

Requirements of uniformity in the system play a paramount role here. Bell Canada's control of equipment specification cuts down the scope for experimentation with new techniques and keeps to a minimum any possibility of significant equipment sales to the Bell System by outside suppliers. It thereby practically hinders any interest on the part of other electrical equipment producers in developing new products or techniques for the telephone market. In addition, if there is a threat of new entry, through innovation, into the system's traditional markets or into attractive possibilities, the system might augment its research and development activities, by a crash program, to exclude the rival suppliers. Such preemptive innovation in response to would-be competition might be put to the point of negative social returns, i.e.

not only telephone customers will pay the bill through higher rates, but there will also be a waste of resources in the economy.

A final remark must be made about depreciation policies. Telephone companies use long service lives which imply basing most of their depreciation on physical usage and "evolutionary" obsolescence (like replacement due to inadequate capacity) rather than true technological obsolescence (when the marginal cost of continuing with an old technology becomes greater than the average total cost to install a new one). Some major innovations are now displacing old technologies faster and faster. Who will bear the burden imposed by these drastic changes?

7. Conclusion

7.1 Summary of the Report

The current report is subdivided into three parts, each containing two sections. The first part (sections 1 and 2) outlined the main characteristics of the telecommunications industries of service production and equipment manufacturing. Section 1 indicated briefly the meaning of the telecommunications industry and described the related regulatory environment, particularly by specifying the level of regulatory authority which the common carriers are subjected, and whether they are controlled by a private or public ownership. Section 2 focuses on the relevant market structures. The telephone operating industry is mainly dominated by the members of the Trans Canada Telephone System (9 companies) and CNCP Telecommunications. Bell Canada occupies a central place in that industry, and a special mention is given to it. The equipment manufacturing side of the industry comprises around one hundred companies which have some sizeable share of the market. But full competition does not necessarily characterize that sector, particularly because of the great weight of Northern Telecom. A closer look at concentration into that part of the industry is given by focusing at the provincial level which, in most cases, defines the scope of the activity of the major telecommunications carriers.

The second part of the report may be considered an effort to provide a brief synthesis of the current theoretical knowledge concerning vertical integration and technological innovation. These two topics are of paramount importance in order to disentangle the complex problems confronting the telecommunications industry (such as interconnection, cross-subsidy, and the fast changing character of the industry). Section 3 defined the meaning of vertical integration, and analysed the principal incentives underlying vertical integrated structures. Moreover, attention was directed at the main consequences in terms of productivity or barriers

to entry that could result from vertical concentration, both at the industry level and for the economy as a whole. Section 4 studied, in general terms, the impact of market structure on innovation. Briefly in a first stroke, the process of technological change is analysed with the objective of identifying different phases that may define it; then, special attention is given to several ways to measure the flow of technological innovation. Finally, firm size, monopolization and regulation are discussed in order to determine how they influence the pace of technical advance. These determinants were selected because they depict relatively well the main characteristics of the Canadian telecommunications industry.

The main results of these two sections are the following. The major motives prompting vertical integration are, first to reduce costs of producing the firm's final products in reaping profits made before by outside firms or in avoiding some costs (transactions, marketing, planning,...) and second, to enable the integrated firm to discriminate more actively on a price basis. Consequently, one must qualify the statement that vertical concentration will not change the level of optimal output of the final product and its price. There are two important cases in which a vertical merger may affect the quantities and the prices of the final good, even though demand conditions for the final product, and cost conditions at each stage of the production process, are unchanged. The first occurs with price discrimination, the second when there is bilateral monopoly, i.e. if the integrated group is characterized by monopoly power at two successive stages of production. These two situations seem quite relevant to the Canadian telecommunications industry. Moreover, vertical integration may affect the behavior of potential entrants in increasing the needed capital requirements for newcomers, or by limiting the potential market they can share.

When considering technological innovation, there appears to be no general tendency for R and D spending per sales to be higher for large corporations than for their smaller competitors, although a minimal size of the firm is necessary for R and D to be profitable. Con-

cerning innovative output, the number of significant inventions per dollar of R and D expenditures is not greater in the largest firms, though these big enterprises in general devote a greater portion of their R and D spendings to basic research, commit themselves in more technically ambitious projects, and can have longer expected completion time. With respect to monopoly power, the evidence is relatively ambiguous, though it seems reasonable to believe that the influence of market concentration on the rate of technical progress is less important than other variables. It is conceivable that existing monopoly power is a favorable structure only for investment in basic and fundamental applied research, where risks are high and externalities important. Regulation has many opposite effects on innovation, depending on the kind of regulation used and the way it is implemented, and on the structure of the industry. On any event, special mention must be made about one reason to prompt the innovation process. The pace of technical advance may be accelerated by a regulated firm in order to impede freer competition and further entry.

In the last part of the report (sections 5 and 6), we attempted to find out what the impact of vertical integration is on the Canadian telecommunications industry. First, in section 5, we looked at the telecommunications equipment market to see how much each major telephone operating company bought on each submarket and what were their respective purchasing policies. We observed that integrated companies buy most of their equipment from their affiliates and do not make use of competitive bidding. Independent carriers have more diversified sources of supply and often use more competitive bidding. Section 6 attempted to precise the way we look at cross-subsidization in the context of vertical integration. The two main issues questioned about vertical concentration are internal pricing and technological innovation. We indicated the main problems posed by each of them, and briefly sketched the kinds of cross-subsidy tests that are or might be useful for studying the impact of vertical integration.

7.2 More about Cross-Subsidy Tests

The term cross-subsidy is usually ill-defined. We have stressed, in section 5, that when speaking of cross-subsidization we must define whether we are interested in equity or efficiency. If we hope to find out cross-subsidy tests which will have an objective character, we must consider cross-subsidization as an efficiency issue, i.e. the relevant criteria must be defined in terms of optimal resource allocation. On the other hand, if we are interested to equity issues, we have to recognize that any cross-subsidy test may, in some way or another, be considered subjective or arbitrary, since the relevant question is a matter of redistribution of resources or of a fair share of the incurred costs.

The usual cross-subsidy tests are defined on a fully distributed cost basis, or in terms of marginal or incremental costs, or as a burden test. By a fully distributed cost test, we examine whether each service or customer pays a fair share of the total costs, including some arbitrary portion of the common and joint costs. These tests have the benefit of simplicity, but they will always be tarnished by arbitrariness; moreover, they are not motivated by efficiency and they can only be used as equity criteria.

A marginal cost test requires that the price of a service be at least equal to the marginal cost of producing it. This criterion is based on efficiency grounds, and is then an objective test. In principle, it is a simple test since it gives a lower bound for the prices of each service so as to be subsidy-free; however, its implementation may be difficult because marginal costs must be estimated, and this is an arduous task. We can simplify the problem (and also modify it) by replacing marginal costs by incremental costs which are the addition to total costs incurred by the firm when producing a particular service at a definite level of output, relative to not offering the service at all. So defined, this test does not lead necessarily to economic efficiency, but its arbitrariness is much less questionable than in the case of fully

distributed costs. Obviously, both the marginal and the incremental cost tests do not resolve the problem of distributing the common costs.

Finally, a burden test requires that the continued provision of a service permits customers of other services to pay no higher prices than would be otherwise necessary if the service in question was no longer offered. Such a test implicitly implies an allocation of common costs and so, is not, strictly speaking, a criterion of economic efficiency. However, this is the only test which brings into consideration the several cross-elasticities of demand, an important element when dealing with dynamic issues like open entry to competition and deregulation.

Thus, depending on whether we ask the question in terms of equity or efficiency, we restrict ourselves with respect to the available cross-subsidy tests. Of course, there are other tests that can be considered and which we have not discussed here (like when trying to maximize the consumer's and producer's surplus), but we only desire to put emphasis on the limitations we necessarily have on the choice of the tests with respect to the goals expected. Concerning vertical integration, we think that the cross-subsidy problem must be termed on efficiency ground, since that particular market structure aims essentially at increasing performance. On the regulatory side, however, we may be interested with equity issues since a service is often regulated for equity purposes. These two motivations, equity and efficiency, are not always distincly separable from one another, but we must be conscious of their different character.

Another problem with cross-subsidization is that many components must be taken into consideration when we wanted to have a clear idea of the potential flows of cross-subsidy. The major ones are:

a) we must consider a multi-product, regulated firm which have some of its products or services in the competitive, other in the monopoly area;

b) the multiproduct firm is characterized by common costs of production;

c) we must include non-zero cross-elasticities of demand for some final products;

These main characteristics are important if we do not want to be misdirected in our conclusions. Moreover, they imply that some crucial information about costs and demands must be available. This needed information is difficult to obtain readily.

We have seen, in section 6, that the problem of internal pricing is quite arduous because we would precisely need information about costs, prices and demands to have any solid indication about the would-be cross-subsidy flows. Moreover, it is difficult, in this case, to determine the recipients and the sources of the potential subsidy, particularly because we do not know where the firm allocates the related amounts of money. In the case of the impact of vertical integration upon technological innovation, we think that this influence can be traced out more easily, particularly by the way of detailed case studies of some innovations and the consequent reactions of the vertically integrated and independent companies.

7.3 Possible Extensions for Further Work

Optimal policies, such as the cross-subsidy problem, in general require a great deal of information, unlikely to be readily available in practice. Moreover, when dealing with a regulated multiproduct entreprise, it is unrealistic to believe that we can reach desired goals, introducing only one constraint on the decisions of the firm. This behavior would leave the firm with too many degrees of freedom in order to escape the effects of regulation. In fact, the regulator must have at his disposal a full information on costs and demands for all the services involved, as well as a solid intuition of the unmeasurable benefits of competition when promoting innovation and responsiveness to customers' changing needs. Finally, he must also be cognizant that his policy tools are all intimately intertwined, and that an incomplete system of controls

could only lead to inappropriate incentives. These remarks are intended to put emphasis on the fact that the question: "What is the fair price of a service?" might be a quite wrong direction of inquiry if considered out of context.

The problem of internal pricing is a very arduous issue to settle because the serious lack of pertinent information on cost and demand, and there is also the added difficulty of presenting a complete and coherent model of the phenomenon. We are thus confined to develop and use second-best solutions. As we have already said, the impact of vertical integration must be assessed in efficiency terms. We then require information on production costs and demands at a sufficient level of disaggregation in order to devise tests applicable to individual services. If price comparisons are used as methodology, they must be developed to permit an evaluation with respect to their relevant incremental costs of production; it is the only way to take into account the various economies of scale or of integration. If rate of return analysis is selected, it must be performed for each individual service, taking into consideration that these services are produced jointly by the firm and that they do not all face the same pressures on the marketplace.

Another methodology could be envisaged: an analysis based on prices that would maximize the sum of consumers' and producers' surplus. This is a well known tool of applied welfare economics which has the advantage to being an approximation of the net benefit to society. The sum of these surpluses leads to a set of efficient prices with which we could compare the actual prices in order to detect the presence or absence of cross-subsidization. A deviation from these efficient prices would reveal interservice subsidy, whose effect on society would be measured in terms of net lost benefits. This methodology has the great advantage of defining the test in terms of efficient prices, and to take into consideration the relationship between pricing policies and market structure. The main difficulty for the implementation of that approach lies in the fact that a knowledge about demands schedules is required. However, we must remember that any methodology will also necessitate information on costs and demands to be realistic and useful. But one has

to recognize that the surplus approach will always require more data than the other tests, mainly because it takes into account the impact of prices on the entire market, and not only on the multiproduct firm. What makes this approach very interesting is also a source of possible difficulties.

Whatever methodology is to be developed to test the various pricing policies, it must be recognized that a model of the regulated multiproduct firm is necessary. The model must consider the following:

1) existence of common and joint costs of production;
2) possibility of economies of scale and of integration;
3) simultaneous presence of competitive and monopolistic products or services;
4) possibility of non-zero cross-elasticities of demand; and
5) threat of entry into at least one market.

Technological innovation does seem to be very pertinent for analyzing vertical integration in the context of the telecommunications industry. The industry will be faced with some revolution in the coming years; the two principal sources of this warm-up are huge advances in technology and a new wave of bruising competition. A large stream of new products and new services is flowing into the market ranging from computer-like switchboards and terminals to computerized communications networks. These innovations are changing the very nature of the industry in a drastic way.

The main characteristic of these innovations is that it is a complex mixture of semiconductors, optics, large scale integration processes, computers, and space satellites. This means that advanced technologies in telecommunications and in data processing are merging into only one. We have to remember the leading role played by Northern Telecom in computerizing the telecommunications industry, and the new interest manifested by IBM into the telecommunications business (selling PABXs in Europe, attending the FCC commissions and inquiries, and hoping to create a "satellite" network requiring from the consumer only an antenna on the roof of each house to have access to this network).

Moreover, more and more analysts in both the telecommunications and the computer industries tend to agree that it is a mix of these two businesses that will lead, finally, to practical electronic transfers of funds for banks and retailers, to integrated information systems for corporations, to the electronic delivery of mail, and to a wide access to computer data banks via telephone. Thus, a possible war between two different kinds of industries is beginning to get the control of a brand-new market. More importantly, the quickening of the pace of technological change brings with it a new era of potential competition, and signifies for the phone utilities (and also for the regulators) a mixed bag of uncertainties and opportunities.

New problems are coming up with this rapid technological innovation and the blurring of the line between telecommunications and data processing industries, for companies as well as for regulatory authorities. Common carriers will have to change their strategies in the conversion from a telephone company to a communications systems enterprise, since they move from a monopolistic to a competitive environment. This probably implies a broadening of the concepts of products and services, and a change in the objectives of the firm in view to be closer to the needs of the marketplace. Even the limits of the industry will have to be reconsidered by the carriers: new competitors will appear from outside who have a good command over the new technology. This could imply for the common carriers a new philosophy regarding research and development programs.

How regulators will behave vis-à-vis these drastic changes? Will the regulatory authorities classify the new Bell computerized services under regulated communications? How will they consider new sophisticated terminals PBX software packages, and switching systems connecting a distributed set of terminals and creating new integrated networks? Should common carriers enter data-processing business only through unregulated subsidiaries? Is vertical integration a sine qua non prerequisite to make phone utilities capable to compete with giant enterprises in the data processing industry? What rules of behavior will follow with respect to services provided by data processing firms

(which are not regulated) if they have some resemblance with regulated telecommunications offerings? How to consider the new "satellite" service that IBM wants to provide through SBS, and which one will avoid the necessary interconnection to the local network of the common carriers? Will the regulators force IBM, in one way or another, to contribute financially to the local network? Should deregulation be envisaged and proceed gradually so that companies could adjust to the new world of competition, or is it more efficient and less disruptive to move more rapidly toward competition? If deregulation is considered, what will be the extent of the process? In that case, what to do with the fact that Bell is stuck with so much undepreciated and yet obsolete equipment (depreciation is much slower for regulated utilities now than for competitive firms)? Should capitalization policies be modified (by excluding profits and installation costs from capitalized assets) to render them comparable to those of non-regulated enterprises? What are the consequences for the Canadian manufacturing industry of the opening to competition of the protected telecommunications industry since most of the important would-be competitors are not Canadian?

These questions do not pretend to cover the full range of issues arising from the rapid evolution of technological change. They are indicative of some possible changes, institutional or structural, that the telecommunications industry and the related regulatory authorities will have to tackle in the near future. In fact, we have omitted broader social issues such as the impact of technological change upon employment, national sovereignty, and for developing the competitiveness of our firms at an international level. These issues are very important, but we have voluntarily limited our vision to the links between technological innovation, market structure, pricing policies and regulatory behavior. We thus think it could be valuable to try to seize the extent of the technological progress happening in the telecommunications industry, the way it will metamorphose the definition of this industry, and the consequences it will bring for the regulatory authorities, i.e. what is the meaning of a national telecommunications policy in this context, and what are the possible guidelines for practical regulatory processes?