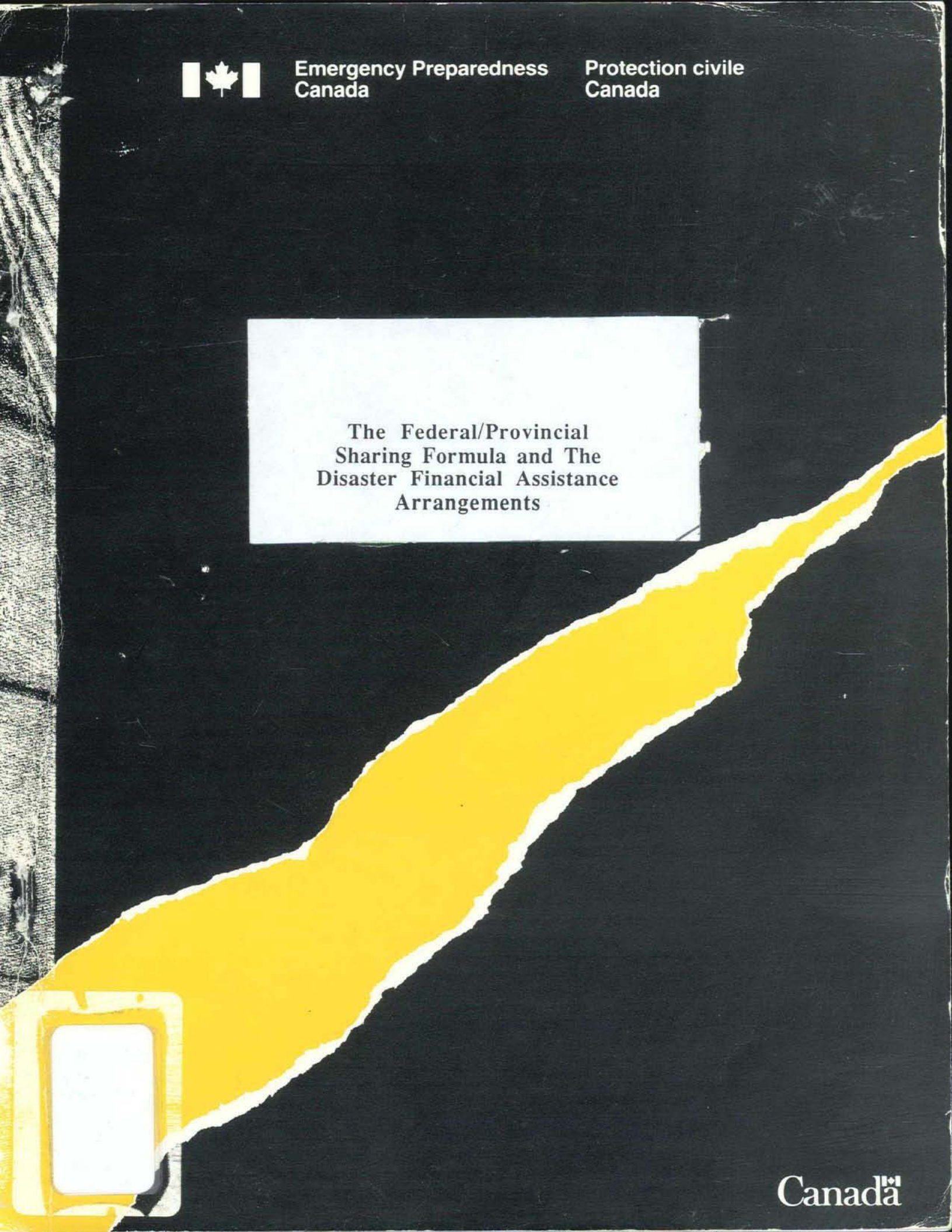
Emergency Preparedness Canada
Protection civile Canada
The Federal/Provincial Sharing Formula and The Disaster Financial Assistance Arrangements
Canada

The Federal/Provincial Sharing Formula and The Disaster Financial Assistance Arrangements

by

Dr. Gregory W. Frank
Evaluation and Analysis

Technical Report 91-1

Emergency Preparedness Canada

October 1991

Executive Summary

The Disaster Financial Assistance Arrangements (DFAA) are a set of guidelines designed to provide provinces with federal assistance in the event of a disaster beyond the province's reasonable economic recovery ability. The guidelines support the determination of levels of assistance, questions of 'reasonable recovery ability', and qualification of eligible (sharable) expenses.

Since its introduction in 1970, DFAA have involved a total of approximately $155 million expended by the Federal government in assistance of disaster recovery, with approximately $80 million of assistance currently under negotiation. These funds have assisted provinces in disaster recovery totalling approximately $330 million of eligible expenses.

DFAA determines the level of federal assistance in response to a disaster by the *sharing formula*, based upon eligible expenses per capita of provincial population. The formula has not been modified since the DFAA's inception in 1970. The primary objective of this report is the updating of the federal sharing formula to reflect current economic and demographic Canadian realities.

In the twenty years since the plan's inception, substantial changes in the milieu in which DFAA operates have occurred which have not been accommodated. These are identified as economic factors resulting from the change in purchasing power of the Canadian dollar, and demographic factors resulting from population growth. The overall effect of decreased purchasing power has been to increase the Federal burden by effectively lowering DFAA sharing thresholds. The effect of a growing national population has been to raise the per-capita based sharing thresholds and thus slightly lower the federal burden. When both economic and demographic effects are taken into consideration, the relative federal burden has *increased* substantially.

A collection of alternative sharing formulae are presented and assessed against several criteria involving requirements of fairness, simplicity, conformance with the original intent of the DFAA guidelines, and overall adequacy. Candidate sharing formulae which satisfy these criteria are then examined for their economic impact, using a simple model of resource flow which incorporates several economic mechanisms which can act to redistribute funds and effectively shift the federal/provincial sharing ratio.

The sharing formula option which results in an increase of current thresholds by a factor of three, with an additional sharing level introduced at the $1 per capita level, would compensate for the effects of inflation and population change, while continuing to allow participation in the arrangements at the current entry level.

Resumé

L'Aide financière en cas de catastrophe (AFC) énonce une série de lignes directrices permettant au gouvernement fédéral d'apporter une aide aux provinces lorsqu'une catastrophe entraîne des dommages tels que les coûts de rétablissement dépassent la capacité économique raisonnable de la province en cause. Les lignes directrices traitent de la détermination des montants d'aide qui peuvent être accordés, des questions de "capacité raisonnable de rétablissement" et du calcul des dépenses admissibles, au partage.

Depuis l'entrée en vigueur de l'AFC en 1970, quelque 155 millions de dollars ont été versés par le gouvernement fédéral au titre de l'aide au rétablissement suite à des catastrophes, ainsi que des montants totalisant environ 80 millions de dollars qui font actuellement l'objet de négociation. Ces sommes représentent l'aide au rétablissement versée aux provinces à l'égard de montants totaux d'environ 330 millions de dollars de dépenses admissibles.

L'AFC permet de déterminer le niveau de l'aide fédérale versée en cas de catastrophe selon la *formule de partage de coûts*, établie à partir des dépenses admissibles en fonction de la population de la province. Cette formule n'a jamais été modifiée depuis que l'AFC a été mise sur pied en 1970. Le présent rapport vise principalement à remettre à jour la formule fédérale de partage des coûts à la lumière des réalités économiques et démographiques du Canada d'aujourd'hui.

Au cours des vingt années qui se sont écoulées depuis l'adoption du programme, des changements substantiels affectant l'AFC se sont produits dans la société sans pour autant que le programme soit rajusté en conséquence. Il s'agit de facteurs économiques rattachés à la dévaluation du dollar canadien et de facteurs démographiques se rapportant à l'augmentation de la population. La dévaluation du dollar a pour effet d'accroître le fardeau financier du gouvernement fédéral en abaissant les seuils de partage de l'AFC. Par ailleurs, l'augmentation de la population a pour effet de hausser les seuils de partage calculés par habitant, allégeant quelque peu le fardeau fédéral. Mais en tenant compte à la fois des facteurs économiques et démographiques, on constate que la contribution relative du gouvernement fédéral a considérablement *augmenté*.

Dans le présent rapport, nous présentons diverses formules de partage des coûts et les évaluons en fonction de nombreux critères utilisés pour en établir l'équite, la simplicité d'application, la conformité à l'intention originale du programme et la pertinence générale. Les formules qui satisfont à ces critères sont ensuite examinées sous l'angle économique à l'aide d'un modèle simple d'attribution des ressources qui tient compte d'une série de mécanismes économiques, lesquels peuvent entraîner une rédistribution des fonds et modifier par le fait même le rapport du partage fédéral-provincial.

La formule de partage des coûts qui entraîne le rehaussement des seuils actuels par un facteur de trois, et qui incorpore un niveau supplémentaire de partage au niveau de 1 $ par habitant, permettrait de compenser les effets de l'inflation et de l'augmentation de la population tout en maintenant la participation fédérale à son niveau actuel d'entrée.

The Federal/Provincial Sharing Formula and the Disaster Financial Assistance Arrangements

Technical Report 91-1

This analysis was made in support of a review of the Disaster Financial Assistance Arrangements, conducted by the Director General Readiness and Operations EPC, who has authority for this federal programme.

The opinions expressed are those of the author and not those of Emergency Preparedness Canada nor the Government of Canada. This study is distributed as a working document to interested parties and should not be construed as official government policy.

Table of Contents

List of Figures

List of Tables

The Federal/Provincial Sharing Formula and the Disaster Financial Assistance Arrangements

1. INTRODUCTION

Disaster Financial Assistance Arrangements (DFAA)

The Disaster Financial Assistance Arrangements (DFAA) are a set of guidelines designed to provide provinces with federal assistance in the event of a disaster beyond the province's reasonable economic recovery ability. The guidelines support the determination of levels of assistance, questions of 'reasonable recovery ability', and qualification of eligible (sharable) expenses. Since its introduction in 1970, DFAA have involved a total of approximately $155 million expended by the Federal government in assistance of disaster recovery, with approximately $80 million of assistance currently under negotiation. These funds have assisted provinces in disaster recovery totalling approximately $330 million of eligible expenses.

The Sharing Formula

DFAA determines the level of federal assistance in response to a disaster by the *sharing formula*, based upon eligible expenses per capita of provincial population. The current sharing formula is shown in Table 1, giving federal/provincial sharing ratios as a function of eligible expenses per capita of provincial population. The plan has not been modified since the DFAA's inception in 1970. The primary objective of this report is the updating of the federal sharing formula to reflect current economic and demographic Canadian realities.

Expenses (per capita)	**Federal/Provincial**
$0-$1	0% / 100%
$1 - $3	50% / 50%
$3-$5	75% / 25%
>$5	90% / 10%

Table 1: The present DFAA sharing formula. The formula is based on a set of thresholds, fixing Federal/Provincial sharing in terms of eligible expenses per capita of provincial population.

Objective

The objective of this study is to identify and assess options for amending this formula to reflect better current Canadian economic and demographic conditions. Following a survey of the existing plan over the past two decades, economic effects are incorporated, first by a simple transposition of the sharing formula to accommodate changes in the economy since 1970, then by using fuller economic models to capture more detailed changes. Demographic changes involving population variations are discussed. A collection of possible revisions to the current sharing formula are developed, and assessed against a simple yet realistic model of resource flow through the federal and provincial

economies. This allows a set of criteria to be developed against which each option is judged in a simulation of small, medium and large disasters occurring in small, medium and large provinces. In conclusion, a summary and set of recommendations for possible sharing formulae are presented, together with possible mechanisms to allow future revisions.

2. HISTORY OF DFAA

Federal disaster financial assistance through DFAA has been invoked in over 60 disaster situations from 1970 through 1990. Federal assistance has ranged in scope from $13,473 for hail and storm damage (PEI, 1974) to $22,000,000 as an advance payment following major tornado damage (Alberta 1987). A detailed review of DFAA appears in Annex 2.

Federal assistance by event type

Table 2 summarize federal assistance over the period 1970-1988, categorized by the type of disaster. Categories are loosely defined and not mutually exclusive, and some overlap in unavoidable. For example, much storm damage can occur by flooding. The sole DFAA response to disease refers to a 1983 livestock encephalitis outbreak in Manitoba. Almost two-thirds of disasters involving DFAA, accounting for approximately three-quarters of all federal assistance, have involved floods or flood-related events.

Event	Frequency (Events)		Federal assistance	
Flood	43	66%	$117 M	75%
Storm	13	20%	$15 M	10%
Tornado	3	5%	$23 M	14%
Fire	3	5%	In process	
Earthquake	2	3%	$1 M	1%
Disease	1	2%	$1 M	1%

Table 2: Distribution of DFAA funds by type of disaster. The frequency and total federal shares from 1970-1990 appear in absolute and percentile form.

Federal shares: geographic distribution

Figure 1 shows the geographic distribution of DFAA federal assistance by province, from 1970 through 1990, not including funds currently in process. In order of decreasing total federal assistance, Quebec, Alberta and Manitoba have received the most federal support through DFAA, while the Yukon, Northwest Territories and Ontario have received the least.

Federal shares with time

Figure 2 shows annual DFAA expenditures since 1970. Federal shares in a single year have varied from nil (1976/1977) through to approximately $27 million (1975/1976). There is no readily discernible pattern to the annual expenditures, due to the intrinsically random nature of disasters. In 10 of 19 years, DFAA expenditures have been below $5M. Expenditures have exceeded $10M in 4 years, and $20M in only 2 years.

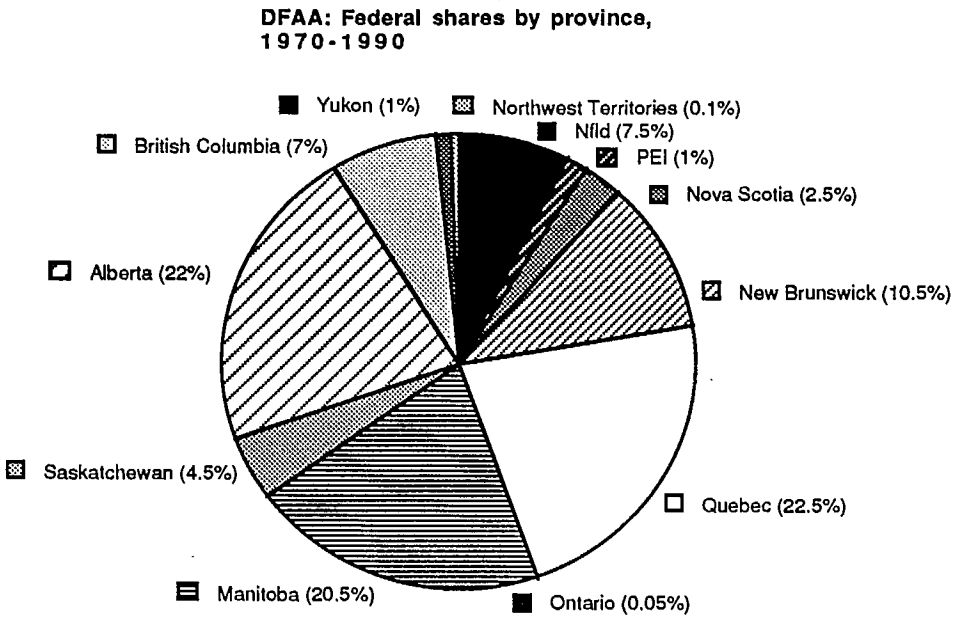

Figure 1: Geographic distribution of federal assistance by province, not including amounts under negotiation.

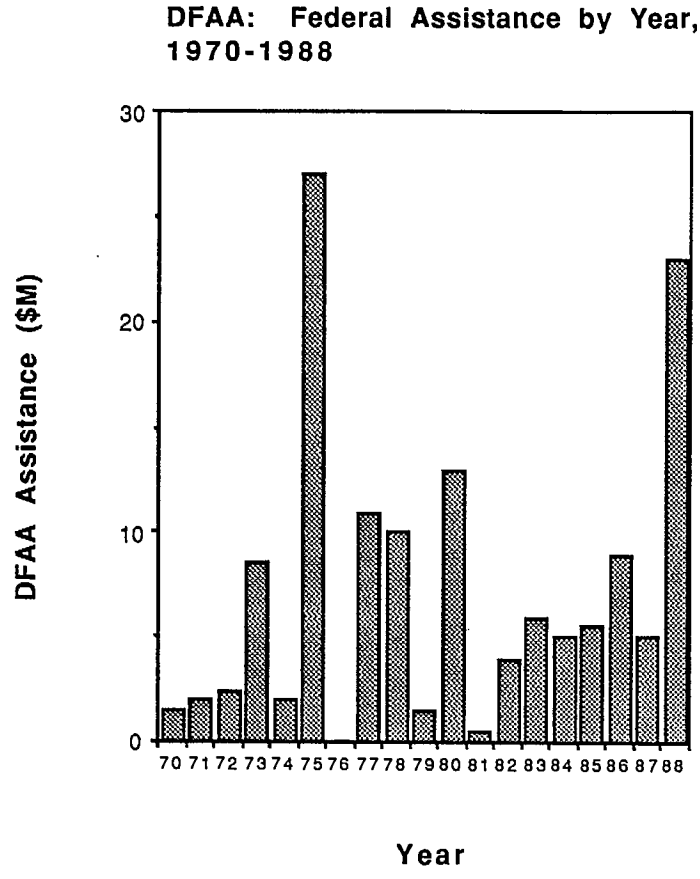

Figure 2: DFAA annual expenditures, from 1970-1988 inclusive. Annual expenditures varied randomly from nil to in excess of $27M.

3. DFAA ASSESSMENT, 1970-1988

The federal shares shown in Figures 2 are with respect to floating dollars, with no attempt to make corrections for changing economic conditions. It is of little value to assess DFAA by simply comparing money spent in 1990 with money spent in 1970. This section addresses this problem and compares assistance over time using 'constant' dollars corrected for variations in purchasing power.

Changes affecting DFAA

DFAA is in place to provide provinces with emergency disaster recovery funds, using a sharing formula dependent upon total eligible expenses and provincial recovery resources (determined from provincial population). In the twenty years since the plan's inception, substantial changes in the milieu in which DFAA operates have occurred which have not been accommodated, identified as (Annex 3):

1. *Economic factors* resulting from the change in purchasing power of the Canadian dollar, and;
2. *Demographic factors* resulting from population growth and shifts.

Economic factors controlling the cost of disaster recovery are assumed to have escalated at the same rate as all other goods and services. This is keyed to the Consumer Price Index (CPI), which has risen 289% from 1 June 1970 to 1 January 1990. That is, goods or services costing $1.00 in 1970 cost, in 1990, an average $3.89. This has *increased* the Federal burden by effectively lowering DFAA sharing thresholds.

Demographic factors involve changes in provincial population since 1970 (Figure 4), which controls the entry location of each sharing threshold. An overall national population increase of approximately 23% from 1970 to 1990 has effectively raised the sharing thresholds and had the effect of slightly *lowering* the federal burden. When both economic and demographic effects are taken into consideration, the relative federal burden has *increased* substantially in all cases considered (Annex 3).

Corrected DFAA Expenditures

The assessment of federal DFAA expenses over time should be done with respect to *resource-constant* dollars, to compensate for changes in purchasing power. DFAA annual expenditures expressed in resource-constant dollars are shown in Figure 3. For example, federal assistance in the Edmonton tornado recovery was approximately $22M in 1988 funds, but approximately $6M in (resource-constant) 1970 dollars. The effect of decreased purchasing power is cumulative, becoming more pronounced with time.

Assessing DFAA: The sharing matrix

A useful assessment tool models the effect of DFAA in response to a set of standardized disasters occurring in a set of standardized provinces. Small, medium and large disasters are modelled in small, medium and large provinces. For simplicity, it is assumed that all disasters require the same recovery resources and affect the same economic sectors. The resulting *sharing matrix* summarizes the nine possible scenarios and shows levels of federal and provincial assistance.

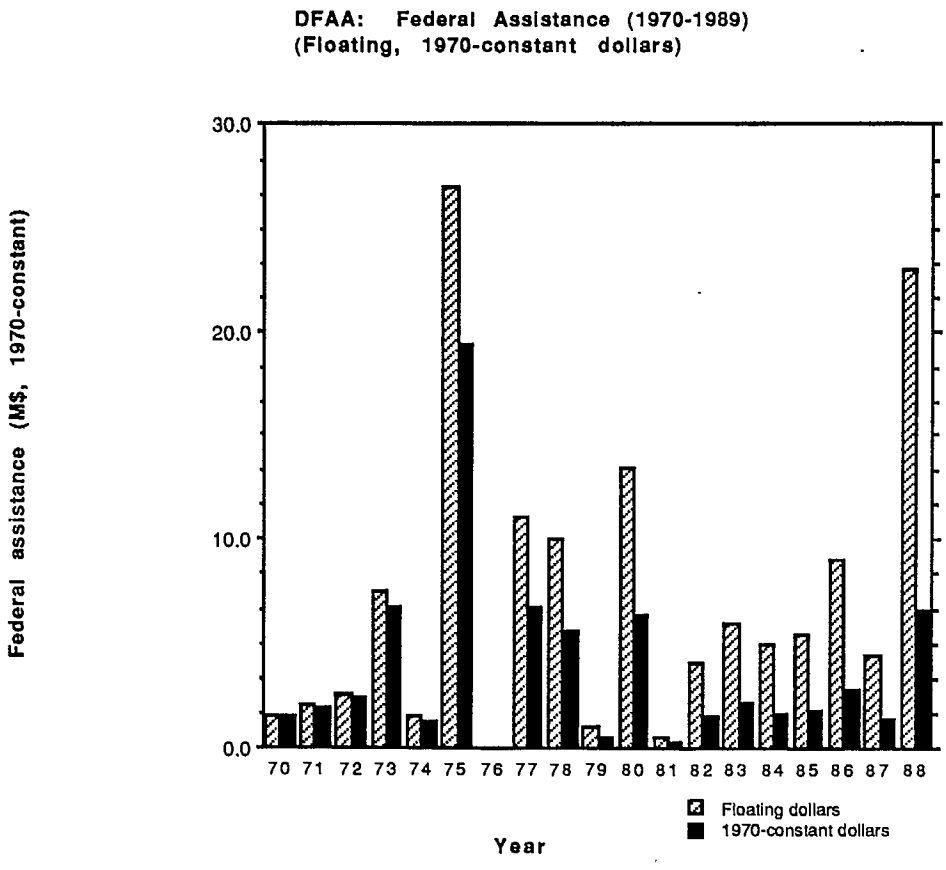

Figure 3: DFAA federal expenditures, 1970-1988, referred to floating and 1970-constant dollars. The use of resource-constant (1970) dollars shows the cumulative effect of decreased purchasing power.

Disaster events are classified by total eligible expenses:

Small:	$5 million,
Medium:	$25 million,
Large:	$50 million.

Provincial recovery resource capabilities are classed by population:

Small:	0.5 million,
Medium:	3.0 million,
Large:	8.0 million.

The sharing matrix under the existing sharing formula appears in Table 3. For example: under the present plan a medium size disaster ($25M of eligible expenses) occurring in a medium size province (3.0M population) receives approximately $16.5 million (66% of eligible expenses) in federal assistance, leaving $8.5 million (34%) for the province to provide. The sharing matrix allows a rapid assessment of DFAA response to a standardized set of scenarios, under any desired sharing formula option. To illustrate,

under the present formula, small provinces (with limited recovery ability) receive the largest proportion of federal assistance. Assistance decreases with increasing population until large provinces receive comparatively little federal support, and none at all in small disasters.

Changes in Federal/Provincial sharing 1970-1990:

A meaningful examination of changes of sharing with time must attempt to compensate for the two factors of inflation and population change. One can set the basis as applying to 1970 and then shift to 1990 through the factors for economic influence and demographics, presented in Table 4. Federal/provincial assistance ratios for resource-equivalent scenarios are presented in Table 5. The federal burden has *increased* in all scenarios (Table 6). Under the scenarios considered, the relative federal burden has increased by as little as 1% to as much as 35%.

Provincial population	**Disaster Event**					
	Small (5.0M)		Medium ($25.0M)		Large ($50.0M)	
	$M	%	$M	%	$M	%
Small (0.5M)	3.5 / 1.5	(70/30)	21.5 / 3.5	(86/14)	44.0 / 6.0	(88/12)
Medium (3.0M)	1.0 / 4.0	(20/80)	16.5 / 8.5	(66/34)	39.0 / 11.0	(78/22)
Large (8.0M)	0.0 / 5.0	(0/100)	8.8 / 16.2	(35/65)	29.0 / 21.0	(58/42)

Table 3: DFAA sharing matrix under the current sharing formula. Federal and provincial assistance from small, medium and large provinces is shown in response to small, medium and large disaster events. Both absolute costs (in millions of dollars) and percentages are shown. The format is Federal / Provincial, that is x / y denotes x of Federal assistance, y of provincial assistance.

Population		**Eligible expenses**	
1970	**1990**	**1970**	**1990**
0.5M	0.6M	$5M	$19.5M
3.0M	3.6M	$25M	$97M
8.0M	9.6M	$50M	$195M

Table 4: Mean changes in provincial population and DFAA eligible expenses from 1970 to 1990. The average provincial population increase is estimated from the national population growth of approximately 23%. Eligible expense increases are calculated from the CPI.

Provincial population	Event size					
	Small		Medium		Large	
	$M	%	$M	%	$M	%
Small	16.4 / 3.1	(84/16)	86.1 / 10.9	(89/11)	174.3 / 20.7	(89/11)
Medium	10.4 / 9.1	(53/47)	80.1 / 16.9	(83/17)	168.3 / 26.7	(70/30)
Large	5.0 / 14.5	(25/75)	68.1 / 28.9	(70/30)	156.0 / 38.7	(80/20)

Table 5: DFAA sharing matrix for resource-equivalent disasters occurring in 1990. Each scenario is equivalent (in terms of recovery resources required) to the corresponding scenario of events occurring in 1970, shown in Table 3.3. In all events considered, the federal assistance burden in 1990 is increased relative to the 1970 event.

Provincial population	Event size		
	Small	Medium	Large
Small	14 %	3 %	1 %
Medium	33 %	17 %	8 %
Large	25 %	35 %	22 %

Table 6: Percentage increases in the relative federal assistance burden for resource-equivalent events in 1970 and 1990, using the current DFAA sharing matrix. Federal expenses increased by an average 24% in a small event, 18% in a medium event and 10% in a large event.

4. DFAA Sharing Formula Options

Structure of the sharing formula

From the set of all possible sharing formula options, two large classes of sharing formulae were selected, and several options assessed against preliminary criteria of overall fairness and adherence to the original intent of the DFAA guidelines. The classes were:

1. Threshold-based formulae: This class contains the current sharing formula. Federal assistance has the form of a series of plateaus at successively higher levels of federal assistance. A further refinement into two sub-classes identifies *threshold options* (identical to the current plan but with scaled entry levels), and modified threshold options (involving additional sharing levels).

2. Composite sharing plans Combining threshold and non-threshold formats can result in substantially increased flexibility with only a marginal increase in complexity. This is also a useful starting point for identifying salient features of a particular sharing strategy, which can then be transferred to a simpler sharing plan.

Assessment of sharing options

Because of the nature of disasters, DFAA is best regarded as a set of general guidelines, adaptable enough to be modified by the context of a disaster, rather than as a programme of inflexible rules. This places an additional onus on the implementation of DFAA to conform to 'the spirit of the guidelines', as a perspective on the nature of disaster assistance within the Canadian federation. The absence of a hard yardstick complicates the comparison of different sharing options: instead of comparing prospective options against a qualitative figure of merit, options are in large part compared against less rigidly defined concepts of fairness and adequacy.

Prospective sharing formulae are assessed against several criteria: minimal requirements of fairness, simplicity and overall adequacy must be satisfied. The prospective plan must deal with provinces fairly by recognizing the wide variation in economic recovery ability among the provinces. The plan must be simple and easy to implement. It must provide adequate assistance within the framework of the guidelines, and should have some continuity provision to permit an easy transition between the old and new sharing formulae.

Table 7 summarizes the options considered in detail in Annex 4. A sharing matrix was constructed for each option and compared with that of the current formula. This allowed an assessment of each option's relative strengths and weaknesses, weighed against considerations of the basic nature of the DFAA guidelines.

5 Economic Effect of Sharing Options

The effect of each candidate sharing formula upon federal and provincial economies was studied using a simple model of resource flow. Neither the federal nor provincial economies are static entities: funds initially allocated for disaster recovery assistance flow through all sectors of both economies, resources 'leak' across provincial boundaries, and additional revenues are generated through several economic mechanisms.

The injection of a large sum of money into a provincial economy can stimulate further revenues through several economic mechanisms, which can shift the balance of federal/provincial sharing, sometimes significantly. The model developed in Annex 5 was used to approximate the relative shift under possible DFAA sharing formula options.

A simple model of resource flow through both provincial and federal economies was constructed using the input-output paradigm of goods and services being exchanged between distinct economic sectors. The effect of a large injection of federal funds into a provincial economy through DFAA is simulated, and its primary and secondary effects identified. Once the economic impact model is complete, it is used to estimate repercussions of DFAA assistance in standardized disaster scenarios under possible sharing formula options. The options of Section 4 which survived preliminary assessments based on fairness and overall adequacy are next considered for economic effect.

The *primary economic effect* of DFAA is modelled as initial recovery resources allocated between firms and households. The next level of complexity models a further round of resource flow consisting of *secondary economic effects,* including federal and provincial government revenue from taxation on the initial injection, the collective effects of firm's and household's tendency to save, household expenditures and payments from firms (Annex 5).

Option #	Further study?	Threshold Formulae	
Option 1	Yes	Option A	Current formula
Option 2	No		Three times current formula
Option 3	Yes	Option B	Four times current formula
Option 4	Yes	Option C	Twice current formula
		Modified Threshold Formulae	
Option 5	No		Equal sharing
Option 6	Yes	Option D	Twice current with additional level
Option 7	Yes	Option E	Three times current with additional level
		Non-Threshold Formulae	
Option 8	No		Graded response from $0-$10
Option 9	No		Graded response from $0-$15
Option 10	No		Hybrid graded/threshold response

Table 7: Summary of DFAA Sharing formula and recommendations for further study. Options retained for further study are designated Option A through Option E. All options are assessed in detail in Annex 4.

Table 8 shows the sharing matrix accompanying the current sharing formula, giving the estimated federal and provincial shares one year after the initial injection of funds. The effect of secondary factors is to shift the overall federal/provincial balance by returning different amounts to federal and provincial coffers through taxation. For example, consider a medium-size disaster in a large province. Before secondary effects are taken into consideration, 35% ($8.8M) of eligible expenses are provided through federal assistance, and 65% ($16.2M) through provincial assistance (from Table 3). After one year, the equivalent cost after compensating for secondary economic factors is approximately $15.2M (See Annex 5), of which 17% ($2.6M) is provided through federal assistance, and 83% ($12.6M) provided through provincial assistance. The net effect of secondary economic factors has been to shift the balance of sharing by approximately 18% (from 35/65 to 17/83) in favour of the *federal* government. Owing to the complexity of the real-world economy and the simplicity of the model, the figure of 18% should be loosely interpreted as representing a moderate federal advantage of anywhere from 10% to 30%. The magnitude of the burden shift varies considerably depending on the particular disaster size/population base scenario. In some cases (for example a small event in a large province) it is possible for the federal government to recoup, through taxation, *more* than its original expenditure through DFAA.

Provincial population	Event size					
	Small ($5.0M)		Medium ($25.0M)		Large ($50.0M)	
	$M	%	$M	%	$M	%
Small (0.5M)	2.25 / 0.8	(74/26)	15.3 / -0.1	(101/-1)	31.5 / -1.1	(103/-3)
Medium (3.0M)	-0.25 / 3.3	(-8/108)	10.3 / 5.0	(67/33)	26.5 / 3.9	(87/13)
Large (8.0M)	-0.13 / 4.3	(-41/141)	2.6 / 12.6	(17/83)	16.5 / 13.9	(54/46)

Table 8: The sharing matrix after accommodating secondary economic factors, under the current formula. Figures show the estimated effective federal and provincial assistance after one year. Negative amounts indicate an effective gain. For example, in a small disaster in a large province the federal government provides no assistance, yet makes over $0.1M in taxation revenue from provincially-provided funds.

This model was used to assess each of the five sharing formula options of Table 7, in terms of the role of secondary effects in shifting the federal/provincial sharing ratio. Details are presented in Annex 5. Ranking the sharing formula options in order of *decreasing* federal advantage, they are:

Option C - Three times current formula
Option E - Three times current formula with additional level
Option B - Twice current formula
Option D - Twice current formula with additional level
Option A - Current formula.

That is, Option C (three times the current formula) had the greatest overall advantage to the federal government from secondary factors, and Option A (the current formula) the least.

Recommendation for avoiding future disparities

The present increased federal burden is a result of the sharing formula not being upgraded to accommodate relevant changes. It is recommended that some mechanism be introduced to avoid the problem of large-scale readjustments to the sharing formula. For example, a review of the sharing formula each time the combined effects of inflation and population growth increased by an integer value. Since 1970, the combined effect has been equivalent to a factor of approximately 3. Instituting this review procedure would have resulted in a review of the DFAA sharing formula every six years. This time frame is sufficiently short that large-scale adjustments to the sharing formula would not be necessary.

6. CONCLUSIONS AND RECOMMENDATIONS

Conclusions

The Disaster Financial Assistance Arrangements (DFAA) have been providing provinces with federal assistance in disaster recovery since 1970. The level of federal assistance in response to a disaster is determined through a sharing formula, based on total eligible expenses per capita of provincial population. The net effect of economic and demographic changes since 1970 has been to increase substantially the federal sharing burden.

Economic changes since 1970 affect DFAA through the reduced purchasing power of the Canadian dollar. The majority of disasters receiving DFAA assistance have involved damages across essentially the entire spectrum of economic activity. As a result, disaster recovery costs have escalated in tandem with the consumer price index. Viewed as an index of reduced purchasing power, the CPI indicates an increase in disaster recovery expenses of approximately 400% since 1970.

Changes in provincial populations since 1970 have affected the provincial sharing burden. An overall national population growth of approximately 23% has had the effect of slightly reducing the federal DFAA burden by increasing the per capita-based sharing thresholds. Taken together, disaster recovery expenses adjusted for population growth have increased by a factor approximately equal to three. The combined effect has been to increase substantially the relative federal burden.

Several economic mechanisms exist which can serve to redistribute federal and provincial disaster assistance funds, and alter the federal/provincial sharing ratio. A simple economic model was developed to simulate the injection of a large amount of money into a provincial economy, and estimate the overall effect of these mechanisms upon the relative sharing burdens. It was found that in most scenarios, secondary economic factors such as the multiplier effect and taxation served to shift the balance of sharing in favour of the federal government. The extent of the advantage varies with the scenario chosen, and is based on a simple model. A more detailed analysis would require an elaborate, computer-driven economic model.

Recommendations

A collection of alternative sharing formulae for DFAA have been developed with a view to updating the federal sharing formula to reflect current Canadian economic and demographic realities. The candidate replacement formulae have been assessed against several criteria. Primary criteria included fairness, simplicity, overall adequacy and conformance with the original intent of the DFAA guidelines. Secondary criteria addressed economic effects, including the multiplier effect, leakage of resources out of province, and federal and provincial taxation.

Based on this methodology and these criteria, it is recommended that the current sharing formula be replaced by Option E, which results in an increase of current thresholds by a factor of three, with an additional sharing level introduced at the $1 per capita level. This would compensate for the effects of inflation and population change, while continuing to allow participation in the arrangements at the current entry level. A second possibility is Option D: an increase of current thresholds by a factor of two, together with an additional sharing level at the $1 per capita level.

It is recommended that provisions be made to accommodate future economic and population changes. A review of the sharing formula each time the combined effects of reduced purchasing power and increased population reaches an integer value is recommended.

7. REFERENCES

1. `Disaster Financial Assistance: Manual to assist in the interpretation of federal guidelines', EPC 22/88.

2. `Disaster Financial Assistance Arrangements and the Federal/Provincial Sharing Formula', EPC Discussion Paper, May 1991.

3. `A Preliminary Assessment of the Effects of Applying the 1970 DFAA Sharing Formula to Current Disaster Financial Recovery Assistance Situations', EPC Memorandum 2800-8-1, October 1987.

4. `Alberta: Tornado and flooding 1987; Disaster Assistance in Recovery', EPC, Edmonton Alberta, July 1988.

5. `The Canadian Sourcebook', Corpus Information Services (1990).

6. `Input/Output structure of the Canadian Economy 1986', Statistics Canada Publications 15-201 (1989).

7. R.G. Lipsey, D.D. Purvis, P.O. Steiner, `Economics', Fifth Edition, Harper and Row (New York 1985).

8. D. Greenwald, `Dictionary of Modern Economics', McGraw-Hill (New York 1973).

Annex 1
Introduction

Developed in 1970, the Disaster Financial Assistance Arrangements (DFAA) are a set of guidelines designed to address questions of federal financial assistance to a province in the event of a large disaster. Levels of assistance are currently determined from a sharing formula governing federal and provincial financial burden sharing, and based on per capita expenses. Owing to changes within Canada since 1970, the sharing formula may no longer be serving its original purpose in providing a yardstick for fair financial recovery sharing. The purpose of this study is to assess the sharing formula in terms of relevant changes to factors affecting the arrangement's fairness and implementation, and to put forward a revised formula which better reflects the DFAA's original intent within the context of the current Canadian political and economic scene.

1.1 Disaster Financial Assistance Arrangements

Disaster Financial Assistance Arrangements (DFAA)

The Disaster Financial Assistance Arrangements (DFAA) are a set of guidelines designed to provide provinces with federal assistance in the event of a disaster beyond that province's reasonable economic recovery ability. The guidelines support the determination of levels of assistance, questions of 'reasonable recovery ability', and qualification of eligible (sharable) expenses. Since its introduction in 1970, DFAA have involved a total of approximately $155 million expended by the Federal government in assistance of disaster recovery, with approximately $80 million of assistance currently in process. These funds have assisted provinces in disaster recovery totalling approximately $330 million of eligible expenses.

DFAA is administered by Emergency Preparedness Canada under guidelines approved by the Cabinet. Through these, the federal government provides basic financial assistance to help provincial governments meet the costs of disasters which exceed what they might reasonably be expected to bear on their own. Funds are not budgeted for the arrangements because there is no way to predict the amount that might be needed in a given year. Funds are obtained, as needed, by means of a submission to the Treasury Board.

Eligible Expenses

The phrase 'eligible expenses' will refer to provincial government expenditures which meet eligibility criteria set out in the federal guidelines. Eligible expenses include those related to rescue, transportation, costs in determination and containment of the extent of the disaster, etc. They may also include restoration and repair costs for property, clearance of debris, etc. The guidelines are general in nature and open to some interpretation within the context of a given disaster event.[1]

---

1 'Disaster Financial Assistance: Manual to assist in the interpretation of federal guidelines', EPC 22/88, pp 7-10.

The Sharing Formula

DFAA determines the level of federal assistance in response to a disaster by the *sharing formula*, a threshold plan based upon eligible expenses per capita of provincial population. The current sharing formula is shown in Table 1.1, giving federal/provincial sharing ratios as a function of eligible expenses per capita of provincial population. The plan has not been modified since the DFAA's inception in 1970. The primary objective of this report is the updating of the federal sharing formula to reflect more accurately the current economic and demographic Canadian climates.

Expenses (per capita)	**Federal/Provincial**
$0-$1	0% / 100%
$1 - $3	50% / 50%
$3-$5	75% / 25%
>$5	90% / 10%

Table 1.1: The present DFAA sharing plan. The plan is based on a set of thresholds, fixing Federal/Provincial sharing in terms of eligible expenses per capita of provincial population.

DFAA in disaster response

Recovery following a major disaster can take many forms, involving two broad avenues of response types: non-governmental and governmental mechanisms. The central features of the disaster recovery process are sketched in Figure 1.1. Non-governmental recovery resources include individual and community self-help, insurance coverage, as well as volunteer organizations, and other non-governmental organizations. Governmental assistance begins at the provincial level and escalates to higher federal levels as thresholds are exceeded.[2]

DFAA is initiated by a request from the province, usually in the form of a letter or telex from the provincial Minister responsible for emergency measures to the federal Minister Responsible for Emergency Preparedness. Assessment and appraisal teams are established to assess public and private sector damage, and provide the basis for deciding whether damage is sufficient to warrant a request for federal financial assistance. If provincial costs are deemed eligible for DFAA, financial assistance is provided to the province to be used in recovery.

Principles of Disaster Financial Assistance

The essentially random nature of disasters requires DFAA to provide a flexible response within the framework of a well-delineated set of guidelines. Applications of DFAA must follow stringent guidelines, but maintain sufficient flexibility to address the exceptional cases which invariably accompany a disaster. Because of this, assessments of DFAA must often be referred to a set of underlying principles which provide a philosophy of disaster assistance within the Canadian federation. These principles are broadly summarized below.[3]

---

2 'Disaster Financial Assistance Arrangements and the Federal/Provincial Sharing Formula', EPC Discussion Paper May 1991.

3 'A Preliminary Assessment of the Effects of Applying the 1970 DFAA Sharing Formula to Current Disaster Financial Recovery Assistance Situations', Annex J, EPC Memorandum 2800-8-1, 14 October 1987.

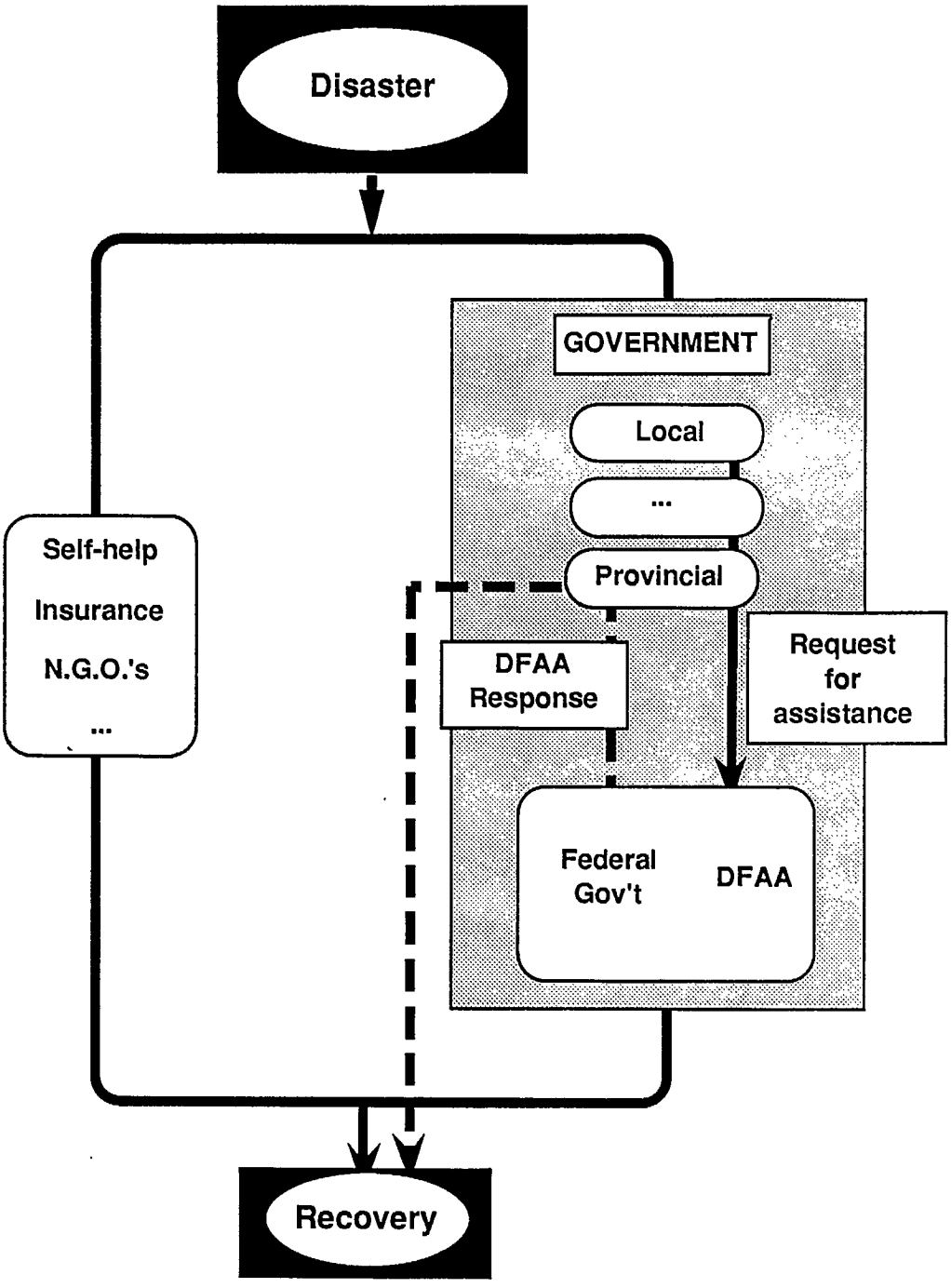

Figure 1.1: DFAA in disaster recovery. The figure indicates the central features of DFAA operating within the framework of governmental and non-governmental response mechanisms.

1. The provinces are constitutionally responsible for all property-related matters in their geographical area, and should be prepared to fund a significant amount of the expenses involved in responding to the needs of individuals and organizations in their province.

2. There is a wide diversity in population sizes, resource bases and economic situations between provinces. Some method is required to accommodate regional disparities in assisting provinces in responding to the recovery phase of major disasters.

3. This regional disparity indicates the need for a graded federal response to requests for assistance from the provinces.

4. It is a recognized principle of the insurance industry that no one should obtain an absolute gain from insurance. Instead, one should be helped back to a condition as close as possible to that previously enjoyed. This should also be considered a basic tenant of any financial assistance arrangement provided by the federal government.

5. It is a basic principle of emergency preparedness in Canada that such preparedness begins with the individual and only escalates to higher orders of government when it is beyond the capability of an individual or lower order of government to respond. All citizens have some responsibility to make at least minimal basic provisions to respond to emergencies and disasters. Being properly insured where such insurance is practicable is an individual's (and corporate body's) responsibility. Other preparatory action should be undertaken by individuals, private organizations and governments depending on the risks that are inherent to their particular situation. Furthermore it should be a governmental responsibility at all levels to assist citizens and organizations to make such preparations, especially by providing information in a useable and practicable form.

1.2 Objective and Outline

DFAA helps to coordinate financial disaster recovery through a formula which delegates provincial and federal assistance sharing. The sharing formula has been in use, without revisions, since 1970. The primary objective of this study is to identify and assess options for amending the sharing formula to reflect current Canadian economic and demographic conditions. The set of options has evolved through the development of a simple and easily applied sharing formula which conforms to the 'spirit of the guidelines', and which better reflects the current conditions.

The study includes a brief survey of the existing plan over the past two decades. Economic effects are then incorporated, first by a simple transposition of the sharing formula to reflect changes in the economy since 1970, then by using fuller economic models to capture more detailed changes. Demographic changes involving population variations are discussed. A collection of possible revisions to the current sharing formula are developed. and are assessed against a simple yet realistic model of resource flow through the federal and provincial economies. This allows a set of criteria to be developed against which each option is judged in a simulation of small, medium and large disasters occurring in small, medium and large provinces. Several options are used in re-examinations of historical disaster events for a better 'feel' for each option's potential financial effect. The study concludes with a summary and set of recommendations for possible sharing formulae, and mechanisms to allow future revisions.

Annex 2
History of DFAA

The Disaster Financial Assistance Arrangements (DFAA) help the federal government to provide fair financial assistance to provincial governments when the cost of dealing with a disaster would place an undue burden on the provincial economy. DFAA was introduced in 1970 to assist the provinces in disaster recovery with federal financial assistance. As of January 1991, twenty years after the present arrangements were put into effect, a total of $155 million has been expended by the federal government (with approximately $80 million in process) to assist provinces in disaster recovery totalling $332 million of eligible expenses.[1]

2.1 Disasters and Disaster Trends

Global Disaster Trends

Disasters are random events superposed over an ever-growing backdrop of human activity. While disasters are by their character unforeseen and essentially random, they are more likely to occur in regions where conditions are suitable for significant effect. These can vary from environmental (earthquakes and volcanoes constitute major concerns in many parts of the world) to societal (for example, a cholera epidemic, which can be checked by implementing minimal public health standards) and beyond. Given the rapidly growing population of underdeveloped countries in regions susceptible to major disasters, it is not surprising to discover that the apparent global trend is towards an increasing number of disasters involving a greater number of people and resources. Figures 2.1 and 2.2 summarize the recent trends towards an increasing number of significant global disasters.[2]

From these figures, there appears to be a general world trend towards an increasing number of natural and man-made disasters, involving an increasing number of people and consuming an increasing amount of recovery resources. This is a result of many environmental and societal factors: a globally expanding population, urban replacing rural lifestyles, increasingly sophisticated and interconnected economic bases, increasing public concern for environmental issues and quality of life, increased media coverage worldwide, and so on. For these reasons, when disasters occur they tend to affect more people and to cause greater damage.

Disasters as random events

In terms of global disaster trends, Canada has fared well, with fewer major disasters claiming fewer lives and causing less property damage than the global norm. Reasons must include the favorable environment (the temperate climate and comparatively stable geology) and a relatively extensive social support system (public health, safety and security and a public awareness of emergency preparedness issues). Major disasters which do occur tend to be random events beyond reasonable expectation of prevention. For example, consider the Edmonton tornado. In late summer of 1987 a tornado caused

---

1 'Disaster Financial Assistance Arrangements and the Federal/Provincial sharing formula', EPC Discussion paper, May 1991.

2 'Sigma, Swiss Reinsurance Company.' The term 'significant disaster' cannot be defined precisely. The data intended to show recent trends, and should not be interpreted in an absolute sense.

extensive damage to an industrial region of Edmonton, taking 27 lives and causing an estimated $500 million dollars damage.[3] Such an event is difficult to prepare against and is essentially random: a small difference in prevailing winds could have changed conditions enough to move the tornado's path by several miles; perhaps to an empty field, perhaps to a crowded suburban centre. Most large Canadian disasters, natural or man-made, tend to fall into this class of random event.

Modelling disasters

Disasters are fundamentally unpredictable events. Much of this report concerns modelled disasters and their effect on regional economies. This necessarily involves the use of standardized events: idealized disasters of a fixed magnitude expressed as a specific dollar amount of damage in a hypothetical geopolitical area. This is an essential, if unrealistic, part of the modelling process. The severity of an event can vary with both location and time of occurrence. A major event striking a resource-poor, sparsely populated province in a vital economic sector will have dramatically different economic repercussions than a similar event affecting a less vital economic sector of a densely populated, resource-rich province. The time of occurrence is also important: a major event occurring in the winter will have a different effect than the same event occurring in the summer. For example, in a winter disaster expensive interim measures may have to be provided: short-term repairs, pre-fabricated housing, etc.

---

3 'Alberta: Tornado and Flooding 1987, Disaster Assistance in Recovery,' EPC, Edmonton Alberta, July 1988.

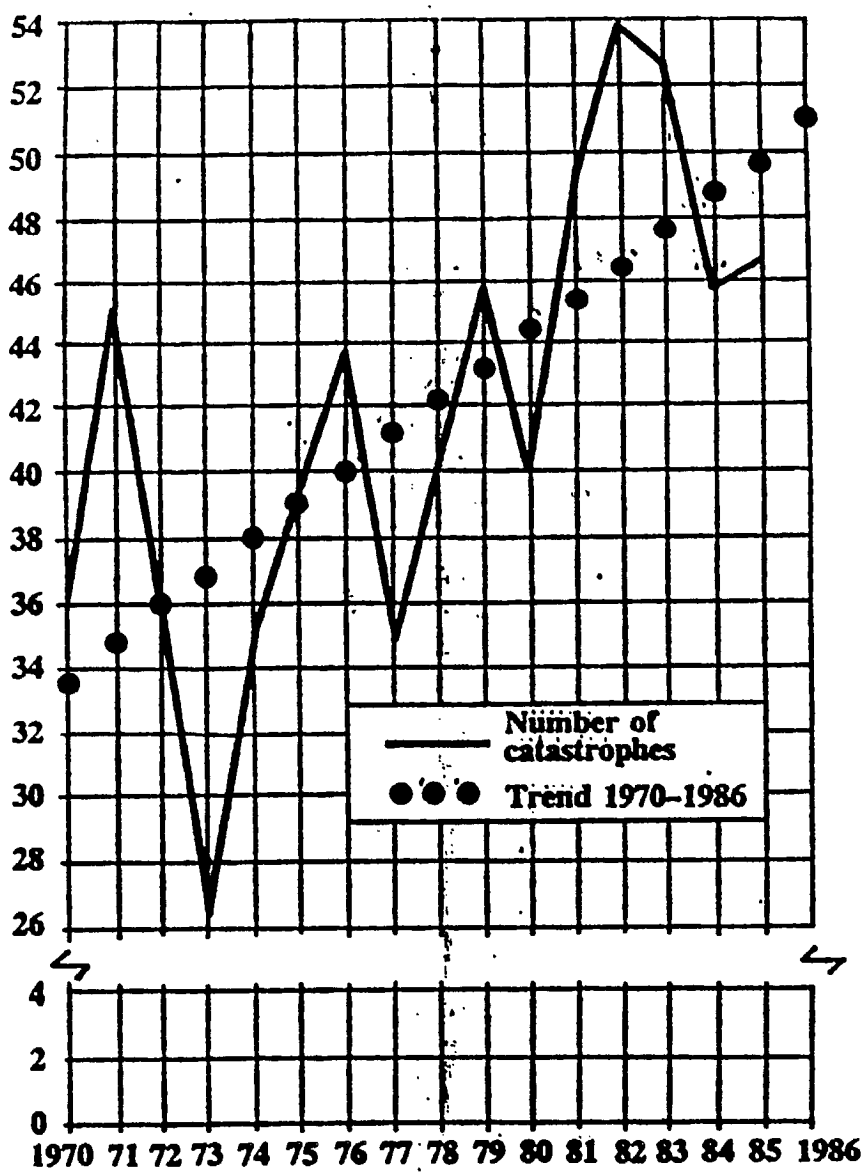

Figure 2.1: The number and trend of natural catastrophes, worldwide 1970-1985. As there is no formal definition of a 'natural catastrophe', the data should be interpreted as showing a relative trend, and should not be interpreted in an absolute sense. (Source: Sigma, Swiss Reinsurance Company)

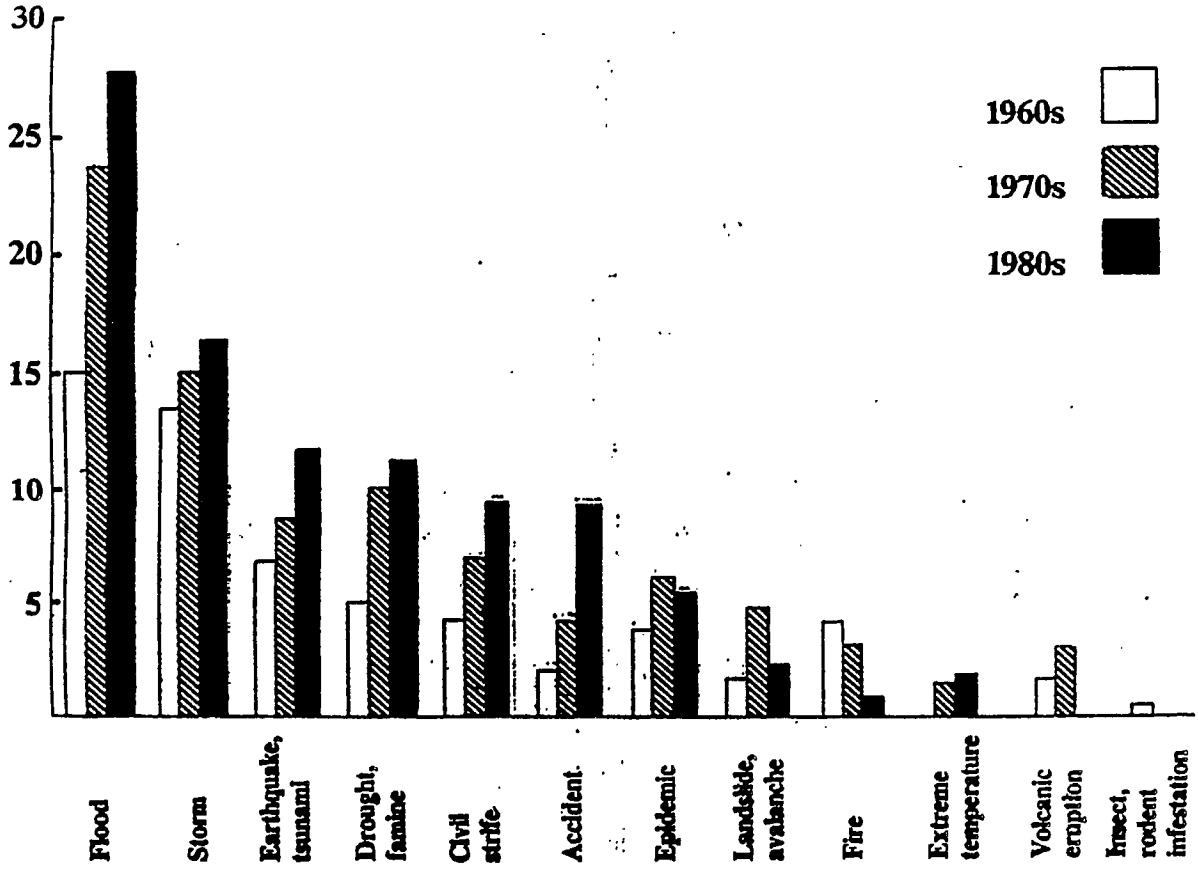

Figure 2.2: The number and type of natural catastrophes, worldwide over 1960-1990. As there is no formal definition of a 'natural catastrophe', the data should be interpreted as showing a relative trend, and should not be interpreted in an absolute sense. (Source: Sigma, Swiss Reinsurance Company)

2.2 Dispersion of DFAA (1970-1988)

Federal disaster financial assistance (through DFAA) has been invoked in approximately 65 disaster situations from 1970 through 1988. Federal assistance has ranged in scope from $13,473 for hail and storm damage (PEI, 1974) to $22,000,000 as an advance payment following major tornado damage (Alberta 1987). This section summarizes the dispersion of federal shares by type of event, by province, and by year.

Federal assistance by event type

Table 2.1 and Figures 2.3 and 2.4 summarize federal assistance, categorized by the type of disaster.[4] Categories are broadly defined and not mutually exclusive, and some overlap in unavoidable. For example, much storm damage can occur by flooding. Additionally, the 'Tornado' category includes hurricane as well as tornado damage, and the 'Earthquake' category includes both earthquakes and landslide damages. The sole DFAA response to disease refers to a 1983 livestock encephalitis outbreak in Manitoba.

Event	Frequency (Events)		Federal assistance	
Flood	43	66%	$117 M	75%
Storm	13	20%	$15 M	10%
Tornado	3	5%	$23 M	14%
Fire	3	5%	In process	
Earthquake	2	3%	$1 M	1%
Disease	1	2%	$1 M	1%

Table 2.1: Distribution of Federal DFAA funds by type of disaster. The frequency and total Federal shares from 1970-1988 appear in absolute and percentile form. Classifications are general and some overlap occurs: for example 'flood' and 'storm' damages are not mutually exclusive.

Federal shares: geographic distribution

Figure 2.5 shows the geographic distribution of DFAA federal assistance by province, from 1970 through 1990 inclusive, not including amounts under negotiation. In order of decreasing total federal assistance, Quebec, Alberta and Manitoba have received the most federal support through DFAA, while the Yukon, Northwest Territories and Ontario have received the least.

Federal shares with time

Figure 2.6 shows DFAA federal assistance each year from 1970 through 1989 inclusive. Federal shares in a single year have varied from nil (1976/1977) through to approximately $27 million (1975/1976). There is no readily discernible pattern to the annual expenditures, again in large part due to the intrinsically random nature of disasters. For example, $22 million of the fiscal 1988 expenditure was in response to a tornado in

---

4 Compiled from 'Disaster Financial Assistance Arrangements Update', 1990.

Edmonton. A slightly different weather system or wind pattern may have resulted in no tornado damage - or even no tornado! Hence the large yearly variations are consistent with the fundamentally random nature of the disaster event. The distribution of federal expenditures is shown in Figure 2.7. In 10 of 19 years, DFAA expenditures have been below $5M, have exceeded $10M in 4 years, and $20M in only 2 years.

The federal shares shown in Figures 2.6 and 2.7 are with respect to floating dollars (valued at the year of occurrence). No attempt has been made to bring them to a common basis by making corrections for changing economic conditions. Hence it is of questionable value to assess DFAA by simply comparing money spent in 1990 with money spent in 1970. Section 3 addresses this problem and compares assistance over time using 'constant' dollars corrected for variations in purchasing power.

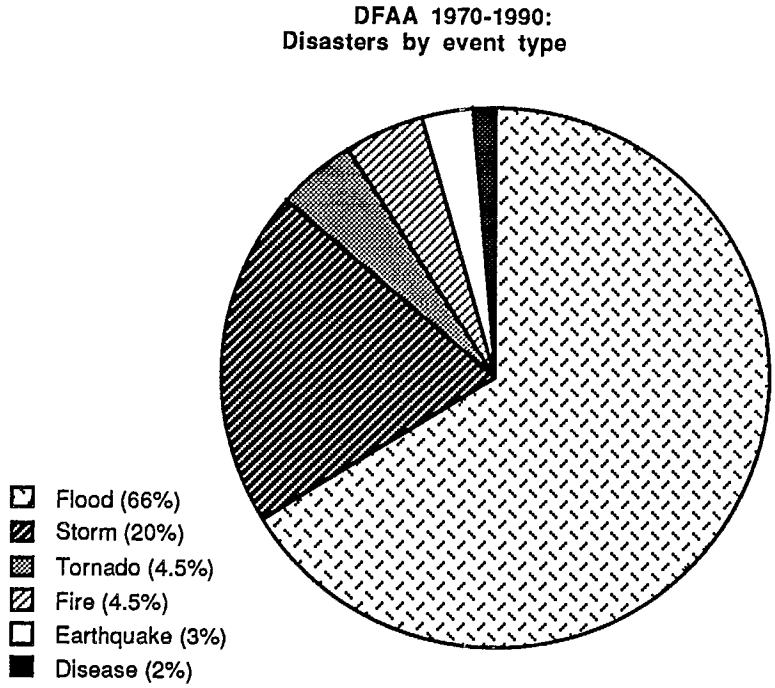

Figure 2.3: DFAA disasters by event type, 1970-1988. Over ninety per cent of events involved climate conditions: floods, storms or tornadoes.

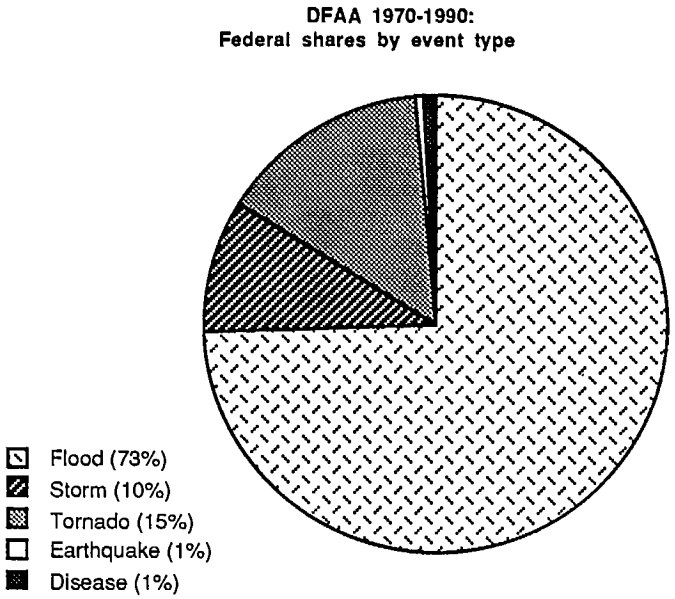

Figure 2.4: DFAA shares by event type, 1970-1988. Of the approximately $155 million dollars expended by the federal government since 1970, approximately 75% has assisted recovery from flood damage, and a further 24% to storm and tornado assistance.

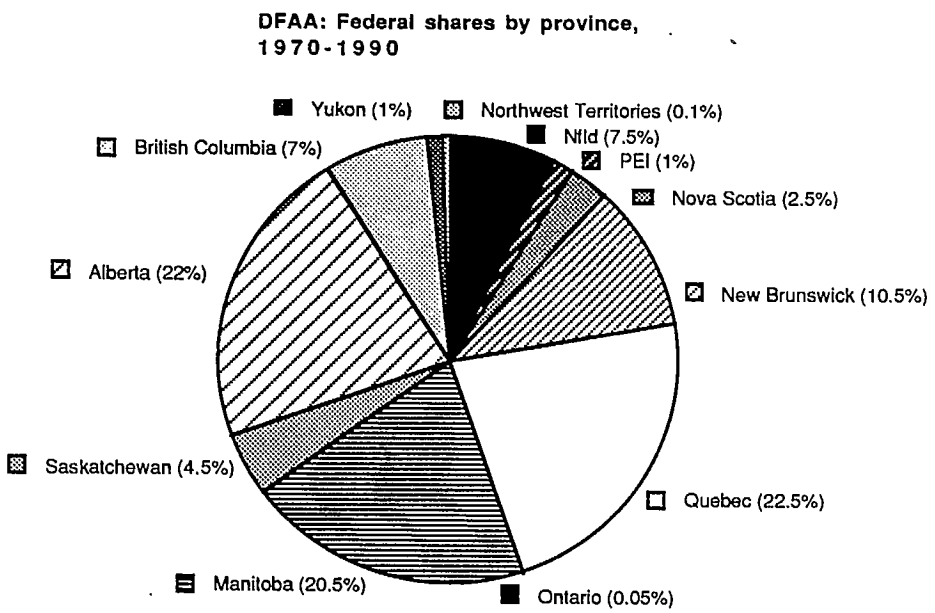

Figure 2.5: Geographic distribution of federal assistance by province, not including amounts under negotiation.

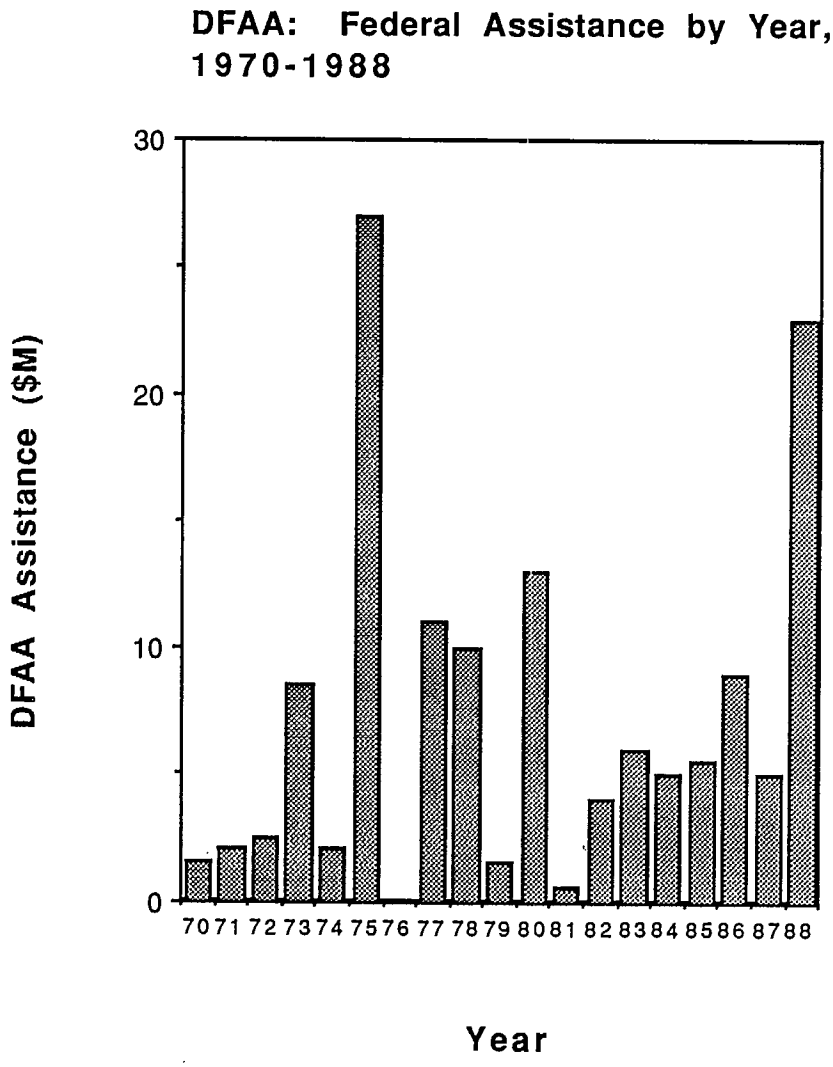

Figure 2.6: Annual DFAA federal assistance, from 1970-1988 inclusive. Annual expenditures varied randomly from nil to in excess of $27M.

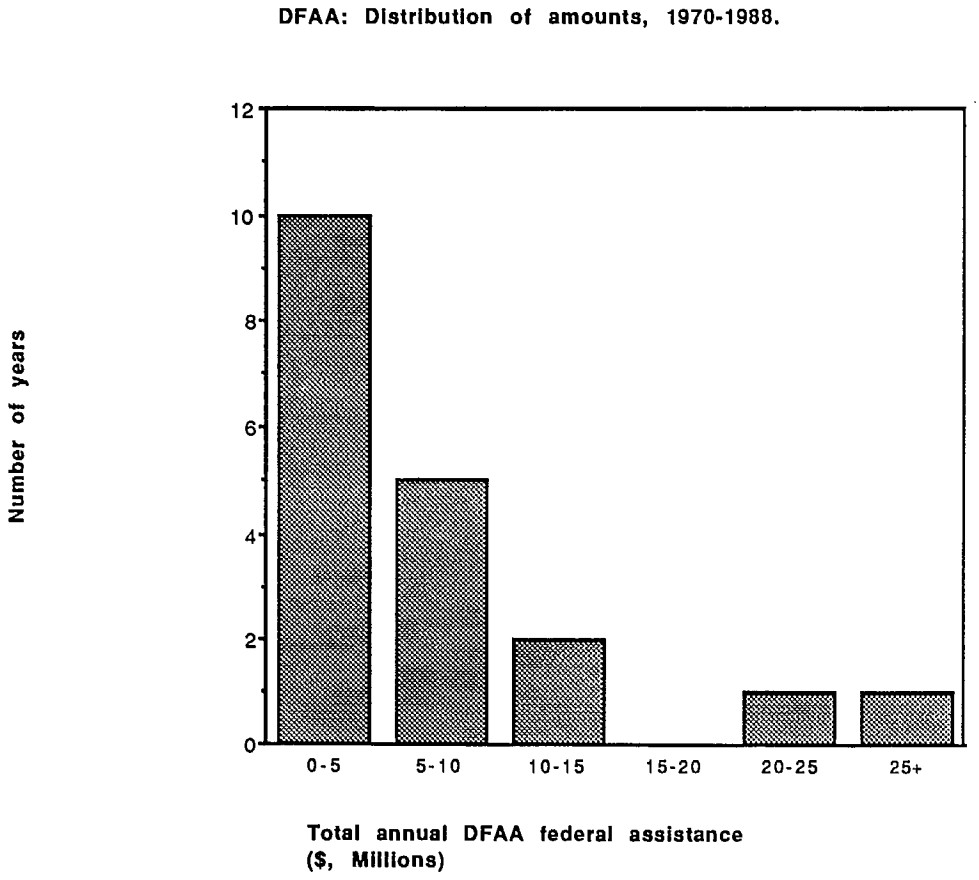

Figure 2.7: Distribution of DFAA federal assistance, showing the total number of years with expenditures between 0-$5M, $5M-$10M, etc.

2.3 Summary

Disaster Financial Assistance Arrangements (DFAA) help the federal government to provide fair financial assistance to provincial governments when the cost of dealing with a disaster would place an undue burden on the provincial economy. As of January 1991, twenty years after the present arrangements were put into effect, a total of $155 million has been expended by the federal government (with approximately $80 million in process) to assist provinces in disaster recovery from losses totalling $332 million of eligible expenses.

Federal disaster financial assistance (through DFAA) has been invoked in approximately 65 disaster situations from 1970 through 1988. Events were surveyed by disaster type, location, and date of occurrence. Disaster types have included floods, storms, tornadoes, forest fires, earthquakes and disease outbreaks. In order of decreasing total federal assistance, the provinces of Quebec, Alberta and Manitoba have received the most federal support through DFAA, while the Yukon, Northwest Territories and Ontario have received the least. Total federal DFAA expenditures in a single year have varied from nil (1976/1977) through to approximately $27 million (1975/1976). There is no readily discernible pattern to the annual expenditures, in large part due to the intrinsically random nature of disasters. In 10 of 19 years, DFAA expenditures have been below $5M, have exceeded $10M in 4 years, and $20M in only 2 years.

ANNEX 3
METHODOLOGY

Federal and provincial recovery assistance under DFAA has been governed by the same sharing formula for the past twenty years. This Annex identifies and examines relevant factors which affect DFAA's implementation and fairness through the sharing formula. Since financial assistance under DFAA is based on eligible expenses per capita of provincial population, relevant sources of change involve

1. Changes in purchasing power in directly affected economic sectors, and;
2. The demographic redistribution of provincial populations.

Economic changes are examined in Section 3.1, and demographic shifts in Section 3.2. Their effect upon DFAA through the sharing formula is considered in Section 3.3.

3.1 DFAA and the Canadian Economy

The Canadian economy has changed greatly in the twenty years since DFAA was introduced. This section identifies the most relevant aspects of the economy affecting DFAA, and their changes since 1970.

Sources of economic change: The consumer price index and mean purchasing power

As a first approximation, the cost of disaster recovery has escalated at the same rate as all goods and services. This is keyed to the Consumer Price Index (CPI), a measure of the Canadian dollar's purchasing power averaged across the entire economic spectrum. The CPI has risen from 41.0 in April 1970 to 156.3 at the end of fiscal year 1989/1990 (normalized against a CPI of 100.0 on 1 June 1981). This is equivalent to an effective devaluation of the Canadian dollar by 389% in averaged purchases since 1970. Hence, a good or service costing $1.00 in 1970 costs an average $3.89 in 1990. Table 3.1 and Figure 3.1 show the decreasing purchasing power of the Canadian dollar since 1970.[1] Since federal financial assistance is computed from per capita expenses, the effect of a devalued dollar is to *lower* the thresholds for federal assistance in the sharing formula, *increasing* the relative federal burden.

Variations in the CPI are representative of changes in purchasing power averaged across all economic sectors. Because disasters act indiscriminately across all economic sectors, the CPI is a broad indicator of how costs of disaster recovery have escalated. While it is possible to imagine disaster scenarios which affect only a limited number of economic sectors for which the CPI is not representative of actual purchasing power variation, such events are not likely to occur in practice.[2] Historically, most disasters which have been large enough to involve DFAA (floods, storms, ...) have involved wide-

---

1 Source: Statistics Canada

2 Source: Dr. Louis Parai, ORAE/DSEA. Personal communication.

spectrum damage across most, if not all, economic sectors. Because of this, the CPI was chosen as a readily-available economic indicator for changes in disaster recovery expense.

3.2 Demographics

Changes in provincial population affect the implementation of the sharing formula by altering the position of the per capita-based sharing thresholds. An *increasing* provincial population elevates sharing thresholds (in dollar terms) and thus reduces the federal burden in a given disaster. A *decreasing* provincial population increases the federal burden by lowering sharing thresholds.

National and provincial population variation

Table 3.2 shows the fractional changes in national and provincial population since 1970.[3] From a population of 21,568,000 in 1970, the national population has grown to 26,584,000 in 1990 (23% growth).

Not all provinces have grown at the same rate: Table 3.2 summarizes provincial population variation. Saskatchewan had the smallest overall growth (6%), while the Northwest Territories had the largest in absolute terms (the territorial population grew from 33,000 in 1970 to 54,000 in 1990, for 63% growth). Alberta had the largest population increase among large provinces.

The inclusion of demographic change, through population increase, into the economic model will use the national figure of 23% growth. This is in accordance with the original intent of the guidelines, that DFAA should reflect disaster recovery assistance within the Canadian federation. Provinces whose population growth *lags* the national average will reach each assistance level earlier than predicted by the national growth model. They will receive more federal assistance than the national growth model predicts, and so derive a provincial benefit proportionate to the deviation from the national average. Similarly, provinces whose population growth *exceeds* the national average (greater than 23%) will receive less actual assistance than the national growth model predicts, operating to the federal advantage. In the special cases of the Yukon and Northwest Territories, there is no 'penalty' for the relatively large population increases, as the small populations mean that federal assistance thresholds are rapidly met.

---

3 Source: 'The Canadian Sourcebook', Corpus Information Services (1990).

Year	CPI (April 1)	$ (1970 constant)	Equivalent purchase
1970	41.0	1.00	1.00
1975	56.9	0.72	1.39
1980	86.6	0.47	2.13
1985	125.2	0.33	3.03
1990	156.3	0.26	3.89

Table 3.1: Variation in Canadian dollar purchasing power, 1970-1990, based on the Consumer Price Index. The index reflects changing purchasing power averaged across all economic sectors.

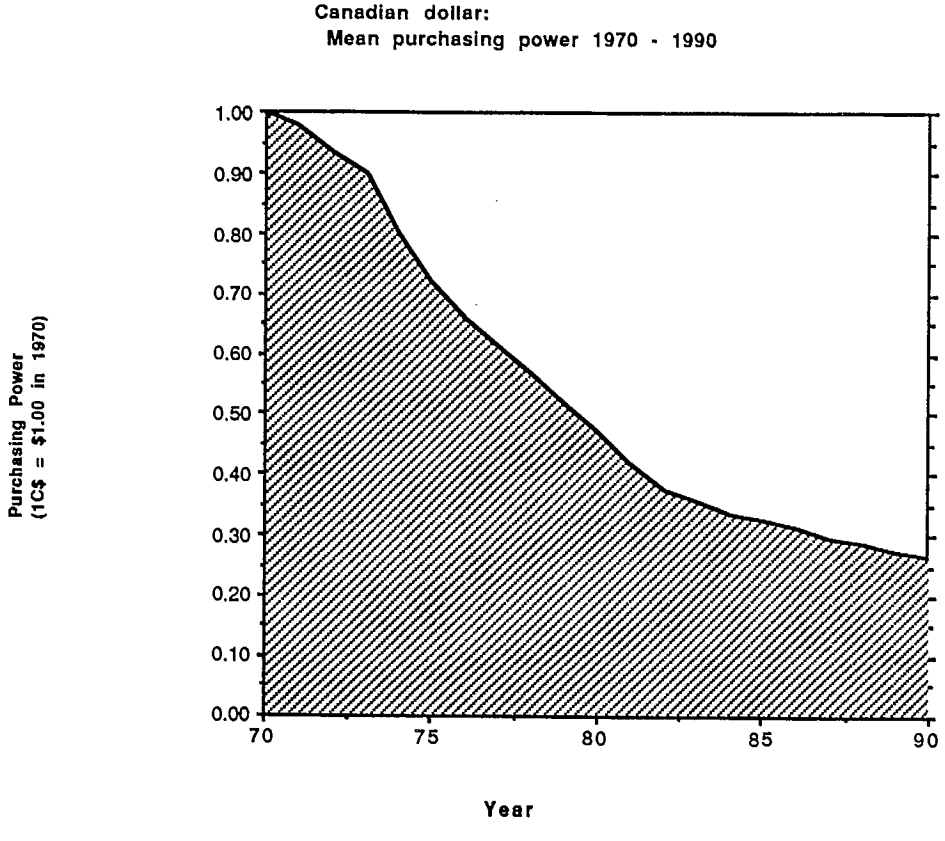

Figure 3.1: Mean purchasing power of the Canadian dollar from 1970-1990. Compiled from the consumer price index (CPI), showing decreased purchasing power averaged across all economic sectors.

Province	Percentage Growth
Newfoundland	19%
Prince Edward Island	18%
Nova Scotia	14%
New Brunswick	16%
Quebec	12%
Ontario	29%
Manitoba	11%
Saskatchewan	6%
Alberta	55%
British Columbia	47%
Yukon Territories	53%
Northwest Territories	63%
Canada	23%

Table 3.2: National and provincial population growth, 1970-1990 (compiled from Statistics Canada data).

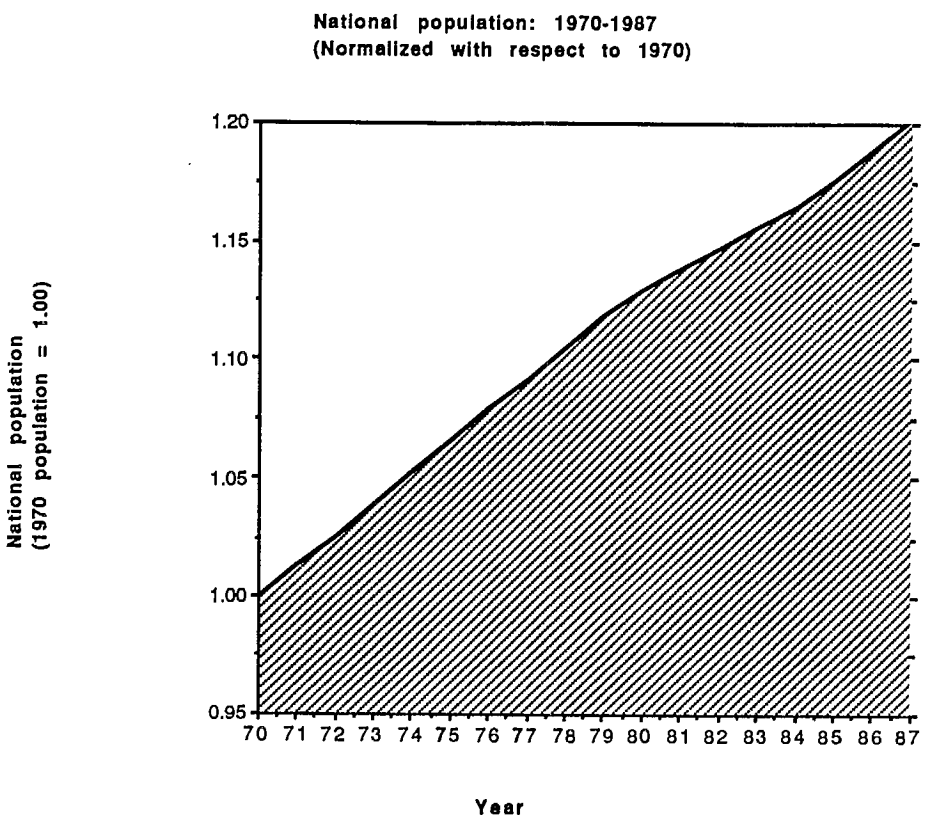

Figure 3.2: National population growth, 1970-1990, normalized with respect to the 1970 national population of 21,568,000.

3.3 Effect on DFAA

DFAA was originally designed to provide financial support to provinces with insufficient economic resources to recover from a severe disaster. In the twenty years since the plan's inception, conditions relevant to DFAA have changed, most notably in the Canadian economic and demographic environments. This section examines how the federal/provincial financial burden has shifted from 1970 to 1990.

Federal Assistance corrected for economic variation

The assessment of federal DFAA expenses over time should be done with respect to resource-constant dollars, to compensate for changes in purchasing power. Resources costing (on average) one dollar in 1970 cost (on average) approximately $4.00 in 1990. By defining *resource-constant* dollars to compensate for variations in purchasing power, federal DFAA expenses are referred to a constant benchmark. Federal expenses adjusted to compensate for reduced purchasing power (Figure 3.1) yield federal DFAA expenses in terms of resource-constant dollars (Figure 3.3).

The effect of decreased purchasing power is cumulative, and becomes more pronounced with time. For example, federal assistance in the Edmonton tornado recovery was approximately $22M in 1988 funds, but approximately $6M in (resource-constant) 1970 dollars. Figure 3.4 shows the new distribution of yearly federal assistance through DFAA, once primary economic variation has been accounted for.

Assessing DFAA: The sharing matrix

A useful assessment tool models the effect of DFAA in response to a set of standardized disasters occurring in a set of standardized provinces. Small, medium and large disasters are modelled in small, medium and large provinces. For simplicity, it is assumed that all disasters require the same recovery resources and affect the same economic sectors. The resulting *sharing matrix* summarizes the nine possible scenarios and shows levels of federal and provincial assistance.

Disaster events are classified by total eligible expenses:

Small:	$5 million,
Medium:	$25 million,
Large:	$50 million.

Provincial recovery resource capabilities are classed by population:

Small:	0.5 million,
Medium:	3.0 million,
Large:	8.0 million.

The sharing matrix under the existing sharing formula appears in Table 3.3. For example: under the present plan a medium size disaster ($25M of eligible expenses) occurring in a medium size province (3.0M population) receives approximately $16.5 million (66% of eligible expenses) in federal assistance, leaving $8.5 million (34%) for the province to provide. The sharing matrix allows a rapid assessment of DFAA response to a standardized set of scenarios, under any desired sharing formula option. For example,

under the present formula, small provinces (with limited recovery ability) receive the largest proportion of federal assistance. Assistance decreases with increasing population until large provinces receive comparatively little federal support, and none at all in small disasters.

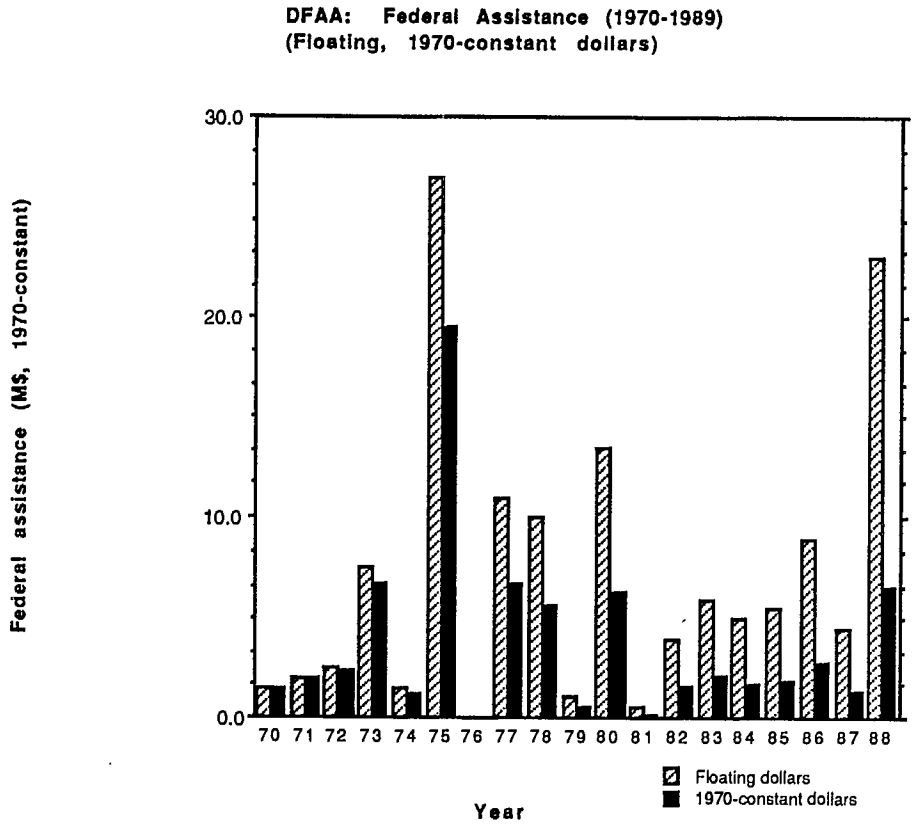

Figure 3.3: DFAA federal expenditures, 1970-1988, referred to floating and 1970-constant dollars. The use of resource-constant (1970) dollars shows the cumulative effect of decreased purchasing power.

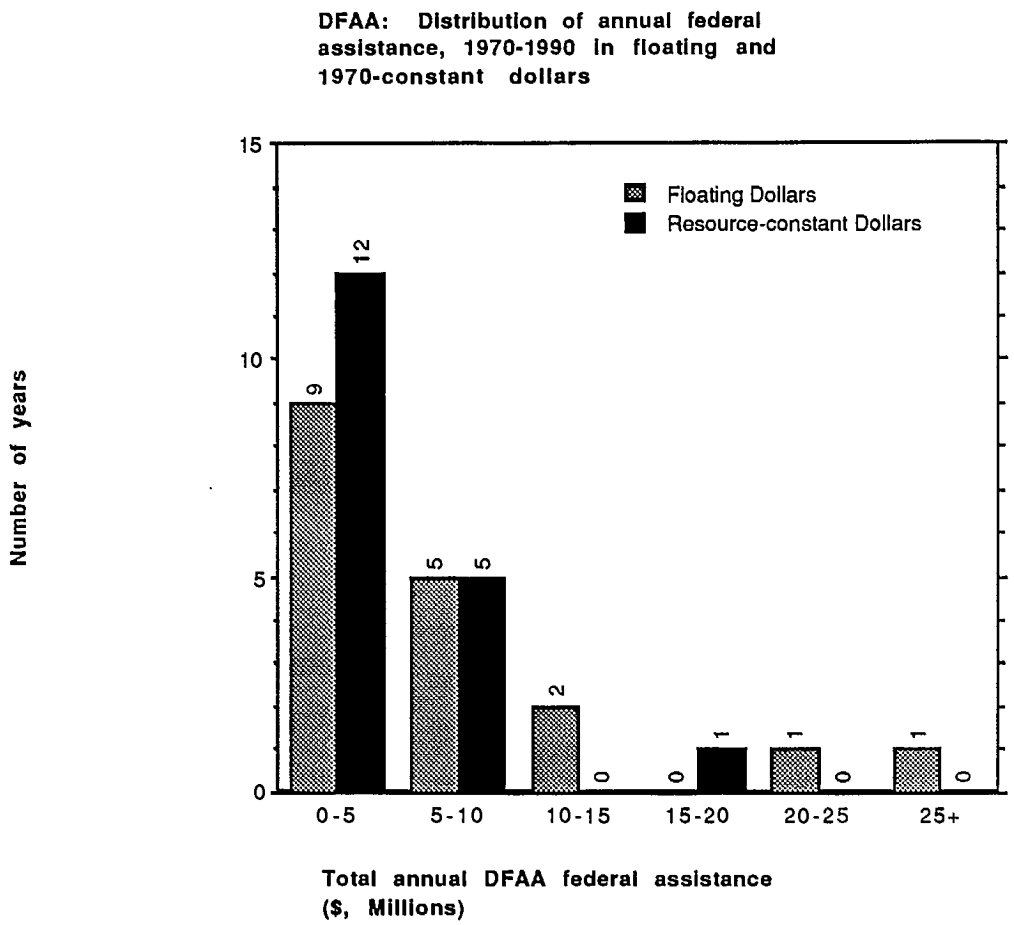

Figure 3.4: Distrirbution of annual DFAA expenditures, 1970-1988 in both floating and resource-constant (1970) dollars. Compensating for inflation lowers the 'absolute' cost of a disaster and changes the distribution.

Provincial population	Disaster Event					
	Small (5.0M)		Medium ($25.0M)		Large ($50.0M)	
	$M	%	$M	%	$M	%
Small (0.5M)	3.5 / 1.5	(70/30)	21.5 / 3.5	(86/14)	44.0 / 6.0	(88/12)
Medium (3.0M)	1.0 / 4.0	(20/80)	16.5 / 8.5	(66/34)	39.0 / 11.0	(78/22)
Large (8.0M)	0.0 / 5.0	(0/100)	8.8 / 16.2	(35/65)	29.0 / 21.0	(58/42)

Table 3.3: DFAA sharing matrix under the current sharing formula. Federal and provincial assistance from small, medium and large provinces is shown in response to small, medium and large disaster events. Both absolute costs (in millions of dollars) and percentages are shown. The format is Federal / Provincial, that is x / y denotes x of Federal assistance, y of provincial assistance.

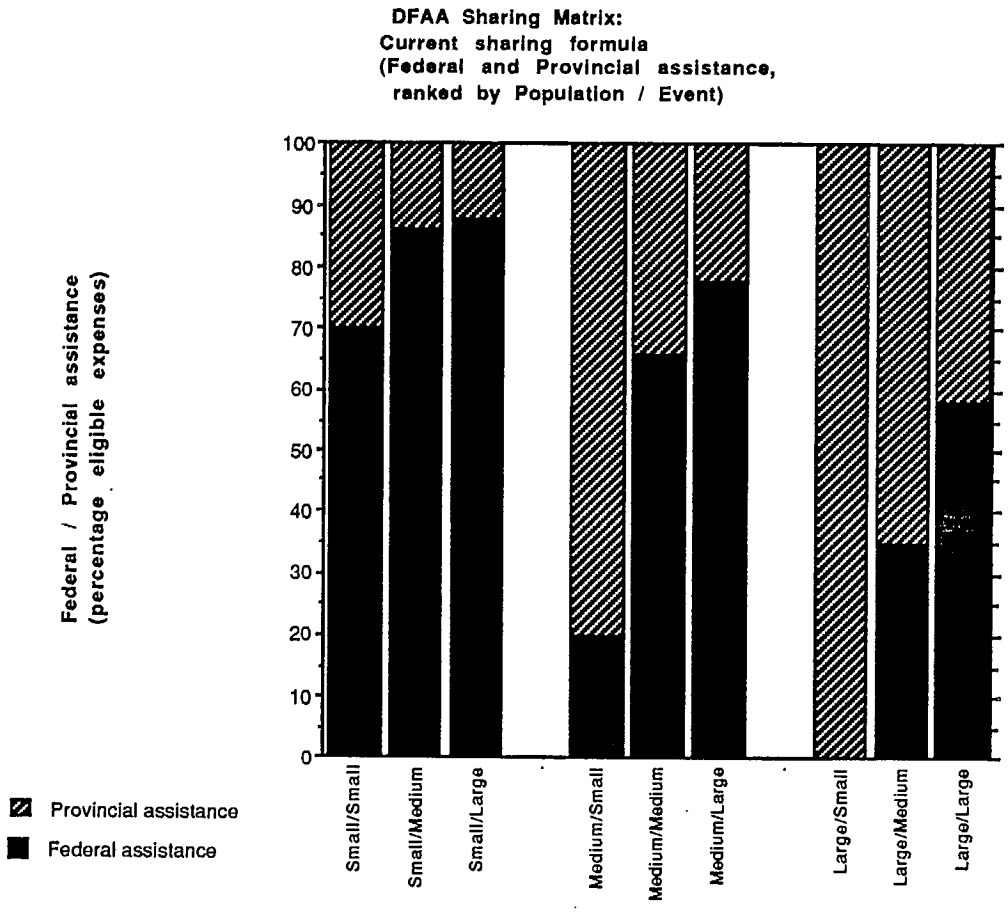

Figure 3.5: The DFAA Sharing Matrix under the present sharing formula. Federal and provincial assistance ratios are shown in small, medium and large provinces striken with standardized small, medium and large disaster events. Scenarios are clustered by province, then event size.

Changes in Federal/Provincial sharing 1970-1990:

Changes in federal-provincial sharing have occurred largely from two factors:

1. Economic (Figure 3.1), and
2. Demographic (Figure 3.3).

A meaningful examination of changes of sharing with time must attempt to compensate for these two factors. This may be found by referring to resource-constant disasters occurring in 1970 (the historical base year) and 1990 (the current year). It will be convenient to use the sharing matrix format of three sizes of disaster occurring in each of three sizes of province. One can set the basis as applying to 1970 and then shift to 1990 through the factors for economic influence and demographics. These results are presented in Table 3.4.

Population		Eligible expenses	
1970	1990	1970	1990
0.5M	0.6M	$5M	$19.5M
3.0M	3.6M	$25M	$97M
8.0M	9.6M	$50M	$195M

Table 3.4: Mean changes in provincial population and DFAA eligible expenses from 1970 to 1990. The average provincial population increase is estimated from the national population growth of approximately 20%. Eligible expense increases are calculated from the CPI.

The psychology of change: perception

The perception of change is an important factor in assessing DFAA performance over time. Perception of the world is an individual process: each person identifies and processes new information in terms of a framework built up over a lifetime of experience. The process ultimately acquires a human bias: comparisons are unavoidably 'colored' by the participant. This is especially true when comparing temporally distinct events: comparing a present-day event with one occurring in the past involves many perceptually subjective processes: memory, attitudes, and others operating at a background level.

An example of this is found in the comparison of equivalent disasters in 1970 and 1990. A simple application of a mathematical formula shows that small, medium and large disasters with $5M, $25M or $50M eligible expenses in 1970, cost approximately $20M, $100M and $200M in 1990. However, many people would immediately identify $20M with a medium-sized (not small) disaster, $100M with large (not medium), and $200M with catastrophic-level (not large) disasters in 1990. Hence the subjective perception of events and expenses typically do not keep pace with more objective magnitude measurements. The role of subjective perception is a subtle factor which must be recognized.

A further issue is the subjective nature of changing standards: since DFAA are arrangements wherein the type of acceptable costs of a disaster is negotiable in each instance, there may be a more generous interpretation for application as time goes on, as Canadian society becomes more affluent. This kind of escalation is difficult to measure. It would seem that the tyes of acceptable costs, once set and included, can never be reduced.

Sharing matrix of equivalent events, 1970-1990

Federal/provincial assistance ratios for resource-equivalent scenarios are found using Table 3.4, and are presented in Table 3.5. A comparison of sharing in equivalent events occurring in 1970 and 1990 shows that the federal burden has *increased* in all scenarios (Figure 3.5, Table 3.4).

The magnitude of the increased burden diminishes with increasing event size since larger events receive more assistance from the 90%/10% sharing level. Similarly, the federal burden increases with increasing population. The sole exception is the case of a small disaster striking a large province. This scenario violates both rules because the 1970 disaster expenses do not even reach the first sharing threshold, so comparison of 1970 with 1990 events is meaningless.

Provincial population	**Event size**					
	Small		Medium		Large	
	$M	%	$M	%	$M	%
Small	16.4 / 3.1	(84/16)	86.1 / 10.9	(89/11)	174.3 / 20.7	(89/11)
Medium	10.4 / 9.1	(53/47)	80.1 / 16.9	(83/17)	168.3 / 26.7	(70/30)
Large	5.0 / 14.5	(25/75)	68.1 / 28.9	(70/30)	156.0 / 38.7	(80/20)

Table 3.5: DFAA sharing matrix for resource-equivalent disasters occurring in 1990. Each scenario is equivalent (in terms of recovery resources required) to the corresponding scenario of events occurring in 1970, shown in Table 3.3. In all events considered, the federal assistance burden in 1990 is increased relative to the 1970 event.

Provincial population	**Event size**		
	Small	Medium	Large
Small	14 %	3 %	1 %
Medium	33 %	17 %	8 %
Large	25 %	35 %	22 %

Table 3.6: Percentage increases in the relative federal assistance burden for resource-equivalent events in 1970 and 1990, using the current DFAA sharing matrix. Federal expenses increased by an average 24% in a small event, 18% in a medium event and 10% in a large event.

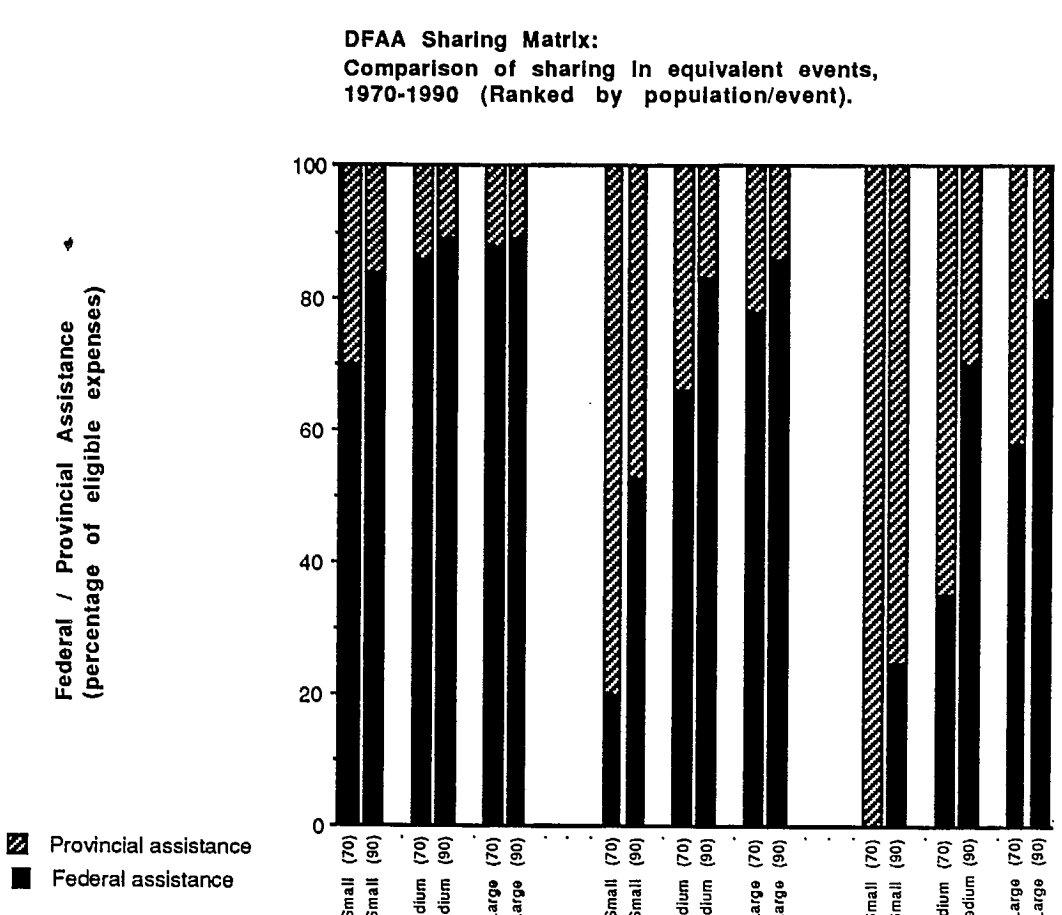

Figure 3.6: The change in application of DFAA from 1970 to 1990. Shown are federal and provincial assistance ratios in resource-equivalent events occurring in 1970 and 1990. Disaster expenses are scaled by average inflation, while provincial populations are adjusted by the national population growth ratio.

3.4 Summary:

DFAA is in place to provide provinces with emergency disaster recovery funds, using a sharing formula dependent upon total eligible expenses and provincial recovery resources (determined from provincial population). In the twenty years since the plan's inception, substantial changes in the milieu in which DFAA operates have occurred which have not been accommodated. These were identified as:

1. *Economic factors* resulting from the change in purchasing power of the Canadian dollar,
2. *Demographic factors* resulting from population growth and shifts,.

Economic factors controlling the cost of disaster recovery are assumed to have escalated at the same rate as all other goods and services. This is keyed to the Consumer Price Index (CPI), which has risen 389% since 1970. That is, goods or services costing $1.00 in 1970 cost, in 1990, an average $3.89. This has *increased* the Federal burden by effectively lowering DFAA sharing thresholds.

Demographic factors involve changes in provincial population since 1970, which controls the entry location of each sharing threshold. An overall national population increase of approximately 23% from 1970 to 1990 has effectively raised the sharing thresholds and slightly lowered Federal burden. When both economic and demographic effects are taken into consideration, the relative federal burden has increased substantially in all cases considered.

Annex 4
Assessment of sharing options

4.1 Classes of options

Structure of the sharing formula

There are an infinite number of possible sharing formulae, reflecting the infinite number of ways expenses can be shared between federal and provincial governments. The set of all possible options is divided into a small number of classes, each characterized by a dominant attribute of the sharing formula. The classes are taken as:

Threshold sharing plans

The current DFAA sharing plan has a *threshold* structure: federal assistance in response to a given level of eligible expenses has the form of a series of plateaus at successively higher levels of federal assistance. This format is easily understandable, and is easy to work with. Its primary disadvantage is the relative inflexibility of a sequence of flat responses. A sharing formula is specified by the number of response plateaus, the width, height and number of each level.

Non-threshold sharing plans

Abandoning the threshold structure allows for a greater variety of sharing options by permitting more flexible responses. This permits greater realism in fine-tuning the model to actual conditions, but at the cost of a less understandable and more complex plan.

Composite sharing plans

Combining threshold and non-threshold formats can result in substantially increased flexibility with only a marginal increase in complexity. This is also a useful starting point for identifying salient features of a particular sharing strategy, which can then be transferred to a simpler sharing plan.

Representations of sharing plans

The DFAA sharing plan is usually expressed as a set of thresholds governing the level of federal assistance. This format is appropriate when the sharing plan consists of a set of 'flat' response levels, but can be confusing if a non-threshold plan is used. A useful complementary representation of the sharing plan expresses federal support (in dollars per capita) in response to a given level of eligible expenses (also in dollars per capita).

For example, Section 4.2 examines the present sharing formula as Option 1. Figures 4.1, 4.2 show the current DFAA sharing plan in both representations. Figure 4.1 shows the sharing plan as a set of threshold plateaus, in which federal assistance is calculated by summing over all encountered levels up to eligible per capita expenses. For example, an event at $4 per capita eligible expenses places response in the third plateau of the chart. The total federal assistance per capita of provincial population is found by a weighted sum over the three levels:

Level I:	\$0 - \$1 / capita	@ 0% =	\$0.00 assistance per capita,
Level II:	\$1 - \$3 / capita	@ 50% =	\$1.00 assistance per capita,
Level III:	\$3 - \$4 / capita	@ 75% =	\$0.75 assistance per capita,
Total federal assistance for this event:			\$1.75 assistance per capita.

Eligible expense (per capita provincial pop)	**Federal/Provincial sharing ratio**
\$0-\$1	0% / 100%
\$1 - \$3	50% / 50%
\$3-\$5	75% / 25%
>\$5	90% / 10%

Table 4.1: The present DFAA sharing formula. This is a threshold-based scheme using 4 sharing plateaus.

That is, this event receives \$1.75 per capita federal assistance. This is simply the total area under the sharing curve from \$0.00 to \$4.00 per capita of eligible expenses. This is easily tabulated (Figure 4.2), giving the cumulative federal share as a function of eligible expenses, in units of dollars per capita. This alternate representation provides a different perspective on the sharing plan, and will be useful when comparing the effect of different sharing options.

Assessment of sharing options

Because of the capricious nature of disasters, DFAA is at its best when regarded as a set of general guidelines, adaptable enough to be modified by the context of a disaster, rather than as a programme of inflexible rules graven in stone. This places an additional onus on the implementation of DFAA to conform to 'the spirit of the guidelines', regarded as a perspective on the nature of disaster assistance within the Canadian federation. The absence of a hard yardstick complicates the comparison of different sharing options: instead of comparing prospective options against a qualitative figure of merit, options are in large part compared against less rigidly defined concepts of fairness and adequacy.

Prospective sharing plans must be assessed against several criteria: minimal requirements of fairness, simplicity and overall adequacy must be satisfied. The prospective plan must deal with provinces *fairly* by recognizing the wide variation in economic recovery ability among the provinces. A new plan must be simple and easy to implement, and must provide adequate assistance within the framework of the guidelines, and should have some continuity provision to permit an easy transition between the old and new sharing plans.

Presenting the options

The following sections present several options to the current sharing plan. A tabulation of the set of presentations is given in Table 4.2. Each option is presented either in terms of a set of sharing plateaus, or where appropriate, in terms of federal assistance (per capita) as a function of per capita eligible expenses. A sharing matrix is shown to facilitate the comparison between 'standard' disasters in 'standard' provinces. The effect of each option in terms of disaster size, province size, other options and the current plan, are discussed and summarized.

Threshold Formulae	
Option 1	Current formula
Option 2	Three times current formula
Option 3	Four times current formula
Option 4	Twice current formula
Modified Threshold Formulae	
Option 5	Equal sharing
Option 6	Twice current with additional level
Option 7	Three times current with additional level
Non-Threshold Formulae	
Option 8	Graded response from $0-$10
Option 9	Graded response from $0-$15
Option 10	Hybrid graded/threshold response

Table 4.2: Summary of DFAA Sharing formula Options considered in the following sections. Options are grouped into three classes, *Threshold formulae*, direct variations on the existing sharing formula, *Modified threshold formulae*, threshold-based formulae with additional and/or altered sharing levels, and *Non-threshold formulae*, not based on a series of flat responses.

4.2 Option 1: Existing formula

The current DFAA sharing formula has been in existence since the arrangement's inception in 1970. It is a threshold scheme involving four levels of federal assistance (Table 4.3).

Sharing Matrix:

The sharing formula of Table 4.3 is applied to a matrix of standardized disasters and provinces, chosen as small (total eligible expenses of $5M), medium ($25M) and large ($50M) disasters occurring in small (population of 0.5M), medium (3.0M) and large (8.0M) provinces. Federal and provincial contributions for these events appear as elements in the sharing matrix (Table 4.4).

Eligible expense (per capita provincial pop)	**Federal/Provincial sharing ratio**
$0-$1	0% / 100%
$1 - $3	50% / 50%
$3-$5	75% / 25%
>$5	90% / 10%

Table 4.3: Existing DFAA sharing formula.

Provincial population	**Event size**					
	Small ($5.0M)		Medium ($25.0M)		Large ($50.0M)	
	$M	%	$M	%	$M	%
Small (0.5M)	3.5 / 1.5	(70/30)	21.5 / 3.5	(86/14)	44.0 / 6.0	(88/12)
Medium (3.0M)	1.0 / 4.0	(20/80)	16.5 / 8.5	(66/34)	39.0 / 11.0	(78/22)
Large (8.0M)	0.0 / 5.0	(0/100)	8.8 / 16.2	(35/65)	29.0 / 21.0	(58/42)

Table 4.4: DFAA sharing matrix under the current sharing formula. Federal and provincial assistance from small, medium and large provinces is shown in response to small, medium and large disaster events. Both absolute costs (in millions of dollars) and percentages are shown. The format is Federal / Provincial, that is x / y denotes x of Federal assistance, y of provincial assistance.

Advantages

The primary advantage of retaining the current formula is its historical value. By preserving the status quo and continuing to work with a proven plan, an historically adequate sharing plan with a proven track record is maintained.

Disadvantages

While adequate for maintaining the status quo, the existing formula places an increasingly large burden on the federal government. It does not address either economic or demographic changes over the past twenty years.

Recommendation

This option provides a benchmark against which other sharing formula options may be compared. This option will be retained for further study.

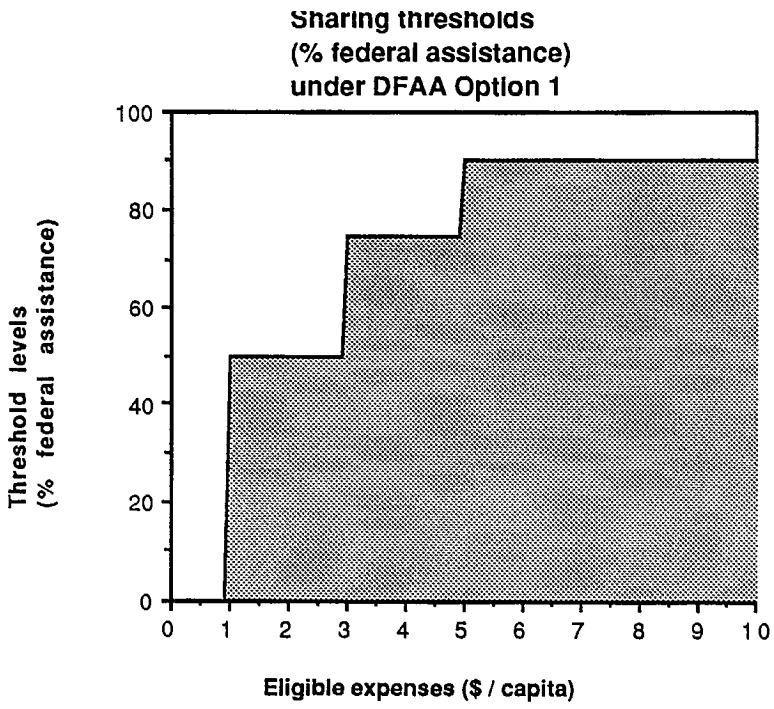

Figure 4.1: Sharing thresholds as a function of eligible expenses (dollars per capita provincial population) under the current DFAA sharing formula (Option 1).

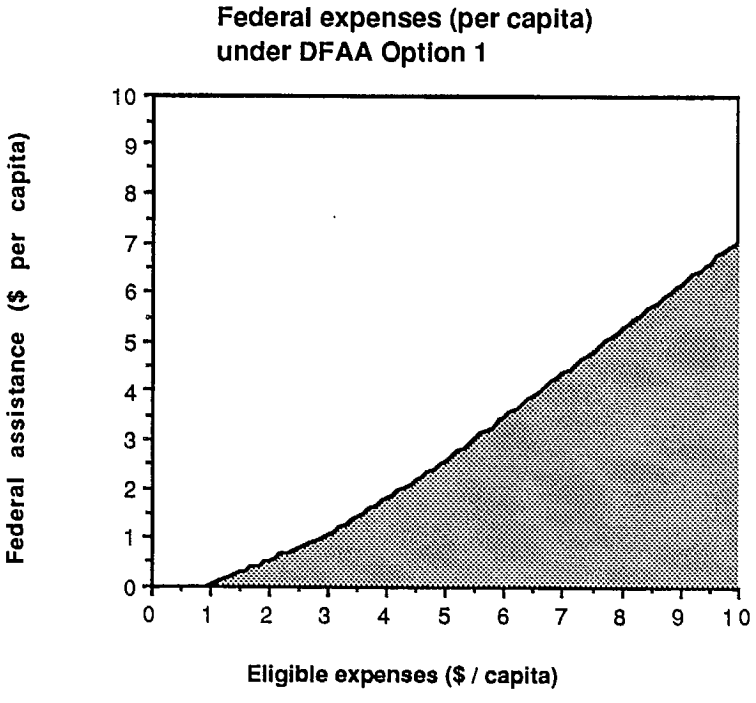

Figure 4.2: Total federal expenses (per capita of provincial population) as a function of total eligible expenses (per capita of provincial population) under the current DFAA sharing formula (Option 1).

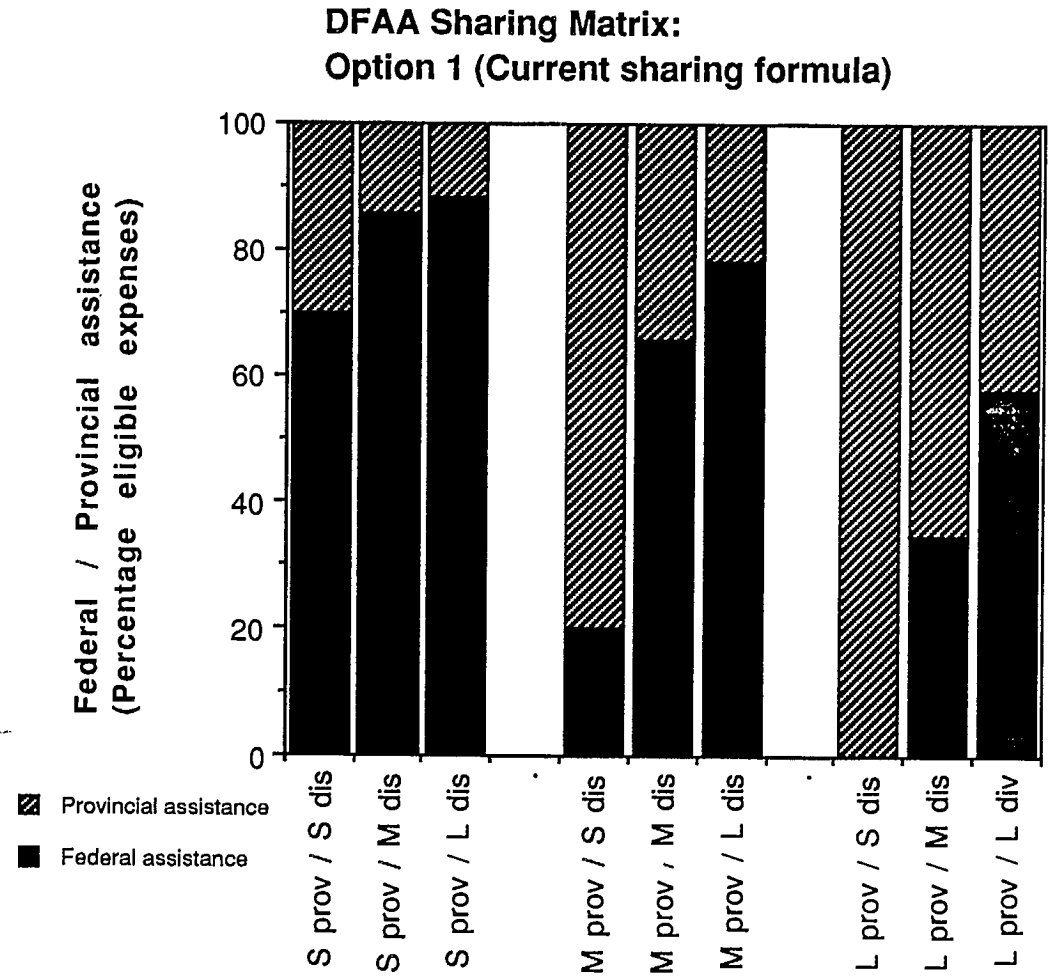

Figure 4.3: The DFAA Sharing Matrix under Option 1 (the present sharing formula). Federal and provincial assistance ratios under this scenario are shown in small, medium and large provinces (population 0.5M, 3.0M and 8.0M respectively) stricken by standardized small, medium and large disaster events ($5.0M, $25.0M, $50.0M respectively). Scenarios are clustered first by province, then by event size.

4.3 Option 2: Existing plan scaled by 4

Since the introduction of DFAA in 1970, the purchasing power of the Canadian dollar has fallen by 385% (January 1970 to January 1990), as indicated by the Consumer Price Index, a composite indicator of purchasing power weighted across the entire economic spectrum. That is, goods that cost $1.00 in 1970 cost, on average, approximately $4.00 in 1990. One possible modification to the DFAA sharing plan is to scale the existing formula to accommodate the full effect of the weakened dollar, scaling by a rounded factor of 4. Table 4.5 shows the modified sharing formula.

Eligible expenses (per capita prov pop)	**Federal/Provincial assistance**
$0-$4	0% / 100%
$4-$12	50% / 50%
$12 - $20	75% / 25%
$20 +	90% / 10%

Table 4.5: Option 2 of DFAA sharing formula: cost sharing thresholds increased by a factor of four.

Sharing Matrix:

The sharing thresholds of Table 4.5 are applied to a matrix of small ($5M), medium ($25M) and large ($50M) events occurring in small (0.5M), medium (3M) and large (8M) provinces The results are given in Table 4.6.

Provincial population	**Event size**					
	Small ($5.0M)		Medium ($25.0M)		Large ($50.0M)	
	$M	%	$M	%	$M	%
Small (0.5M)	1.5 / 3.5	(30/70)	18.5 / 6.5	(74/26)	41.0 / 9.0	(82/18)
Medium (3.0M)	0.0 / 5.0	(0/100)	6.5 / 18.5	(26/74)	22.5 / 27.5	(45/55)
Large (8.0M)	0.0 / 5.0	(0/100)	0.0 / 25.0	(0/100)	9.0 / 41.0	(18/82)

Table 4.6: DFAA sharing matrix under Option 2 of the sharing formula. Federal and provincial assistance from small, medium and large provinces is shown in response to small, medium and large disaster events. Both absolute costs (in millions of dollars) and percentages are shown. The format is Federal / Provincial for both dollars and percentages.

Effect of Modifications:

Table 4.7 examines the changes in federal/provincial sharing which accompany this option with respect to the current formula.

Advantages:

Advantages under this option are in favour of the Federal side. The federal burden is reduced or remains at zero in all cases. Small provinces experience the greatest benefit, in the sense of losing the least assistance for medium and large events.

Disadvantages:

Disadvantages under this option are almost all from the provincial perspective. The effect of adjusting for two decades of decreased purchasing power results in a dramatically increased provincial burden. Small disasters are almost entirely the province's concern, with large provinces receiving federal assistance only in the largest events. A large province with 8.0M population does not meet the lowest sharing threshold ($4 per capita) until $32M eligible expenses.

Recommendation:

Because of the substantial change in federal/provincial sharing with respect to the current formula, this option is *not* recommended for further study.

Provincial population	**Event size**					
	Small ($5.0M)		Medium ($25.0M)		Large ($50.0M)	
	$M	%	$M	%	$M	%
Small (0.5M)	-2.0	-40	-3.0	-12	-3.0	-6
Medium (3.0M)	-1.0	-20	-10.0	-40	-16.5	-33
Large (8.0M)	0.0	0	-8.8	-35	-20.0	-40

Table 4.7: Difference in sharing ratios between current formula and Option 2 of the DFAA sharing formula. Both absolute costs (in millions of dollars) and percentages are shown. Changes are those experienced by the Federal government. For example, for a small disaster in a small province: the federal burden is reduced by $2.0M, which is a 40% reduction in the federal burden.

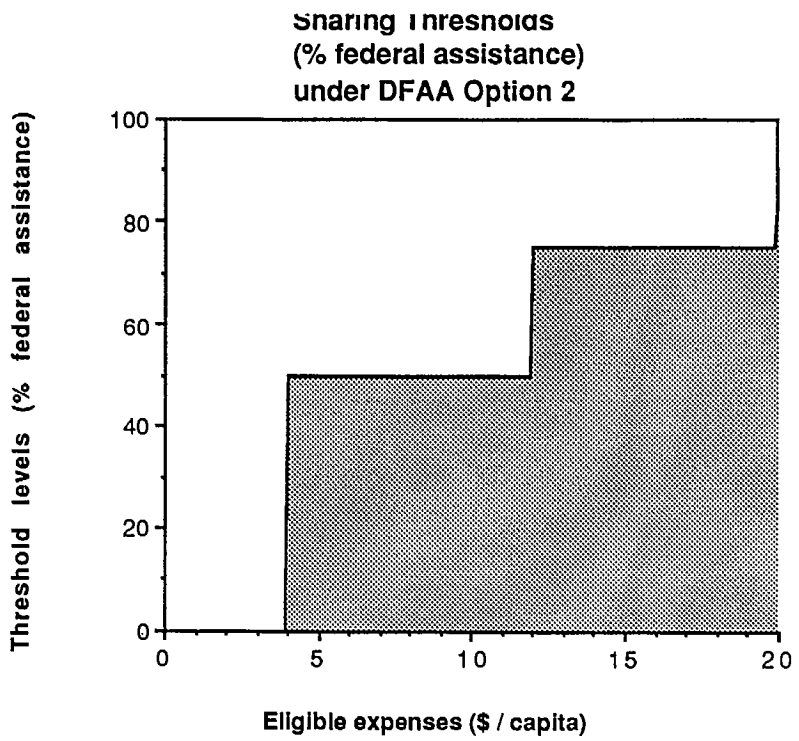

Figure 4.4: Sharing thresholds as a function of eligible expenses (dollars per capita provincial population) under Option 2 of the DFAA sharing formula.

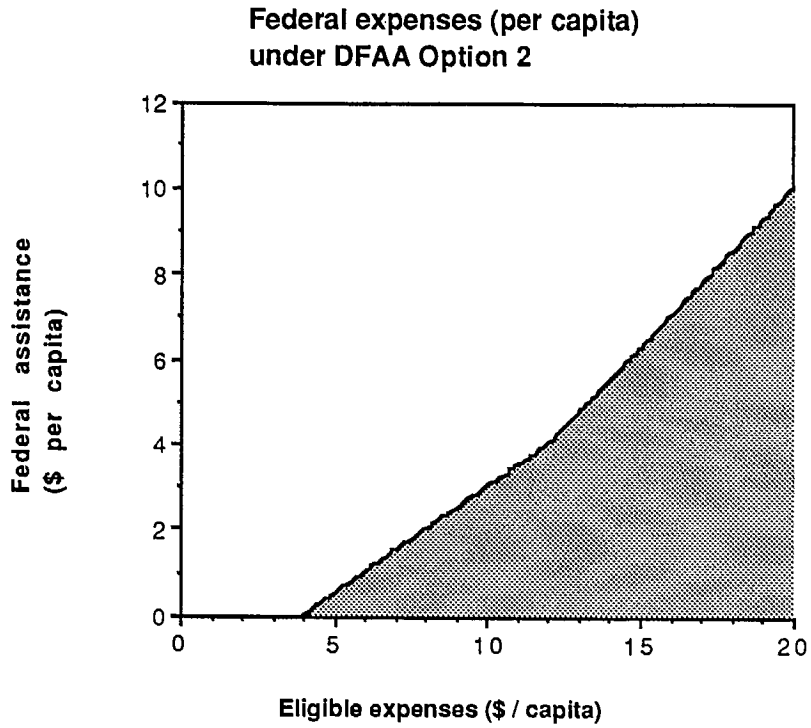

Figure 4.5: Total federal expenses (per capita of provincial population) as a function of total eligible expenses (per capita of provincial population) under Option 2 of the DFAA sharing formula.

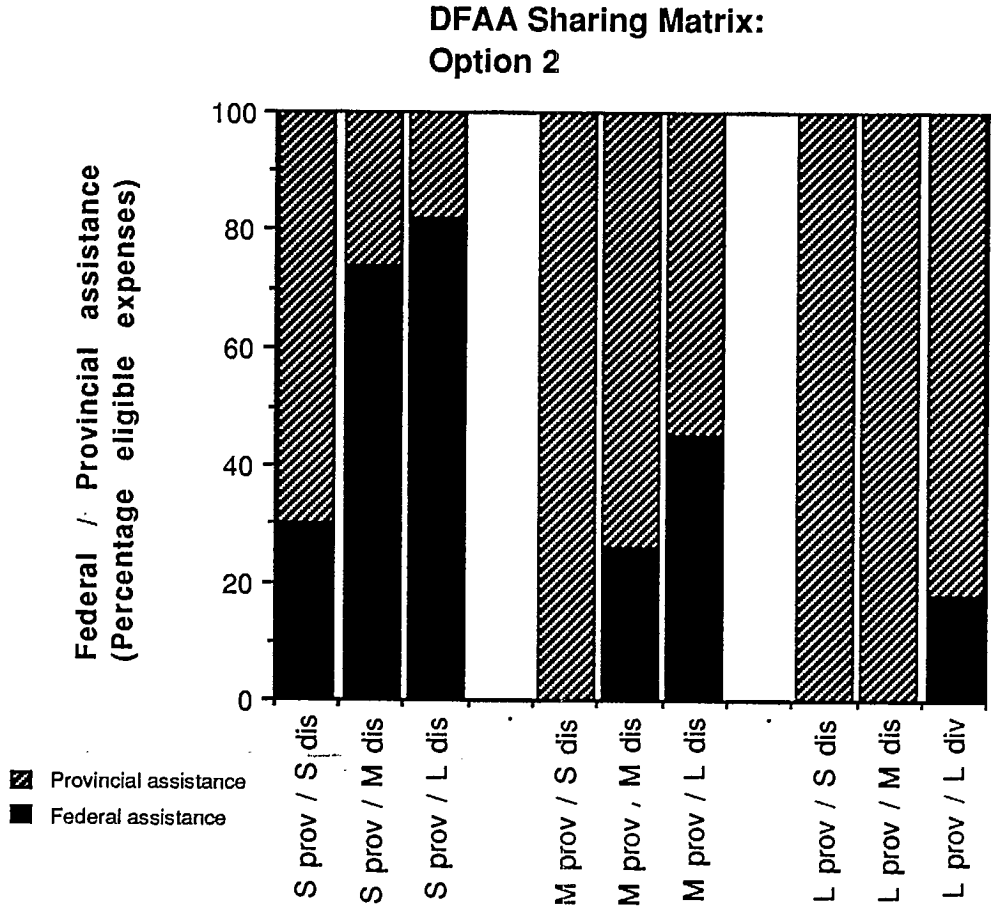

Figure 4.6: The DFAA Sharing Matrix under Option 2 (present sharing formula scaled by a factor of 4). Federal and provincial assistance ratios under this scenario are shown in small, medium and large provinces (population 0.5M, 3.0M and 8.0M respectively) stricken by standardized small, medium and large disaster events ($5.0M, $25.0M, $50.0M respectively). Scenarios are clustered first by province, then by event size.

4.4 Option 3: Existing plan scaled by factor of 3

With this option the existing plan is scaled by a factor of 3 to account for changes in the two primary factors: the change of purchasing power (resulting in an average increase factor of 3.89) and population growth (resulting in a mean decrease factor of 1.22) from 1970 to 1990. Combining the two gives an effective increase factor of approximately 3.2, rounded down to 3 for simplicity. Table 4.8 shows the modified sharing formula.

Eligible expenses (per capita prov pop)	**Federal/Provincial sharing ratio**
$0-$3	0% / 100%
$3-$9	50% / 50%
$9-$15	75% / 25%
>$15	90% / 10%

Table 4.8: Option 3 for DFAA sharing formula: cost sharing thresholds of the current formula are increased by a factor of three to compensate for both reduced Canadian dollar purchasing power and mean national population increase.

	Event size					
Provincial population	Small ($5.0M)		Medium ($25.0M)		Large ($50.0M)	
	$M	%	$M	%	$M	%
Small (0.5M)	1.9 / 3.1	(38/62)	19.5 / 5.5	(78/22)	42.0 / 8.0	(84/16)
Medium (3.0M)	0.0 / 5.0	(0/100)	8.0 / 17.0	(32/68)	27.0 / 23.0	(54/46)
Large (8.0M)	0.0 / 5.0	(0/100)	0.5 / 24.5	(2/98)	13.0 / 37.0	(26/74)

Table 4.9: DFAA sharing matrix under Option 3 of the sharing formula. Federal and provincial assistance from small, medium and large provinces is shown in response to small, medium and large disaster events. The format is Federal / Provincial for both dollars and percentages.

Effect of Modifications:

Table 4.10 examines the changes in federal/provincial sharing which accompany this option with respect to the current formula.

Advantages:

Under this option federal shares are substantially reduced with respect to the present formula. However the increase is not as dramatic as with Option 2 (full economic adjustment with a factor of four). Some level of federal assistance is available in all sized provinces in medium and large events, albeit at substantially reduced levels compared with the present plan.

Disadvantages:

A factor of three increase in the threshold sharing levels still places a large burden on provincial recovery capabilities, compared with the present formula.

Recommendation:

Under this option the federal burden is substantially reduces with respect to that of the current formula. However, the increase in provincial burden is not as great as it would be under a full economic adjustment (scaling by a factor of 4). This option should be retained for further study.

Provincial population	**Event size**					
	Small ($5.0M)		Medium ($25.0M)		Large ($50.0M)	
	$M	%	$M	%	$M	%
Small (0.5M)	-1.6	-32	-2.0	-8	-2.0	-4
Medium (3.0M)	-1.0	-20	-8.5	-34	-12.0	-24
Large (8.0M)	0.0	0	-8.3	-33	-16.0	-32

Table 4.10: Difference in sharing ratios between current formula and Option 3 of the DFAA sharing formula. Both absolute costs (in millions of dollars) and percentages are shown. Changes are those experienced by the Federal government. For example, for a small disaster in a small province: the federal burden is reduced by $1.6M, which is a 32% reduction in the federal burden.

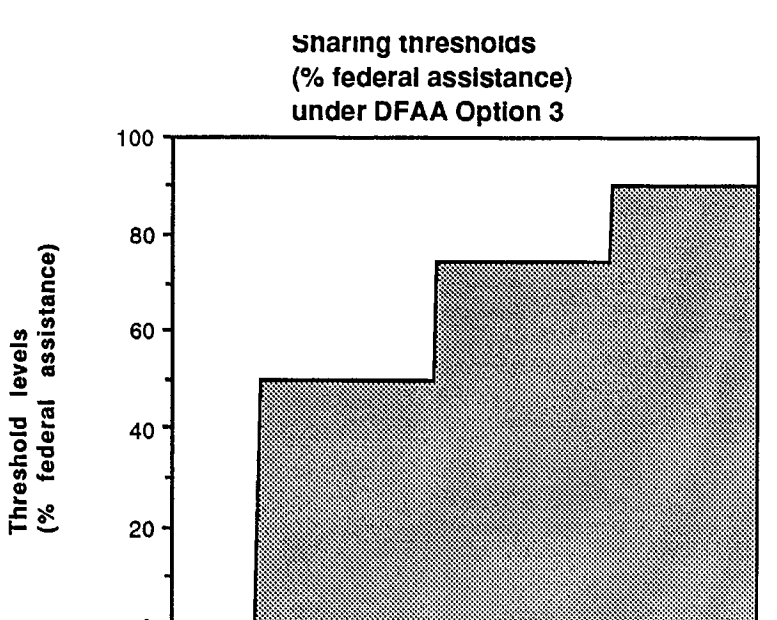

Figure 4.7: Sharing thresholds as a function of eligible expenses (dollars per capita provincial population) under Option 3 of the DFAA sharing formula.

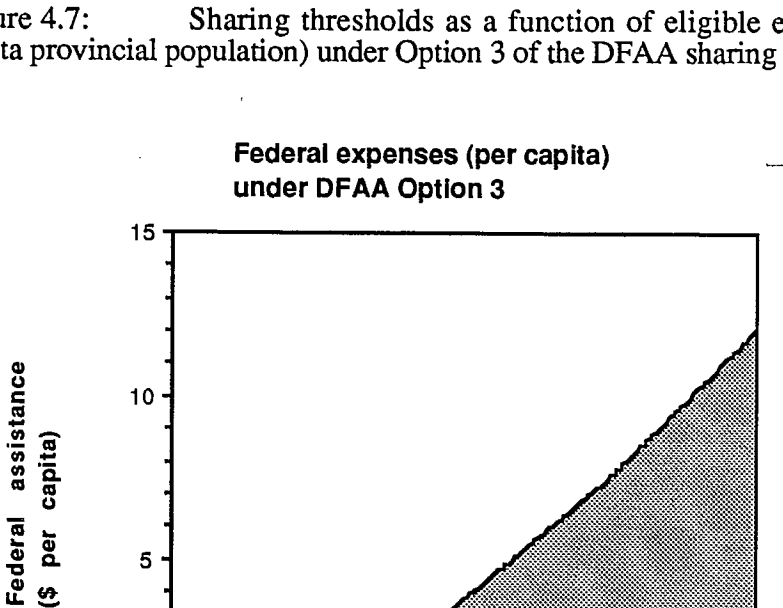

Figure 4.8: Total federal expenses (per capita of provincial population) as a function of total eligible expenses (per capita of provincial population) under Option 3 of the DFAA sharing formula.

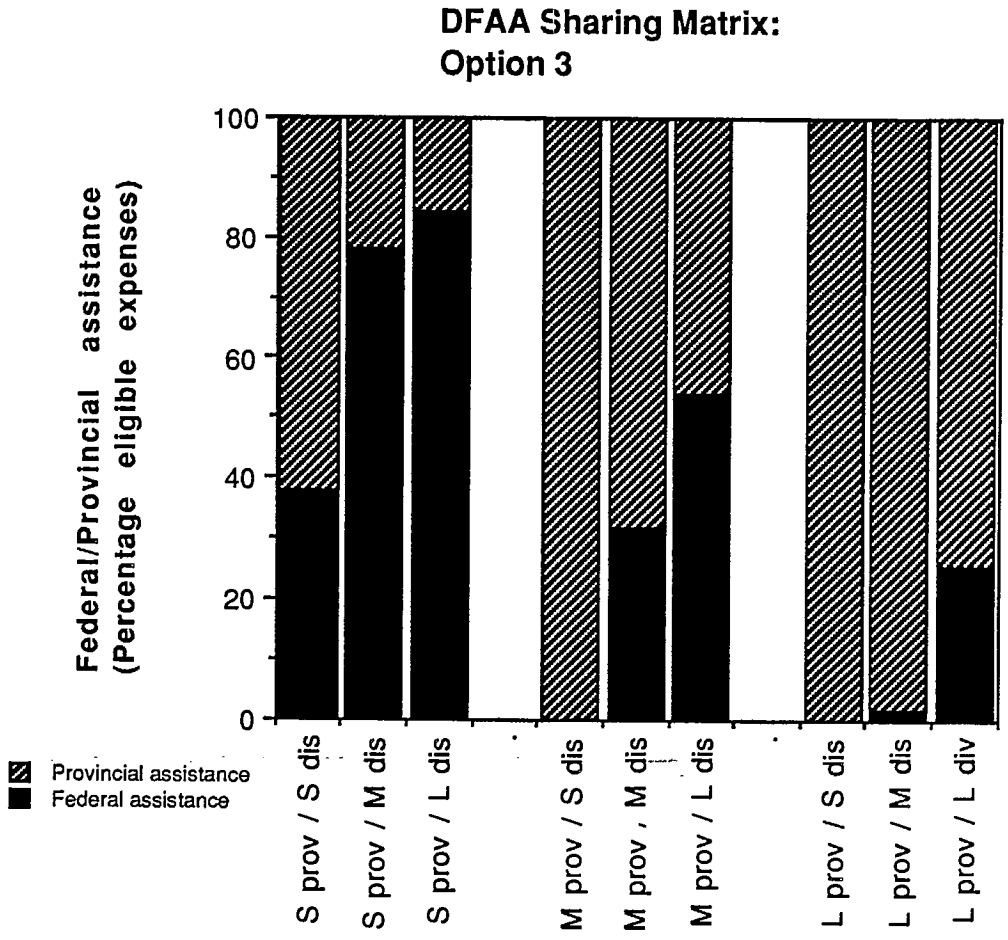

Figure 4.9: The DFAA Sharing Matrix under Option 3 (present sharing formula scaled by a factor of 3). Federal and provincial assistance ratios under this scenario are shown in small, medium and large provinces (population 0.5M, 3.0M and 8.0M respectively) stricken by standardized small, medium and large disaster events ($5.0M, $25.0M, $50.0M respectively). Scenarios are clustered first by province, then by event size.

4.4 Option 4: Existing plan scaled by factor of 2

With this option the existing plan is scaled by a factor of 2 to partially account for changes in the two primary factors: the change of purchasing power (resulting in an average increase factor of 3.89) and population growth (resulting in a mean decrease factor of 1.22) from 1970 to 1990.

Eligible expenses (per capita prov pop)	**Federal/Provincial sharing ratio**
$0-$2	0% / 100%
$2-$6	50% / 50%
$6-$10	75% / 25%
>$10	90% / 10%

Table 4.11: Option 4 for DFAA sharing formula: cost sharing thresholds of the current formula are increased by a factor of two.

Provincial population	**Event size**					
	Small ($5.0M)		Medium ($25.0M)		Large ($50.0M)	
	$M	%	$M	%	$M	%
Small (0.5M)	2.5 / 2.5	(50/50)	20.5 / 4.5	(82/18)	43.0 / 7.0	(86/14)
Medium (3.0M)	0.0 / 5.0	(0/100)	11.3 / 13.7	(45/55)	33.0 / 17.0	(66/34)
Large (8.0M)	0.0 / 5.0	(0/100)	4.5 / 20.5	(18/82)	17.5 / 32.5	(35/65)

Table 4.12: DFAA sharing matrix under Option 4 of the sharing formula. Federal and provincial assistance from small, medium and large provinces is shown in response to small, medium and large disaster events. The format is Federal / Provincial.

Effect of Modifications:

Advantages:

Under this option federal shares are somewhat reduced with respect to the present formula. The increase is small, affecting small provinces by less than 5% in medium and large events, and large provinces by less that 25% in all classes.

Disadvantages:

There still remains a substantial federal burden, as corrections for economic and population changes are only partially accounted for.

Recommendation:

This option represents a balance between the high federal burden accompanying the current formula and the sudden great increase in provincial burden accompanying a complete adjustment for inflation. This option will be retained for further study.

Provincial population	Event size					
	Small ($5.0M)		Medium ($25.0M)		Large ($50.0M)	
	$M	%	$M	%	$M	%
Small (0.5M)	-1.0	-20	-1.0	-4	-1.0	-2
Medium (3.0M)	-1.0	-20	-5.2	-21	-6.0	-12
Large (8.0M)	0.0	0	-4.3	-13	-11.5	-23

Table 4.14: Difference in sharing ratios between current formula and Option 4 of the DFAA sharing formula. Both absolute costs (in millions of dollars) and percentages are shown. Changes are those experienced by the Federal government. For example, for a small disaster in a small province: the federal burden is reduced by $1.0M, which is a 20% reduction in the federal burden.

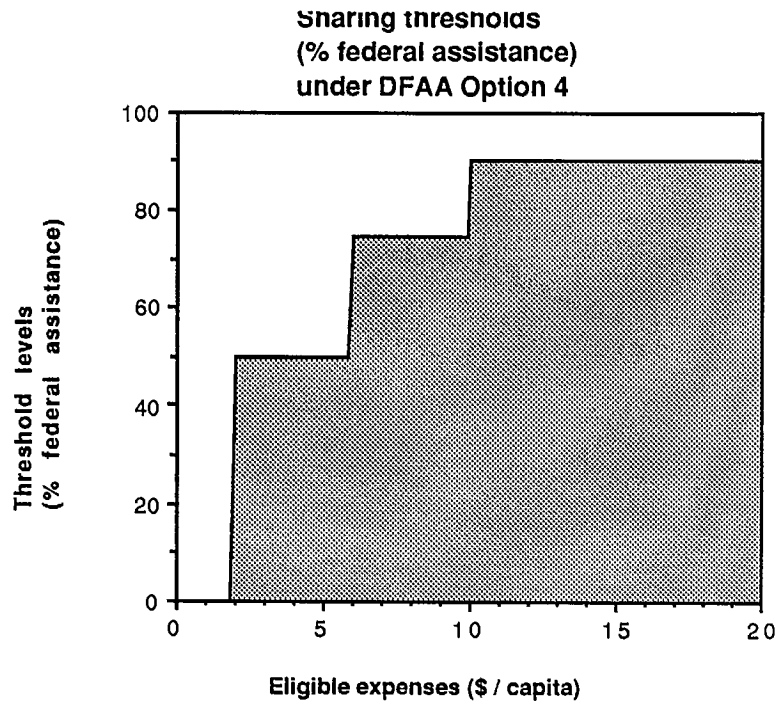

Figure 4.10: Sharing thresholds as a function of eligible expenses (dollars per capita provincial population) under Option 4 of the DFAA sharing formula.

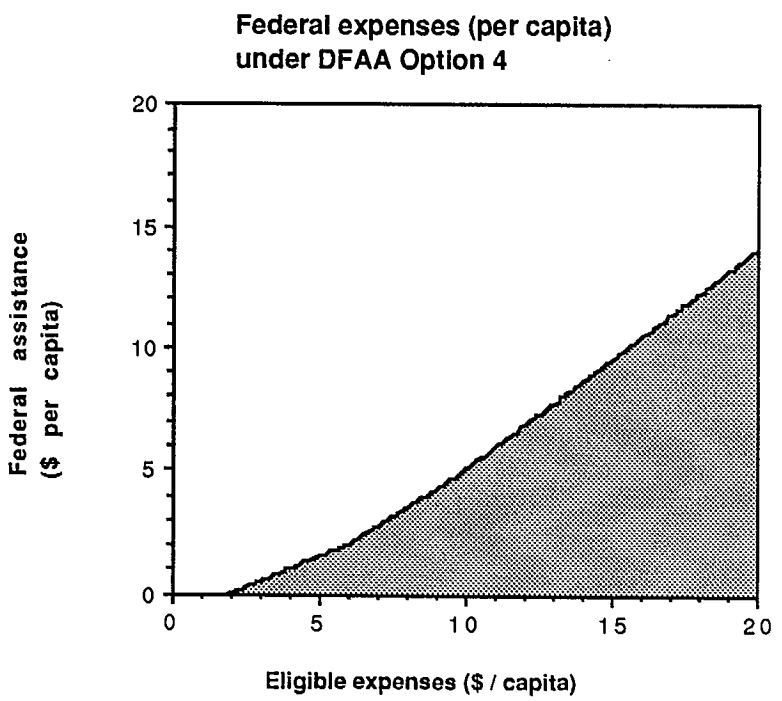

Figure 4.11: Total federal expenses (per capita of provincial population) as a function of total eligible expenses (per capita of provincial population) under Option 4 of the DFAA sharing formula.

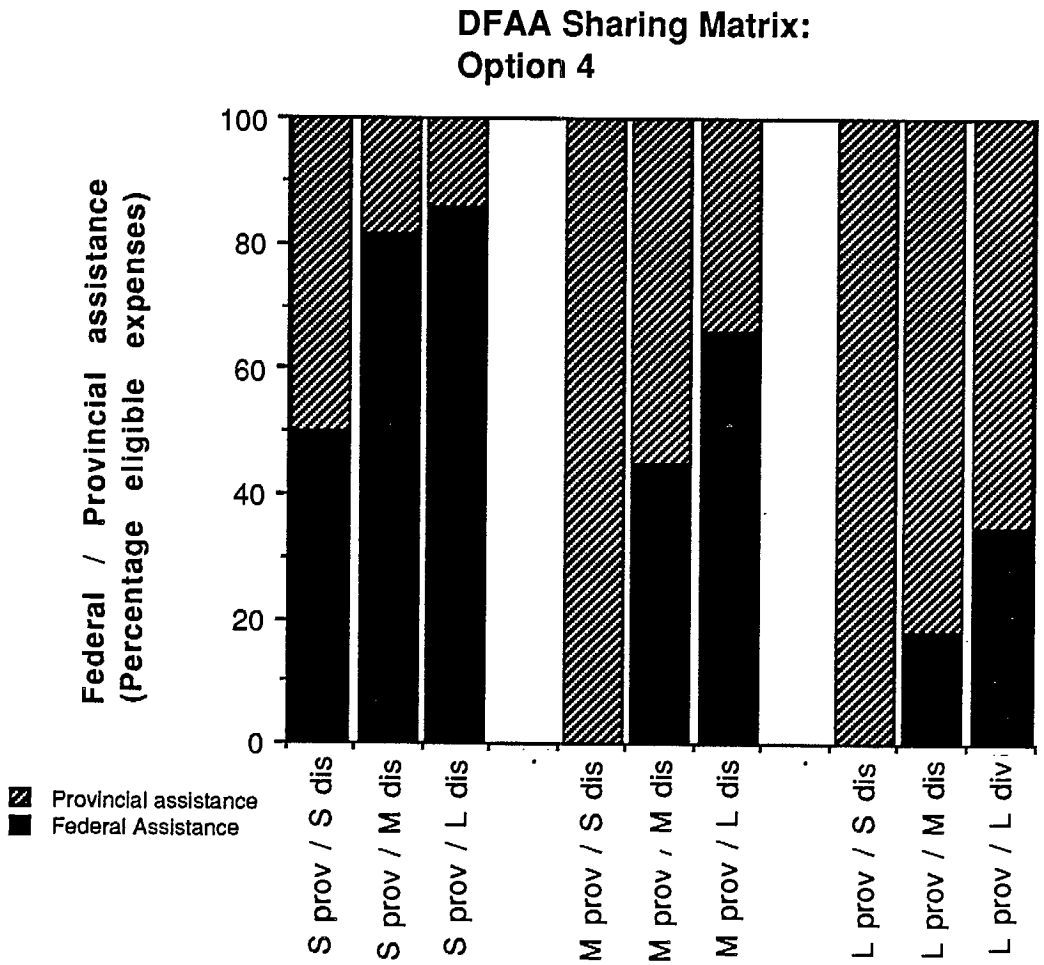

Figure 4.12: The DFAA Sharing Matrix under Option 4 (present sharing formula scaled by a factor of 2). Federal and provincial assistance ratios under this scenario are shown in small, medium and large provinces (population 0.5M, 3.0M and 8.0M respectively) stricken by standardized small, medium and large disaster events ($5.0M, $25.0M, $50.0M respectively). Scenarios are clustered first by province, then by event size.

4.5 Option 5: Equal sharing from $0 per capita.

Plan Summary:

Share federal and provincial assistance equally (50% federal - 50% provincial) from zero eligible expenses. By avoiding any reference to an individual province's economic recovery capability, this option marks an extreme view of 'straight across' sharing, regardless of provincial resources.

Eligible expenses (per capita prov pop)	**Federal/Provincial sharing ratio**
All amounts	50% / 50%

Table 4.14: Option 5 for DFAA sharing formula: equal cost sharing regardless of eligible expenses.

Provincial population	**Event size**					
	Small ($5.0M)		Medium ($25.0M)		Large ($50.0M)	
	$M	%	$M	%	$M	%
Small (0.5M)	2.5 / 2.5	(50/50)	12.5 / 12.5	(50/50)	25.0 / 25.0	(50/50)
Medium (3.0M)	2.5 / 2.5	(50/50)	12.5 / 12.5	(50/50)	25.0 / 25.0	(50/50)
Large (8.0M)	2.5 / 2.5	(50/50)	12.5 / 12.5	(50/50)	25.0 / 25.0	(50/50)

Table 4.15: DFAA sharing matrix under Option 5 of the sharing formula. Eligible expenses are shared equally between federal and provincial governments, regardless of the magnitude of the disaster or the provincial population.

Effect of Modifications

Advantages

Assistance is based solely on the size of the disaster event, and is completely independent of the province's financial recovery resources. This option, and any similar one based on a 'straight-across' sharing formula, results in an equitable division of financial assistance from the point of view of event size.

Disadvantages

This option does not allow for the varying economic recovery resources available to different provinces. By ignoring differential recovery capabilities, this formula (and any similar) runs counter to the original spirit of the DFAA guidelines.

Recommendation

By avoiding all reference to the individual province's recovery ability, this option runs counter to the original intent of the DFAA guidelines. Because of this, it is *not* recommended for further study.

Provincial population	Event size					
	Small ($5.0M)		Medium ($25.0M)		Large ($50.0M)	
	$M	%	$M	%	$M	%
Small (0.5M)	-1.0	-20	-9.0	-36	-19.0	-38
Medium (3.0M)	1.5	30	-4.0	-16	-14.0	-28
Large (8.0M)	2.5	50	3.7	15	-4.0	-8

Table 4.16: Difference in sharing ratios between current formula and Option 5 of the DFAA sharing formula. Both absolute costs (in millions of dollars) and percentages are shown. Changes are those experienced by the Federal government. For example, for a small disaster in a small province: the federal burden is reduced by $1.0M, which is a 20% reduction in the federal burden.

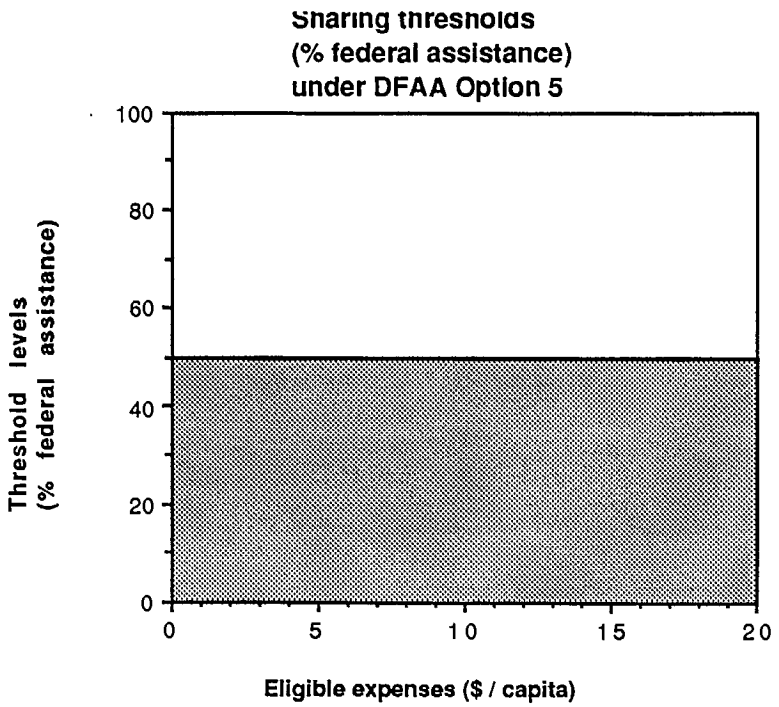

Figure 4.13 Sharing thresholds as a function of eligible expenses (dollars per capita provincial population) under Option 5 of the DFAA sharing formula.

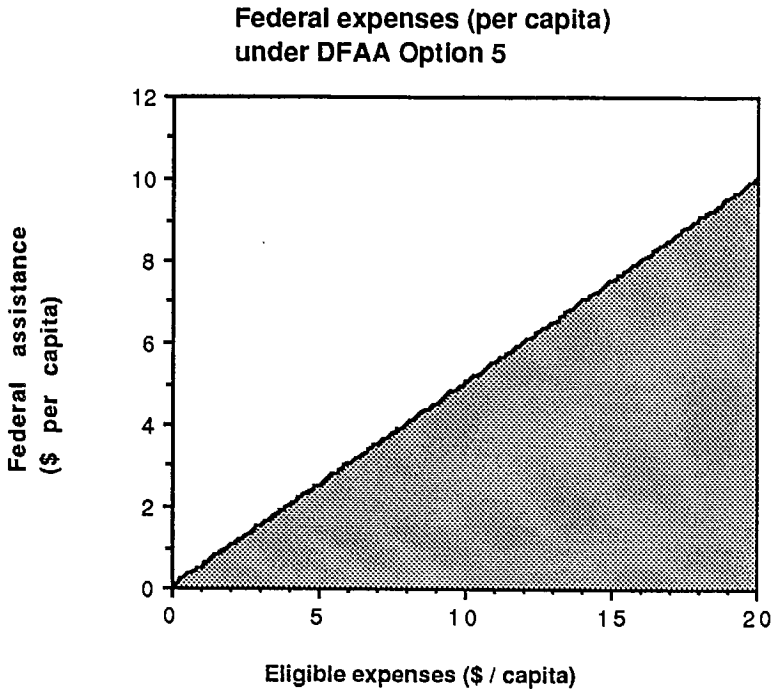

Figure 4.14: Total federal expenses (per capita of provincial population) as a function of total eligible expenses (per capita of provincial population) under Option 5 of the DFAA sharing formula.

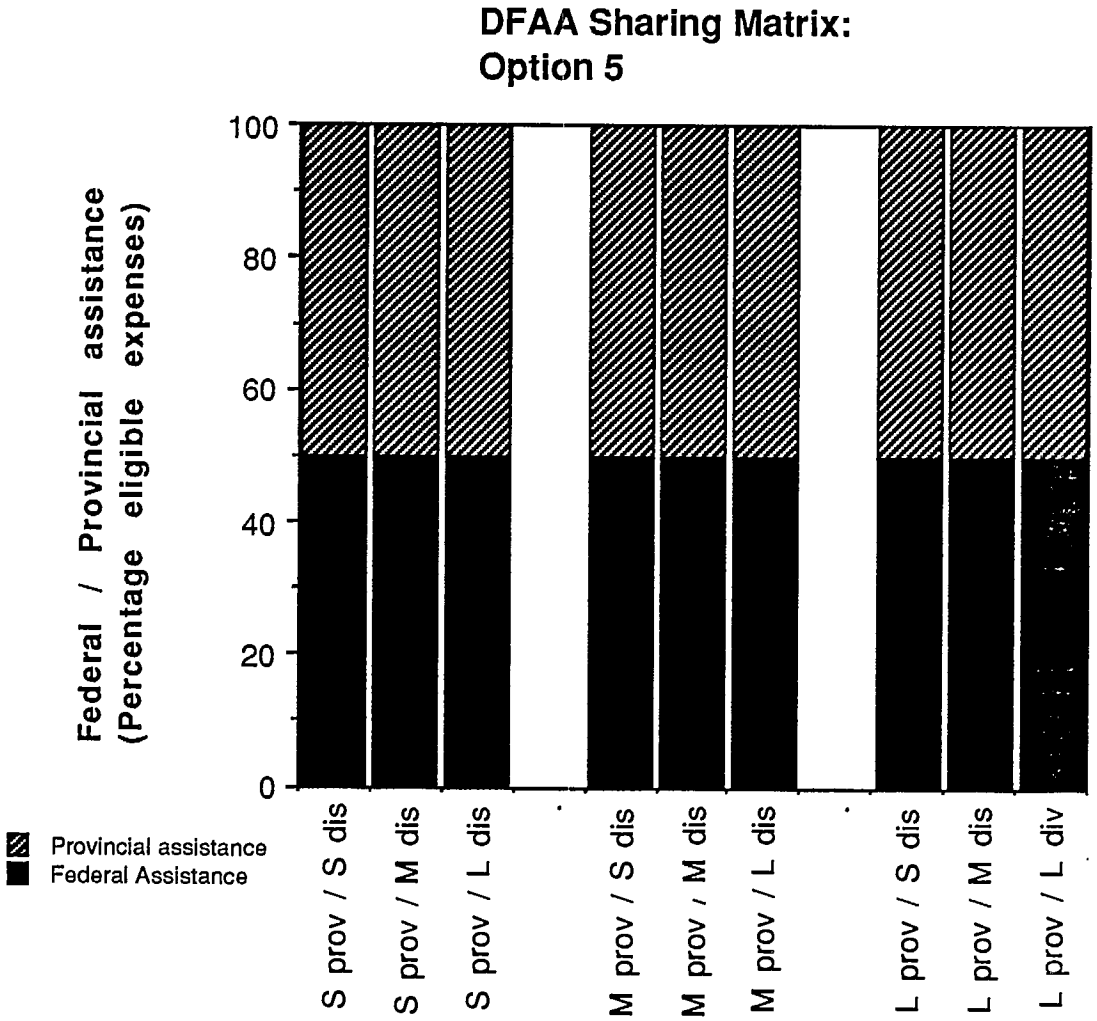

Figure 4.15: The DFAA Sharing Matrix under Option 5 (present sharing formula scaled by a factor of 2). Federal and provincial assistance ratios under this scenario are shown in small, medium and large provinces (population 0.5M, 3.0M and 8.0M respectively) stricken by standardized small, medium and large disaster events ($5.0M, $25.0M, $50.0M respectively). Scenarios are clustered first by province, then by event size.

4.6 Option 6: Twice current formula with extra sharing level

Plan Summary:

This option inflates the present thresholds by a factor of two. This partially accommodates changes owing to reduced purchasing power and population shifts. The threshold scheme is further modified by introducing an additional sharing level from $1-$2 per capita. This would allow provinces to receive federal assistance at the current entry level, although at a lower sharing rate. The factor of two does not fully accommodate changes due to economic and demographic variation, but does provide a smoother transition between old and new sharing formulae. Sharing now begins at $1 per capita eligible expenses, at a level of 25% federal assistance. This option allows provinces to participate in DFAA at the current level, albeit at a lower initial federal share.

Eligible expenses (per capita prov. pop.)	**Federal/Provincial Assistance**
$0-$1	0% / 100%
$1-$2	25% / 75%
$2-$6	50% / 50%
$6-$10	75% / 25%
>$10	90% / 10%

Table 4.17: Option 6 of DFAA sharing plan: cost sharing thresholds modified by a factor of two, with a new level added to permit entry at current threshold.

Provincial population	**Event size**					
	Small ($5.0M)		Medium ($25.0M)		Large ($50.0M)	
	$M	%	$M	%	$M	%
Small (0.5M)	2.6 / 2.4	(52/48)	20.6 / 4.4	(83/17)	43.1 / 6.9	(86/14)
Medium (3.0M)	0.5 / 4.5	(10/90)	12.0 / 13.0	(48/52)	33.8 / 16.2	(67/33)
Large (8.0M)	0.0 / 5.0	(0/100)	6.5 / 18.5	(26/74)	19.5 / 30.5	(39/61)

Table 4.18: DFAA sharing matrix under Option 6 of the sharing formula. This option multiplies current thresholds by a factor of two, and introduces a new sharing level from $1-$2 / capita to allow federal participation at the current level.

Provincial population	Event size					
	Small ($5.0M)		Medium ($25.0M)		Large ($50.0M)	
	$M	%	$M	%	$M	%
Small (0.5M)	-0.9	-18	-0.9	-3	-0.9	-2
Medium (3.0M)	-0.5	-10	-4.5	-18	-5.2	-11
Large (8.0M)	0.0	0	-2.3	-9	-9.5	-19

Table 4.19: Difference in sharing ratios between current formula and Option 6 of the DFAA sharing formula. Both absolute costs (in millions of dollars) and percentages are shown. Changes are those experienced by the Federal government. For example, for a small disaster in a small province: the federal burden is reduced by $1.0M, which is a 20% reduction in the federal burden.

Effect of Modification:

The effect of this option is to place an increased burden on the province to recover, relative to assistance under the current formula. The effect of the full economic change is tempered by both the introduction of an additional sharing level and a factor of two increase in the existing threshold levels. From the sharing matrix (Table 4.10, Figure 4.??), the results are qualitatively similar to those under the current formula: for example a large province does not reach the first sharing threshold in a small event using either sets of rules. Leaving the entry point unchanged allows some measure of continuity between the old and new plans, allowing province's which would participate under the current formula to participate (albeit at a lower initial Federal sharing level).

Advantages

Under this option, any provinces eligible for federal assistance under the current formula would remain eligible under the revised formula. This allows a much-needed sense of continuity between old and new versions. Federal assistance is reduced from that at present by including a factor of three in threshold entry points. From the provincial point of view, initial entry is at the same level ($1 per capita eligible expenses).

Disadvantages

From the federal point of view, the factor of two increase in sharing thresholds does not fully accommodate changes in purchasing power and national population growth since 1970. This together with the additional sharing level does not really change the effect of DFAA from that of its present form.

Recommendation

By scaling sharing thresholds the effect of inflation is at least partially compensated for. By introducing another sharing level, provinces maintain the same entry level. This option will be retained for further study.

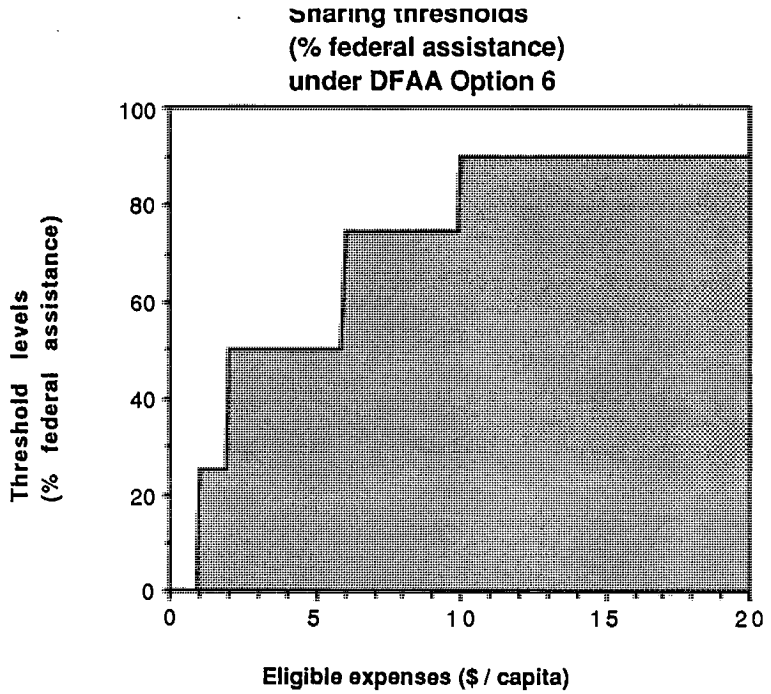

Figure 4.16: Sharing thresholds as a function of eligible expenses (dollars per capita provincial population) under Option 6 of the DFAA sharing formula.

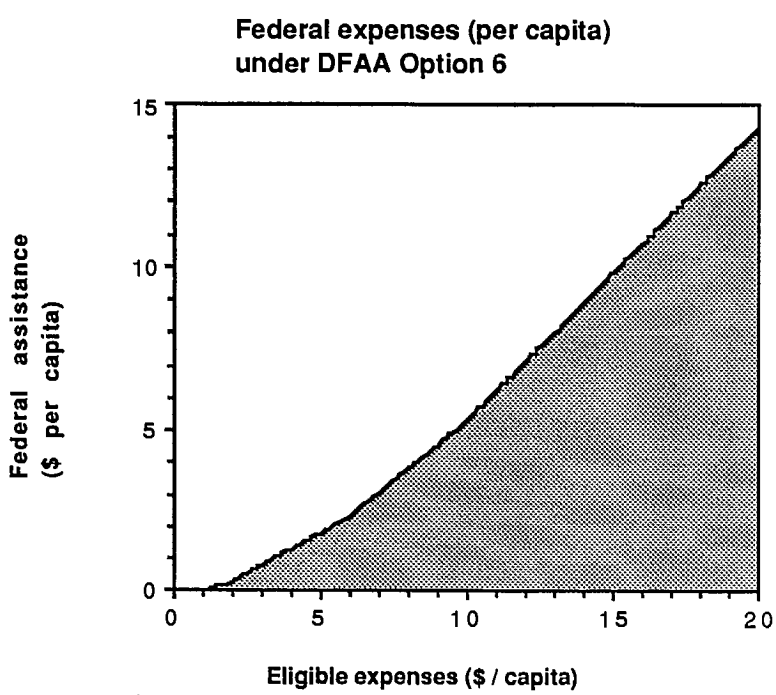

Figure 4.17: Total federal expenses (per capita of provincial population) as a function of total eligible expenses (per capita of provincial population) under Option 6 of the DFAA sharing formula.

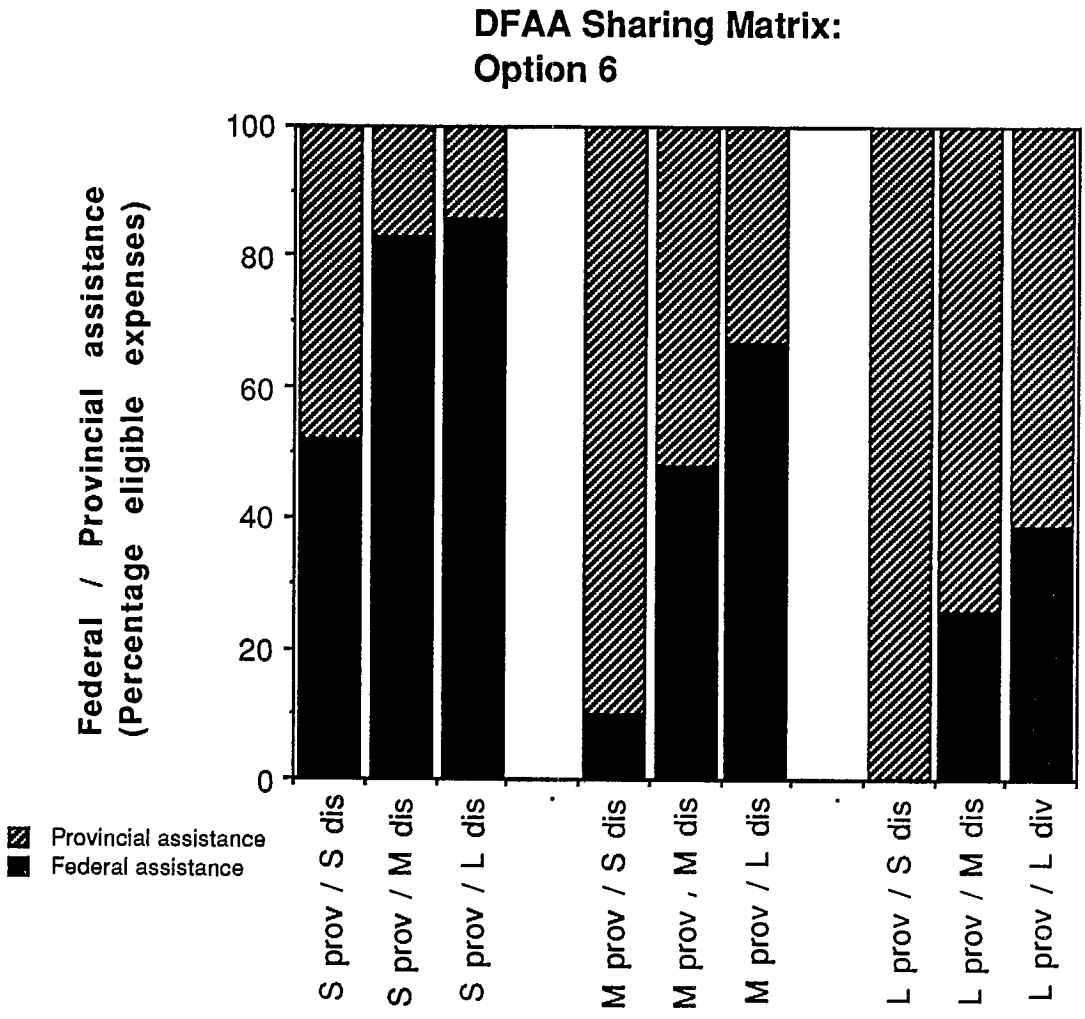

Figure 4.18: The DFAA Sharing Matrix under Option 6 (twice present sharing formula with additional sharing level). Federal and provincial assistance ratios under this scenario are shown in small, medium and large provinces (population 0.5M, 3.0M and 8.0M respectively) stricken by standardized small, medium and large disaster events ($5.0M, $25.0M, $50.0M respectively). Scenarios are clustered first by province, then by event size.

4.7 Option 7: Three times current formula with additional sharing level

Plan Summary:

Increase sharing thresholds of the present formula by a factor of three to accommodate reduced purchasing power and population adjustment. The threshold scheme is modified by introducing an additional sharing level from $1-$3 per capita. This would allow large provinces to obtain a measure of federal support when they would otherwise not meet the minimum sharing threshold.

Cost (per capita)	Federal/Provincial
$0-$1	0% / 100%
$1-$3	25% / 75%
$3-$9	50% / 50%
$9-$15	75% / 25%
>$15	90% / 10%

Table 4.20: Option 7 of DFAA sharing plan: cost sharing thresholds modified to take account of modifying factors, with a new level added to permit entry at the current threshold.

Sharing levels:

Sharing levels are similar to simple accommodation of inflation and population (Option 3), the only difference being the $0-$3 per capita interval. Sharing now begins at $1 per capita eligible expenses, at a level of 25% federal assistance. This option allows provinces to participate in DFAA at the current level, albeit at a lower initial federal share.

Provincial population	Event size					
	Small ($5.0M)		Medium ($25.0M)		Large ($50.0M)	
	$M	%	$M	%	$M	%
Small (0.5M)	2.2 / 2.8	(44/56)	19.8 / 5.2	(79/21)	42.2 / 7.8	(84/16)
Medium (3.0M)	0.5 / 4.5	(10/90)	9.5 / 15.5	(38/62)	28.5 / 21.5	(57/43)
Large (8.0M)	0.0 / 5.0	(0/100)	4.5 / 20.5	(18/82)	17.0 / 33.0	(34/66)

Table 4.21: DFAA sharing matrix under Option 7 of the sharing formula. This option multiplies current thresholds by a factor of three, and introduces a new sharing level from $1-$3 / capita to allow federal participation at the current level.

Provincial population	Event size					
	Small ($5.0M)		Medium ($25.0M)		Large ($50.0M)	
	$M	%	$M	%	$M	%
Small (0.5M)	-1.3	-26	-1.7	-7	-2.8	-4
Medium (3.0M)	-0.5	-10	-7.0	-28	-10.5	-21
Large (8.0M)	0.0	0	-4.3	-17	-12.0	-24

Table 4.22: Difference in sharing ratios between current formula and Option 7 of the DFAA sharing formula. Both absolute costs (in millions of dollars) and percentages are shown. Changes are those experienced by the Federal government. For example, for a small disaster in a small province: the federal burden is reduced by $1.3M, which is a 26% reduction in the federal burden.

Effect of Modification:

This option places an increased burden on the province to recover, relative to assistance under the current formula. The effect of the full economic change is tempered by the introduction of an additional sharing level as well as an adjustment for the averaged increase in population base. Results are qualitatively similar to those under the current formula: for example a large province does not reach the first sharing threshold in a small event using either sets of rules. Leaving the entry point unchanged allows some measure of continuity between the old and new plans, allowing provinces which would participate under the current formula to participate (albeit at a lower initial Federal sharing level).

Advantages

Under this option, provinces eligible for federal assistance under the current formula would remain eligible under the revised formula. This allows a much-needed sense of continuity between old and new versions. Federal assistance is reduced from that at present by including a factor of three in threshold entry points. From the provincial point of view, initial entry is at the same level ($1 per capita eligible expenses).

Disadvantages

From the provincial point of view, the factor of three increase in sharing thresholds could cause considerable initial anxiety. This is tempered by the introduction of an additional sharing level.

Recommendation

By scaling sharing thresholds the effect of inflation is at least partially compensated for. By introducing another sharing level, provinces maintain the same entry level. This option will be retained for further study.

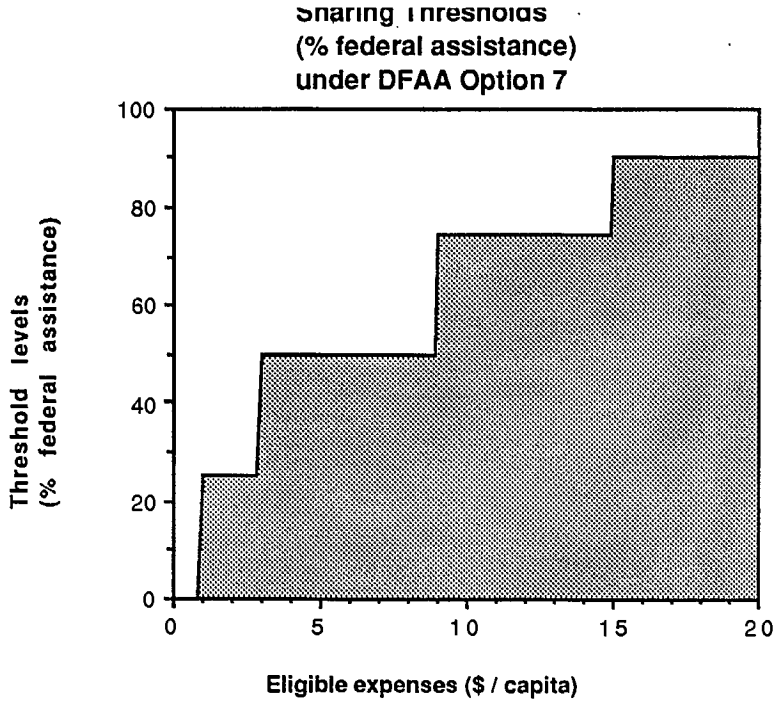

Figure 4.19: Sharing thresholds as a function of eligible expenses (dollars per capita provincial population) under Option 7 of the DFAA sharing formula.

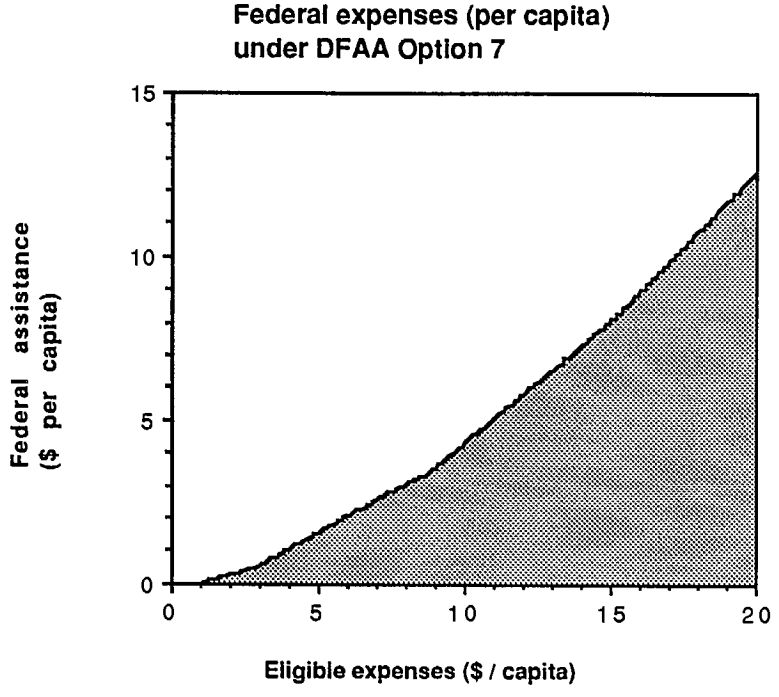

Figure 4.20: Total federal expenses (per capita of provincial population) as a function of total eligible expenses (per capita of provincial population) under Option 7 of the DFAA sharing formula.

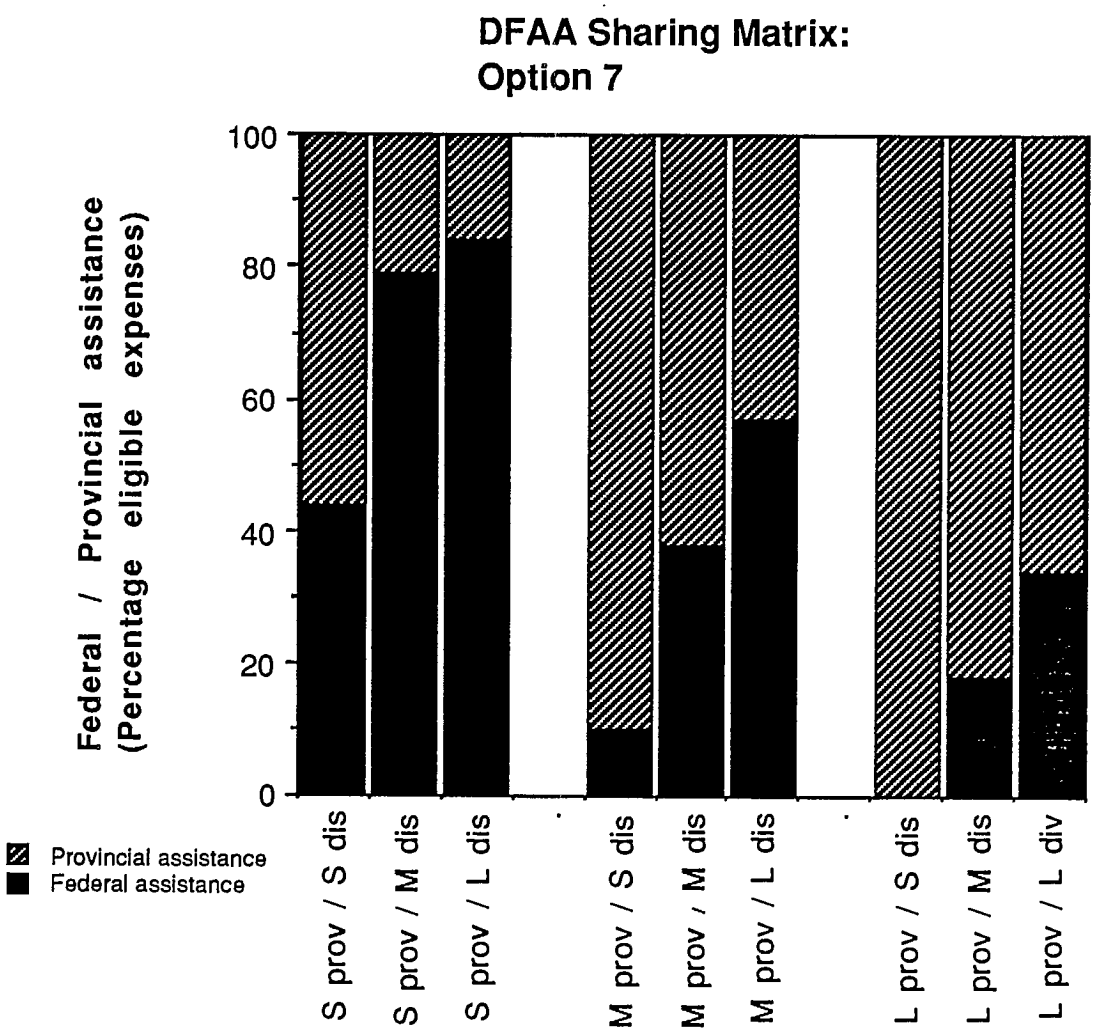

Figure 4.21: The DFAA Sharing Matrix under Option 7 (three times present sharing formula with additional sharing level). Federal and provincial assistance ratios under this scenario are shown in small, medium and large provinces (population 0.5M, 3.0M and 8.0M respectively) stricken by standardized small, medium and large disaster events ($5.0M, $25.0M, $50.0M respectively). Scenarios are clustered first by province, then by event size.

4.8 Option 8: Graded linear response I

Plan Summary

Abandon threshold sharing in favour of a graded sharing formula. Introduce a uniform sharing increase from 0% Federal assistance at $0.00 per capita up to 90% Federal assistance at $15.00 per capita, to remain constant at 90% thereafter. This allows all provinces to participate in all events.

Sharing levels:

In the $0-$15 eligible per capita expense category, the rate of federal sharing is proportional to per capita eligible expenses, linearly from 0% at $0 per capita to 90% at $15 per capita. Calculating the federal/provincial sharing ratio in this region involves the ideas of Section 4.1: the first $0.01 per capita is funded at 0.06%, the second $0.01 per capita funded at 0.12%, and so on according to

$$F = 0.06\ C, \quad F = \text{Federal assistance level (\%)}, \quad C = \text{per capita eligible expense (\$)}.$$

Cumulative federal shares

The cumulative federal share at any point in this interval is the area under the curve to that point,

$$S = 0.03\ C^2, \quad S = \text{Cumulative federal share (Federal dollars per capita)}.$$

For example, federal assistance in a $1 per capita event would be $0.03 federal assistance dollars per capita eligible expenses. Similarly, federal assistance in a $4 per capita event would be $0.48 per capita.

Provincial population	Event size					
	Small ($5.0M)		Medium ($25.0M)		Large ($50.0M)	
	$M	%	$M	%	$M	%
Small (0.5M)	1.5 / 3.5	(30/70)	19.1 / 5.9	(76/24)	41.6 / 8.4	(83/17)
Medium (3.0M)	0.3 / 4.7	(6/94)	6.3 / 18.7	(25/75)	25.0 / 25.0	(50/50)
Large (8.0M)	0.1 / 4.9	(2/98)	2.3 / 22.7	(9/91)	9.4 / 40.6	(19/81)

Table 4.23: DFAA sharing matrix under Option 8 of the sharing formula. Federal and provincial assistance is shared using a graded linear response.

Provincial population	Event size					
	Small ($5.0M)		Medium ($25.0M)		Large ($50.0M)	
	$M	%	$M	%	$M	%
Small (0.5M)	-2.0	-40	-2.4	-9	-2.4	-5
Medium (3.0M)	-0.7	-14	-10.2	-41	-14.0	-28
Large (8.0M)	0.1	2	-6.5	-26	-19.6	-39

Table 4.24: Difference in sharing ratios between current formula and Option 8 of the DFAA sharing formula. Both absolute costs (in millions of dollars) and percentages are shown. Changes are those experienced by the Federal government. For example, for a small disaster in a small province: the federal burden is reduced by $2.0M, which is a 40% reduction in the federal burden.

Advantages

By abandoning the threshold schemes, a wider and richer choice of response type is available. The graded linear response is one example of customizing assistance to fit specific needs. All provinces can participate in all classes of events, regardless of the size of the event or of the province. In this version, the advantage is to the federal government in 8 of the 9 scenarios. Small provinces experience little change in most classes of events: since most assistance in medium and large events is from the 90% sharing level, sharing ratios under this option in these events is close to those under the present formula.

Disadvantages

Using a graded response means that the transition from sharing ratios to assistance provided is more complicated and perhaps somewhat nonintuitive, compared to the current plan. While a simple formula exists, its implementation may cause some initial concern. This particular plan is to the province's disadvantage in 8 of 9 scenarios considered. Large provinces stand to lose the most: the sharing burden changes by up to 40% in favour of the federal government. In a large event, a large province goes from providing $21M under the current plan to approximately $41M under this option.

Recommendation

Under this option, any province can participate at any level of eligible expense. This would occur at the cost of a more complicated and less comprehensible sharing formula. As the advantages can just as easily be obtained through a threshold-based formula, this option is *not* recommended for further study.

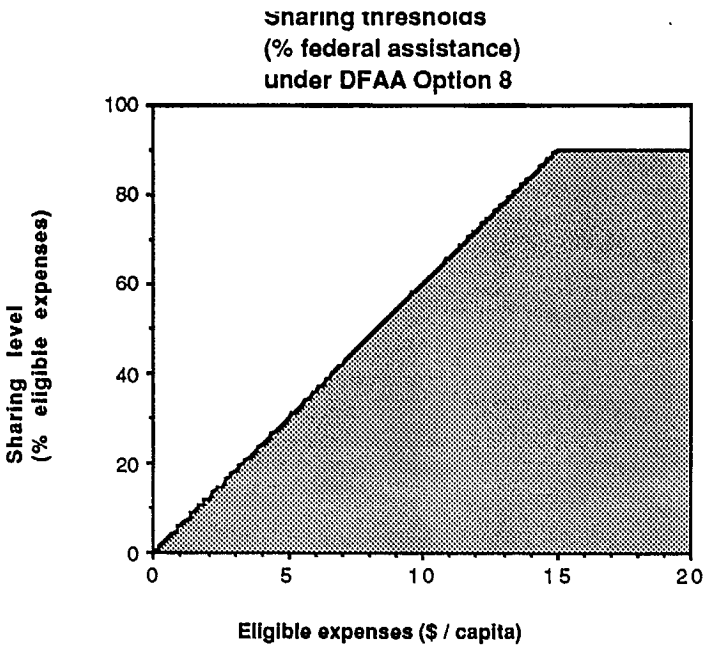

Figure 4.22: Sharing thresholds as a function of eligible expenses (dollars per capita provincial population) under Option 8 of the DFAA sharing formula.

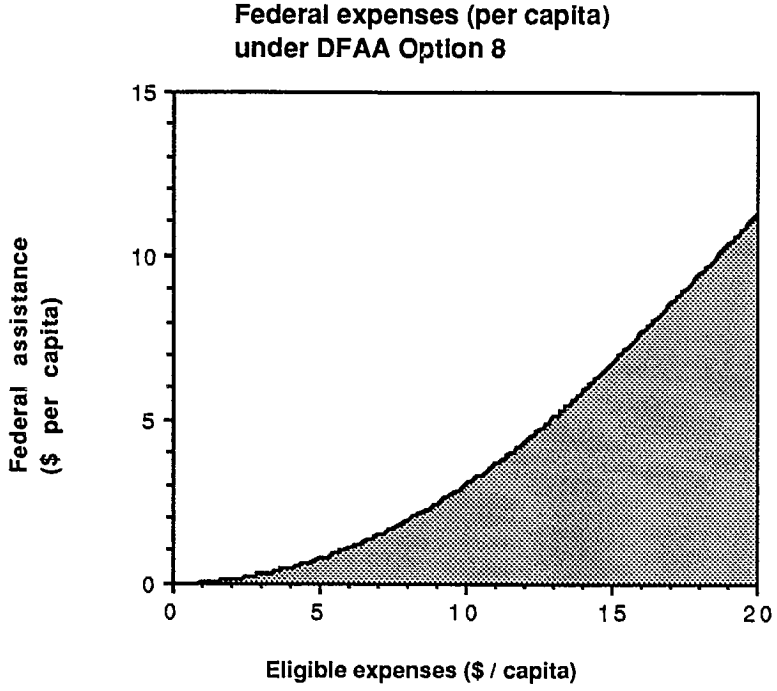

Figure 4.23: Total federal expenses (per capita of provincial population) as a function of total eligible expenses (per capita of provincial population) under Option 8 of the DFAA sharing formula.

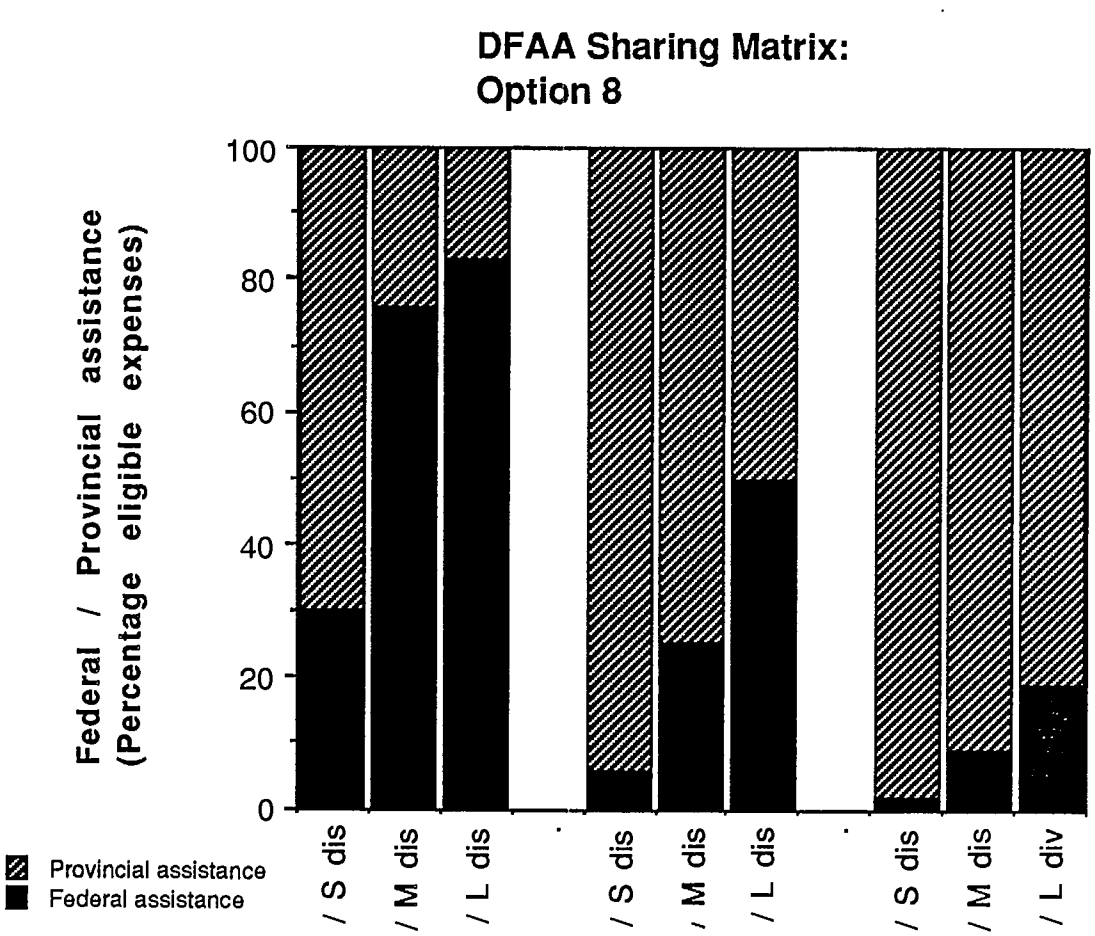

Figure 4.24: The DFAA Sharing Matrix under Option 8 (graded linear response from \$0-\$15). Federal and provincial assistance ratios under this scenario are shown in small, medium and large provinces (population 0.5M, 3.0M and 8.0M respectively) stricken by standardized small, medium and large disaster events (\$5.0M, \$25.0M, \$50.0M respectively). Scenarios are clustered first by province, then by event size.

4.9 Option 9: Graded linear response II

Plan Summary

Modify the graded response of Option 8 by adjusting the scaling region. Introduce a uniform sharing increase from 0% Federal assistance at $0.00 per capita up to 90% Federal assistance at $10.00 per capita, to remain constant at 90% thereafter. This allows all provinces to participate in all events at a relatively greater provincial advantage.

Sharing levels:

In the $0-$10 eligible per capita expense range, federal sharing is proportional to the per capita eligible expense, linearly from 0% at $0 per capita to 90% at $10 per capita. Calculating the federal/provincial sharing ratio in this region involves the ideas of Section 4.1: the first $0.01 per capita is funded at 0.09%, the second $0.01 per capita funded at 0.18%, and so on according to

$F = 0.09\ C$, F = Federal assistance level (%),
C = per capita eligible expense ($).

Cumulative federal shares

The cumulative federal share at any point in this interval is the area under the curve to that point,

$S = 0.045\ C^2$, S = Cumulative federal share (Federal dollars per capita).

For example, federal assistance in a $1 per capita event would be $0.045 per capita. Similarly, federal assistance in a $4 per capita event would be $0.72 federal assistance dollars per capita of eligible expenses.

Provincial population	Event size					
	Small ($5.0M)		Medium ($25.0M)		Large ($50.0M)	
	$M	%	$M	%	$M	%
Small (0.5M)	2.2 / 2.8	(44/56)	19.8 / 5.2	(79/21)	42.2 / 7.8	(84/16)
Medium (3.0M)	0.4 / 4.6	(8/92)	9.4 / 15.6	(38/62)	28.5 / 21.5	(57/43)
Large (8.0M)	0.2 / 4.8	(4/96)	3.5 / 21.5	(14/86)	14.1 / 35.9	(28/72)

Table 4.25: DFAA sharing matrix under Option 9 of the sharing formula.

Advantages

By abandoning the threshold schemes, a wider and richer choice of response types is available. The graded linear response is one example of customizing assistance to fit specific needs. All provinces can participate in all classes of events, regardless of the size of the event or of the province of occurrence.

In this version, the advantage is to the federal government in 8 of the 9 scenarios. Small provinces come closest to experiencing an advantage: since most assistance in medium and large events is from the 90% sharing level, sharing ratios under this option in these events is close to those under the present formula.

Provincial population	Event size					
	Small ($5.0M)		Medium ($25.0M)		Large ($50.0M)	
	$M	%	$M	%	$M	%
Small (0.5M)	-1.3	-26	-1.7	-7	-1.8	-4
Medium (3.0M)	-0.6	-12	-7.1	-14	-10.5	-21
Large (8.0M)	0.2	4	-5.3	-11	-14.9	-30

Table 4.26: Difference in sharing ratios between current formula and Option 9 of the DFAA sharing formula. Both absolute costs (in millions of dollars) and percentages are shown. Changes are those experienced by the Federal government. For example, for a small disaster in a small province: the federal burden is reduced by $1.3M, which is a 26% reduction in the federal burden.

Disadvantages

Using a graded response means that the transition from sharing ratios to assistance provided is more complicated and perhaps somewhat nonintuitive compared to the current plan. While a simple formula exists, it's implementation may cause some initial concern.

The specific choice of plan is to the province's disadvantage in 8 of 9 scenarios considered. While sharing ratios are somewhat better from a provincial point of view (relative to Option 8), large provinces still stand to lose the most: the sharing burden changes by up to 30% in favour of the federal government. In a large event, a large province goes from providing $21M under the current plan to approximately $41M under this option.

Recommendation

Under this option, any province can participate at any level of eligible expense. This would occur at the cost of a more complicated and less comprehensible sharing formula. As the advantages can just as easily be obtained through a threshold-based formula, this option is *not* recommended for further study.

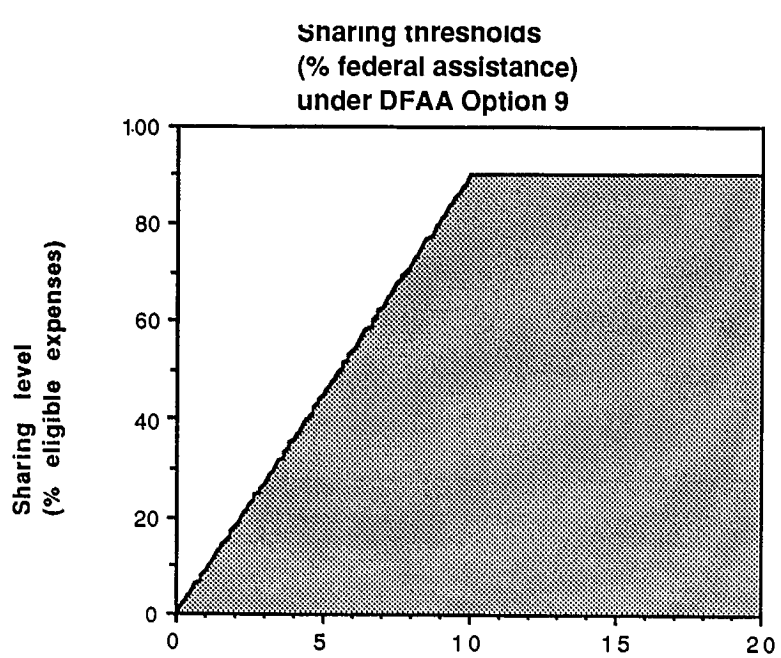

Figure 4.25: Sharing thresholds as a function of eligible expenses (dollars per capita provincial population) under Option 9 of the DFAA sharing formula.

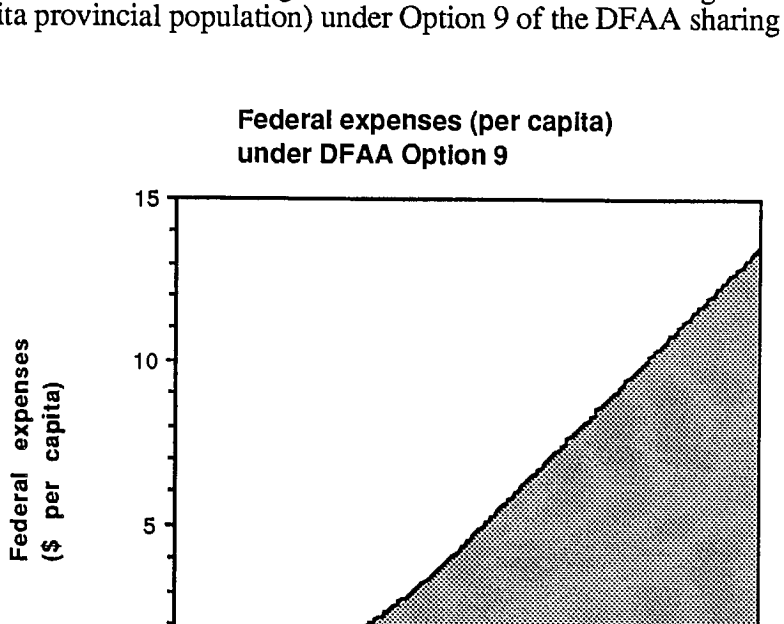

Figure 4.26: Total federal expenses (per capita of provincial population) as a function of total eligible expenses (per capita of provincial population) under Option 9 of the DFAA sharing formula.

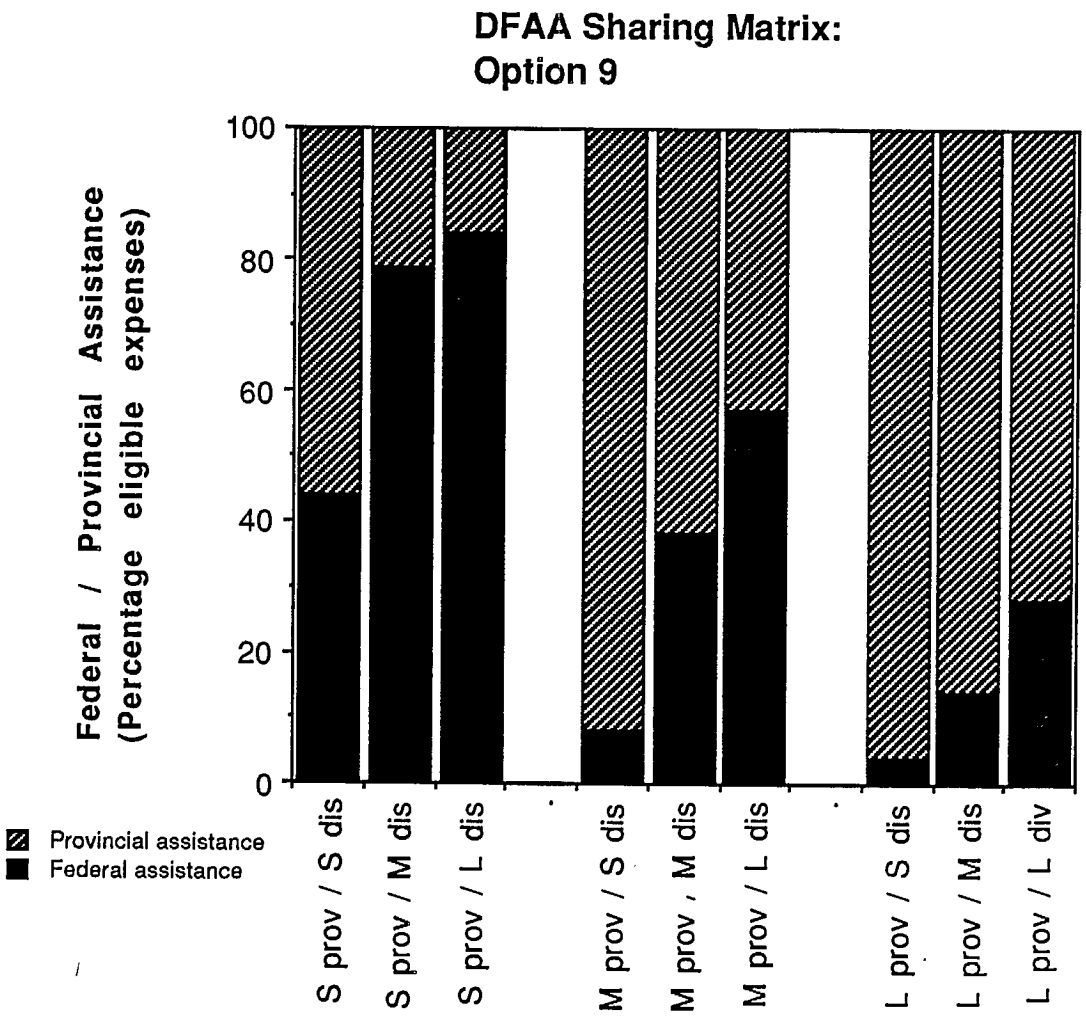

Figure 4.27: The DFAA Sharing Matrix under Option 9 (graded linear response from \$0-\$10). Federal and provincial assistance ratios under this scenario are shown in small, medium and large provinces (population 0.5M, 3.0M and 8.0M respectively) stricken by standardized small, medium and large disaster events (\$5.0M, \$25.0M, \$50.0M respectively). Scenarios are clustered first by province, then by event size.

4.10 Option 10: Modified threshold structure

Plan Summary:

Scale the present formula to accommodate reduced purchasing power (as per Option 2). The threshold scheme is modified by introducing a *graded* response from $0-$4 per capita. This would allow large provinces to obtain some measure of federal support when they would otherwise not meet the minimum sharing threshold. The hybrid approach would combine the best of the threshold and graded response formulae.

Sharing levels:

Apart from the graded response from $0-$4, sharing levels are unchanged from Option 2. In the $0-$4 eligible per capita expenses let federal sharing be proportional to the per capita expense, linearly from 0% at $0 per capita to 50% at $4 per capita. Hence the first $0.01 per capita is funded at 0.125%, the second $0.01 per capita funded at 0.25%, and so on according to

$$F = 12.5\ C,$$

F = Federal assistance level (%),
C = per capita eligible expense ($).

Cumulative federal shares

The cumulative percentile share at any point in the first interval is the area under the curve to that point,

$$S = 0.0625C^2,$$

S = Cumulative federal share (Federal dollars per capita).

For example, federal assistance in a $1 per capita event would be $0.06 per capita. Similarly, federal assistance in a $4 per capita event would be $1 per capita.

Sharing Matrix

Apply the plan to a matrix of small ($5M), medium ($25M) and large ($30M) events occurring in small (0.5M), medium (3M) and large (8M) provinces. The matrix is:

Provincial population	Event size					
	Small ($5.0M)		Medium ($25.0M)		Large ($50.0M)	
	$M	%	$M	%	$M	%
Small (0.5M)	2.0 / 3.0	(40/60)	19.0 / 6.0	(76/24)	41.5 / 8.5	(83/17)
Medium (3.0M)	0.5 / 4.5	(10/90)	9.5 / 15.5	(38/62)	25.5 / 24.5	(51/49)
Large (8.0M)	0.2 / 4.8	(4/96)	6.3 / 18.7	(25/75)	17.0 / 33.0	(34/66)

Table 4.27: DFAA sharing matrix under Option 10 of the sharing formula.

Provincial population	Event size					
	Small ($5.0M)		Medium ($25.0M)		Large ($50.0M)	
	$M	%	$M	%	$M	%
Small (0.5M)	-1.5	-30	-2.5	-10	-2.5	-5
Medium (3.0M)	-0.5	-10	-7.0	-28	-13.5	-27
Large (8.0M)	0.2	4	-2.5	-10	-12.0	-24

Table 4.28: Difference in sharing ratios between current formula and Option 9 of the DFAA sharing formula. Both absolute costs (in millions of dollars) and percentages are shown. Changes are those experienced by the Federal government. For example, for a small disaster in a small province: the federal burden is reduced by $1.5M, which is a 30% reduction in the federal burden.

Effect of Modifications:

Advantages:

Introducing a non-threshold format for the first sharing level results in a fairer federal/provincial sharing partnership when compared with the identical plan without the modification (Option 2, existing plan adjusted by a factor of 4). Compared to Option 2 there is a small increase in the federal burden for all classes of event. However, all provinces receive federal assistance at some level, regardless of the event's size.

Disadvantages:

The major disadvantage to this approach is its complexity: by introducing a non-constant sharing in the first interval greater complexity is introduced.

Discussion:

All provinces receive a measure of federal assistance, regardless of provincial resources. However, the effect is graded to avoid giving a large share to a province with sufficient existing resources. While this results in a more flexible plan capable of accommodating a variety of scenarios, the additional complexity is against it. This approach may be used, however, to stimulate additional options which share some of the positive features of this approach but within a threshold framework.

Recommendation:

Because of the complexity which accompanies this option it is not recommended for further study.

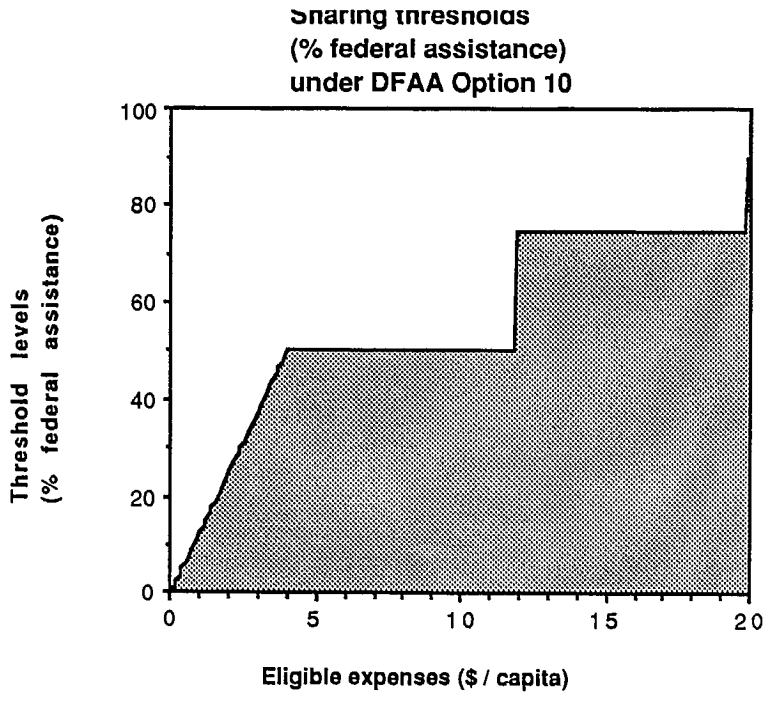

Figure 4.28: Sharing thresholds as a function of eligible expenses (dollars per capita provincial population) under Option 10 of the DFAA sharing formula.

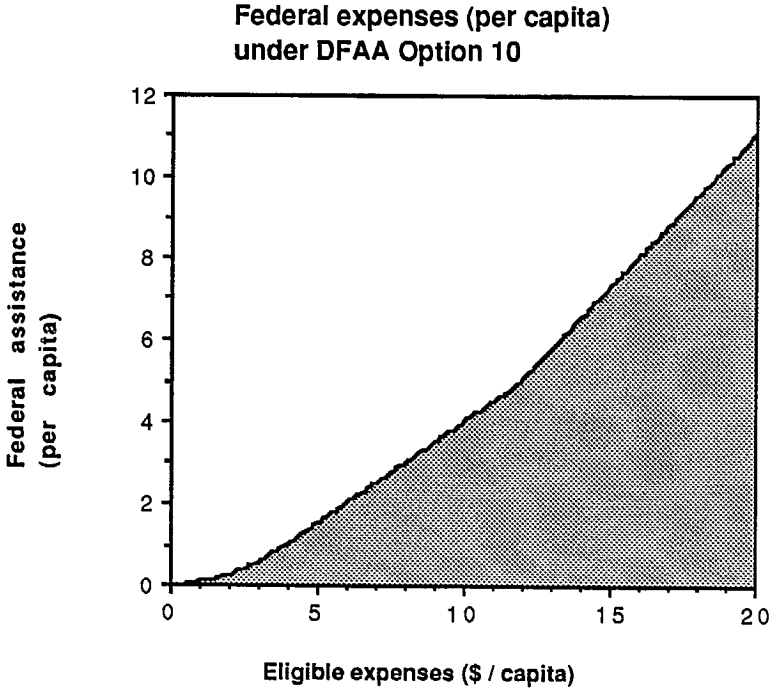

Figure 4.29: Total federal expenses (per capita of provincial population) as a function of total eligible expenses (per capita of provincial population) under Option 10 of the DFAA sharing formula.

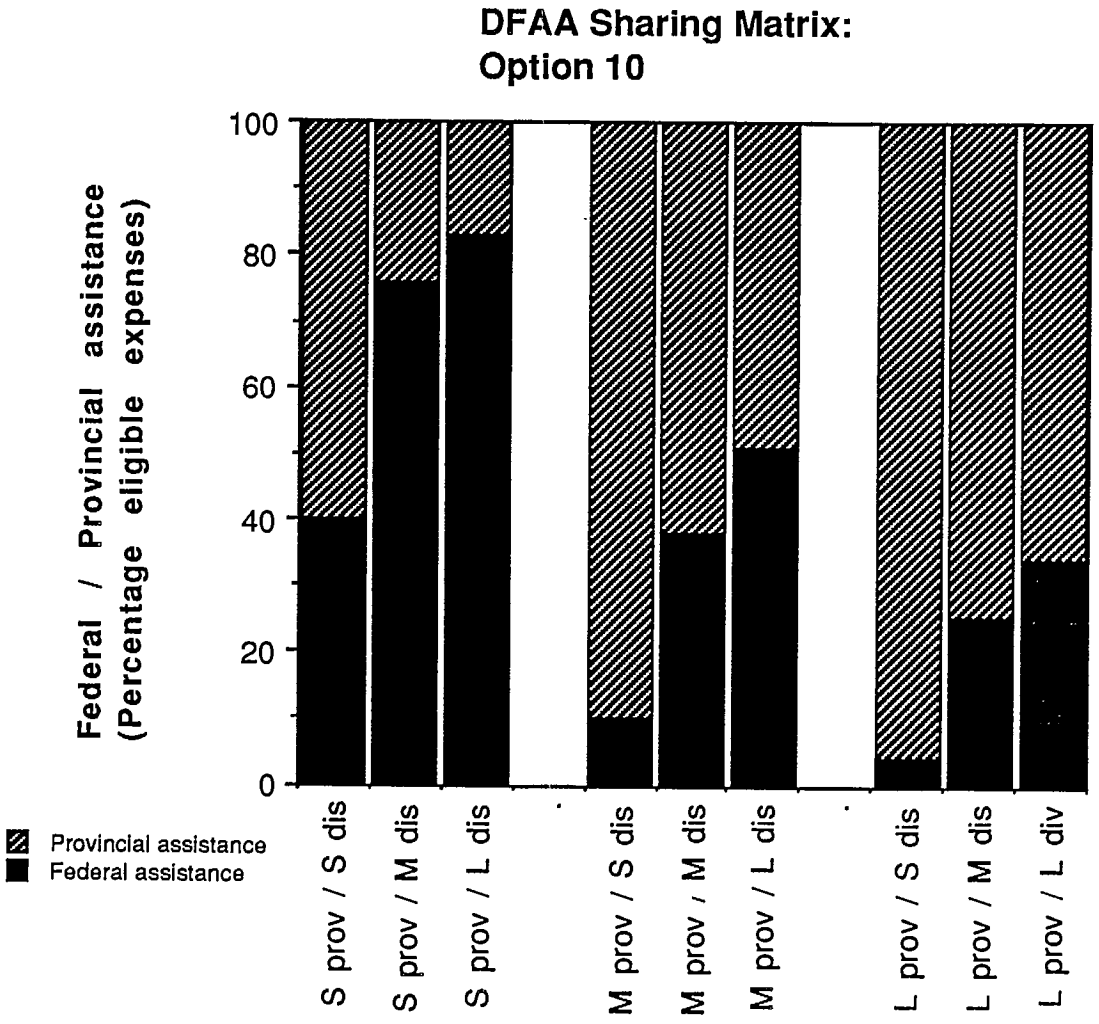

Figure 4.30: The DFAA Sharing Matrix under Option 10 (modified threshold structure). Federal and provincial assistance ratios under this scenario are shown in small, medium and large provinces (population 0.5M, 3.0M and 8.0M respectively) stricken by standardized small, medium and large disaster events ($5.0M, $25.0M, $50.0M respectively). Scenarios are clustered first by province, then by event size.

4.11 Summary

A total of ten candidate DFAA sharing formulae were presented and assessed against several criteria, including fairness of federal and provincial sharing, recognition of differing provincial recovery abilities, simplicity of implementation and overall adequacy, as prescribed in the original DFAA guidelines. Table 4.29 summarizes the results. Candidate formulae to be retained for further study are re-designated Option A, Option B, etc., for simplicity. Having passes this preliminary assessment, these options will be considered for their economic effect on both provincial and federal communities.

	Further study?	**Threshold Formulae**	
Option 1	Yes	Option A	Current formula
Option 2	No		Three times current formula
Option 3	Yes	Option B	Four times current formula
Option 4	Yes	Option C	Twice current formula
		Modified Threshold Formulae	
Option 5	No		Equal sharing
Option 6	Yes	Option D	Twice current with additional level
Option 7	Yes	Option E	Three times current with additional level
		Non-Threshold Formulae	
Option 8	No		Graded response from $0-$10
Option 9	No		Graded response from $0-$15
Option 10	No		Hybrid graded/threshold response

Table 4.29: Summary of DFAA Sharing formula and recommendations for further study. Options are grouped into three classes, *Threshold formulae*, direct variations on the existing sharing formula, *Modified threshold formulae*, threshold-based formulae with additional and/or altered sharing levels, and *Non-threshold formulae*, not based on a series of flat responses. Options which satisfy basic criteria of fairness and ease of use are redesignated Options A-E.

Annex 5
Economic Effects of Sharing Options

5.1 INTRODUCTION

This annex develops a simple model of resource flow through both provincial and federal economies, allowing a study of the economic effect of possible alterative DFAA sharing formula options. The injection of a large sum of money into a provincial economy can stimulate further revenues through several economic mechanisms. This can shift the balance of federal/provincial sharing, sometimes significantly. The model developed here is used to approximate the relative shift under possible DFAA sharing formula options.

Neither the federal nor provincial economies are static entities: funds initially allocated for disaster recovery assistance flow through all sectors of both economies, resources 'leak' across provincial boundaries, and additional revenues are generated through several economic mechanisms. This section develops a simple model which incorporates the dominant primary and secondary economic factors, and assesses their contribution to standardized disaster event scenarios.

Economic modelling: The input-output paradigm

A realistic model of economic resource flow must confront the issue of complexity. An economy is a dynamic entity, consisting of countless loosely-defined economic sectors continually interacting with themselves and with each other. A model provides a faithful representation to the extent it replicates activities in the real world. However, the desire for accurate representation must be balanced against the very real costs of modelling complex systems. The increased computational burden accompanying greater detail can easily overwhelm a marginal increase in model accuracy.

The complexity which an economic model must capture is suggested in Figure 5.1, showing a hierarchy of dependencies between economic sectors in an industry often involved in disaster recovery: the Cement and Concrete industry.[1] Economic interactions take place between this industry and those of many other economic sectors: cement and concrete production has a primary dependence upon the non-metallic products sector, the mining sector, etc... Each of these sectors is in turn dependent upon other sectors, so the set of secondary dependencies spans virtually the entire economy. In particular, sectors such as construction and real estate rely in turn upon the cement and concrete industry, so this industry has a secondary dependence upon itself! Model complexity increases rapidly with each additional level of detail, so that a model which follows resource flow through to second-order dependencies must, in essence, simulate resource flow throughout the entire economy. Such a model would be difficult to design, implement and maintain. Given the capricious nature of disasters, and the wide variety of possible damage scenarios, it is doubtful that the significant increase in model complexity would lead to a corresponding reward of greater insight. Consequently, a simpler and more intuitively appealing model of economic activity was used to model DFAA-induced resource flow. One class of economic models is especially useful for this purpose. This is the class of *Input-output* models, which simulate commodity and resource flow through different sectors of the federal and provincial economies.

---

1 Extracted from tables in Input/Output Structure of the Canadian Economy 1986: Statistics Canada Publications 15-201 (1989).

Model development and use

Section 5.2 develops a simple model of resource flow through both provincial and federal economies using the input-output paradigm. Once the model framework is in place, the effect of a large injection of federal funds into a provincial economy through DFAA is simulated, and its primary and secondary effects identified. The precise magnitudes of these effects are difficult to determine, and vary greatly from event to event. A case study of economic effects accompanying DFAA response to 1987 spring flooding in New Brunswick is considered, and rough operational estimates of economic factors found.

Once the economic impact model is complete, it is used to estimate repercussions of DFAA assistance in standardized disaster scenarios under possible sharing formula options. The options of Annex 4 which survived preliminary assessments based on fairness and overall adequacy are now considered for economic effect. The sharing matrix is used to assess economic factors accompanying each of the sharing formula options of Table 5.1.

Option Title	Description
Threshold Formulae	
Option A	Current formula
Option B	Two times current formula
Option C	Three times current formula
Modified Threshold Formulae	
Option D	Twice current formula with additional level
Option E	Three times current formula with additional level

Table 5.1: Summary of DFAA sharing formula options considered in this annex. Options have already been assessed for basic considerations of fairness, adequacy and ease of use in Annex 4. Here they are assessed for possible economic repercussions which can act to shift the balance of sharing.

5.2 The Economic Model

The input-output model

A simple model of resource flow through both provincial and federal economies is needed to study the economic effect of alternative DFAA sharing strategies. Neither economy is static: funds initially allocated for assistance flow through all sectors of the economy, generating additional revenues and 'leaking' to other provincial economies. This section develops a simple model to assess these contributions in typical event scenarios.

The economic model is sketched in Figure 5.2. The figure identifies market sectors and shows resource flow mechanisms between them.[2] The economy is modelled by four private sector elements:

a. Households,
b. Firms,
c. Factor markets,
d. Product markets, and

and two public sector elements:

g. Financial institutions, and
f. Government.

Elements of the private sector include:

a. *Households*, the smallest economic decision-making unit. Households receive money through government payments, income from factor markets, and loans from financial institutions. Income flows out of households through savings, product expenditures and taxation.

b. *Firms* produce commodities which are sold to other firms. Firms receive income through exchange with other firms, government payments, loans from financial institutions and receipts of sales in product markets. Sources of outflow include taxation and payment to factor markets.

c. *Factor Markets*, where firms sell the factors of production they control. Factor markets receive income from firms, and lose money through paying income to households (factor owners).

d. *Product markets*, where firms sell their product output. Product markets receive money through household expenditures, and lose money through sales to firms.

---

2 Source: R.G. Lipsey, D.D. Purvis, P.O. Steiner, `Economics', Fifth Edition, Harper & Row (New York 1985).

Elements of the public sector include:

e. *Financial institutions*, publicly owned establishments receiving savings from households and firms, and distributing these as loans.

f. *Government*, an aggregate term, including all organizations under direct control of all levels of government. Government receives income through taxation, and dispenses money through payments to firms and households.

Modelling DFAA in the input-output paradigm

DFAA is modelled by an injection of financial recovery assistance funds from the government sector into firms and households. This is the *primary economic impact* (Figure 5.3) as initial recovery resources are allocated between firms (recovery products, materials, etc.) and households (wages and salaries). At this level the economic effect of DFAA is a simple matter of accountancy. The next level of complexity models a further round of resource flow in Figure 5.4. The *secondary economic effects* include federal and provincial government revenue from taxation on the initial injection, the effects of firm's and household's tendency to save, household expenditures and payments from firms (related to the *multiplier factor* - see below). The cycle of Figure 5.2 is not closed: an amount of *leakage* occurs as resources migrate across provincial and federal boundaries. Higher-order effects resulting from additional rounds of spending are not modelled, as Section 5.1 has indicated these can rapidly increase model complexity with no corresponding increase of insight.

Modelling the primary economic impact

The initial effect of federal and provincial recovery assistance is modelled by an injection of money into firms and households, in the form of materials and labour costs respectively. A review of several recent disaster events indicates that initial assistance is split approximately equally between these two sectors.

Tax Revenue

Tax revenues in the model derive from individual and corporate income taxes, as well as from the sales of goods and services. In this study, federal and provincial income taxes are estimated at 20% and 10% of income, respectively. Taxes are assessed after one full year of economic activity, and thus include the effects of both the multiplier and leakage. Provinces are assumed to charge a 7.5% sales tax on material goods (the mean provincial sales tax, averaged across all provinces), and the federal government charges a 7% GST on all goods and services (including labour).

The Multiplier effect

The *multiplier* deals with the magnified effect that changes in investment spending have on total income. The money spent building a new plant, for instance, initiates a chain reaction. It initially increases the incomes of the construction workers, and subsequently the incomes of merchants with whom the workers trade, the incomes of their suppliers, and so on. The dollars do not multiply indefinitely as people spend some of their new income, and they save some. The *multiplier factor*, the ratio of the change in income to the initial

change in expenditure which induced it, is defined in terms of this marginal propensity not to spend.[3]

This generalized multiplier has been developed into many specialized multipliers, such as the foreign-trade multiplier, the successive-period multiplier, and so on.[4] There are so many unknown and poorly-understood factors at work in the economy that it is virtually impossible to determine the precise value of any multiplier. Further, the multiplier varies from region to region and from time to time. In Canada, the multiplier factor has been estimated at 2.1 for an increase in government expenditures purely in the form of capital formation, over time scales of several years. The Economic Council of Canada estimates that the multiplier factor over one year is somewhere between 1.5 and 2.5.[5] That is, the average dollar spent in Canada generates between $0.50 and $1.50 *additional* dollars over a one year period. An important consequence of this is that each dollar generates additional federal and provincial tax revenue. A study of a representative disaster event indicates an appropriate multiplier factor of around 1.8 over one year (Section 5.3).

Leakage

Leakage occurs when a proportion of the funds injected into a provincial economy are expended out of the province. For the purposes of this study, leakage is estimated to be 10% per year. Leakage is a difficult factor to quantify exactly because it varies considerably with the province and the sector of the economy involved. As an example, the leakage associated with $10 million spent on automobiles in Ontario will be much lower than the same amount spent on automobiles, but in Prince Edward Island. A much larger fraction of funds will migrate out of Prince Edward Island, than Ontario. A detailed study of leakage effects would require a computer-driven model, acting on a detailed script of affected sectors in a given province at a given time.

The decentralized nature of the Canadian economy also makes accurate leakage estimates difficult. For example, consider a bookstore in British Columbia purchasing books from a national chain with headquarters in Ontario, and a western distribution centre in Alberta. During the transaction, the *funds* are transferred from British Columbia to Ontario, but the *commodity* has been transferred between Alberta and British Columbia. The complexity of such real-world transactions shows the difficulty of devising any meaningful estimates of what leakage has occurred, and between which provinces.

---

3 Source: R.G. Lipsey, D.D. Purvis, P.O. Steiner, `Economics', Fifth Edition, Harper & Row (New York 1985).

4 Source: D. Greenwald, 'Dictionary of Modern Economics', McGraw-Hill (New York 1973) 386.

5 Source: R.G. Lipsey, D.D. Purvis, P.O. Steiner, `Economics', Fifth Edition, Harper & Row (New York 1985).

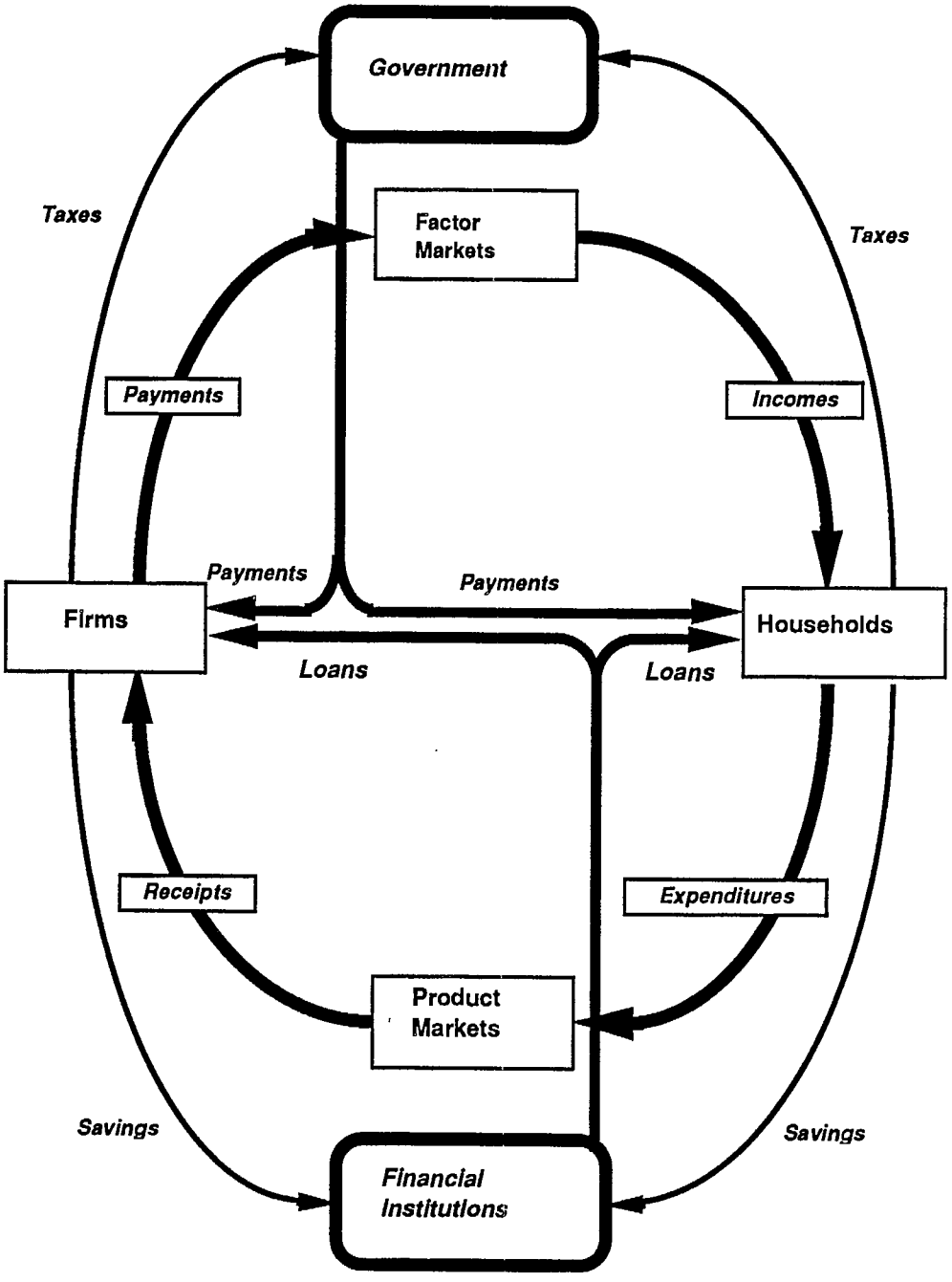

Figure 5.2: Expenditure and income flow in the model economy. The model contains four private sector elements, and two public sector elements. Arrows show resource flow mechanisms between sectors.

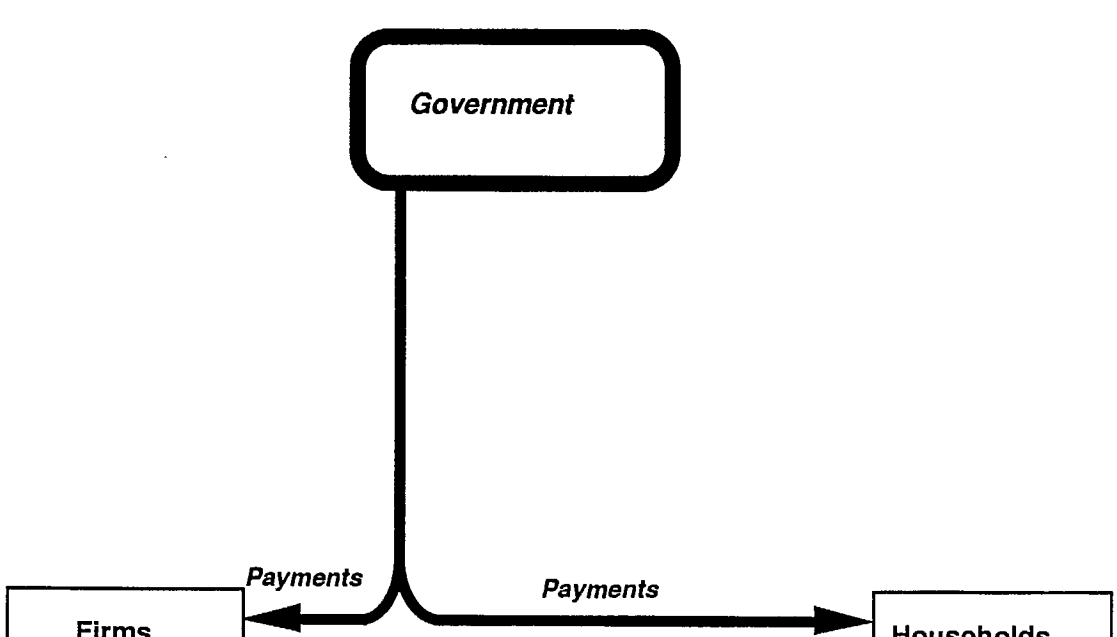

Figure 5.3: Primary elements of resource flow in the economic model. DFAA is modelled by an injection of both federal and provincial government funds into two sectors of the economy. As a first approximation, funds are allocated equally, half to firms (for recovery goods and services), and half to households (salaries and direct recovery assistance)

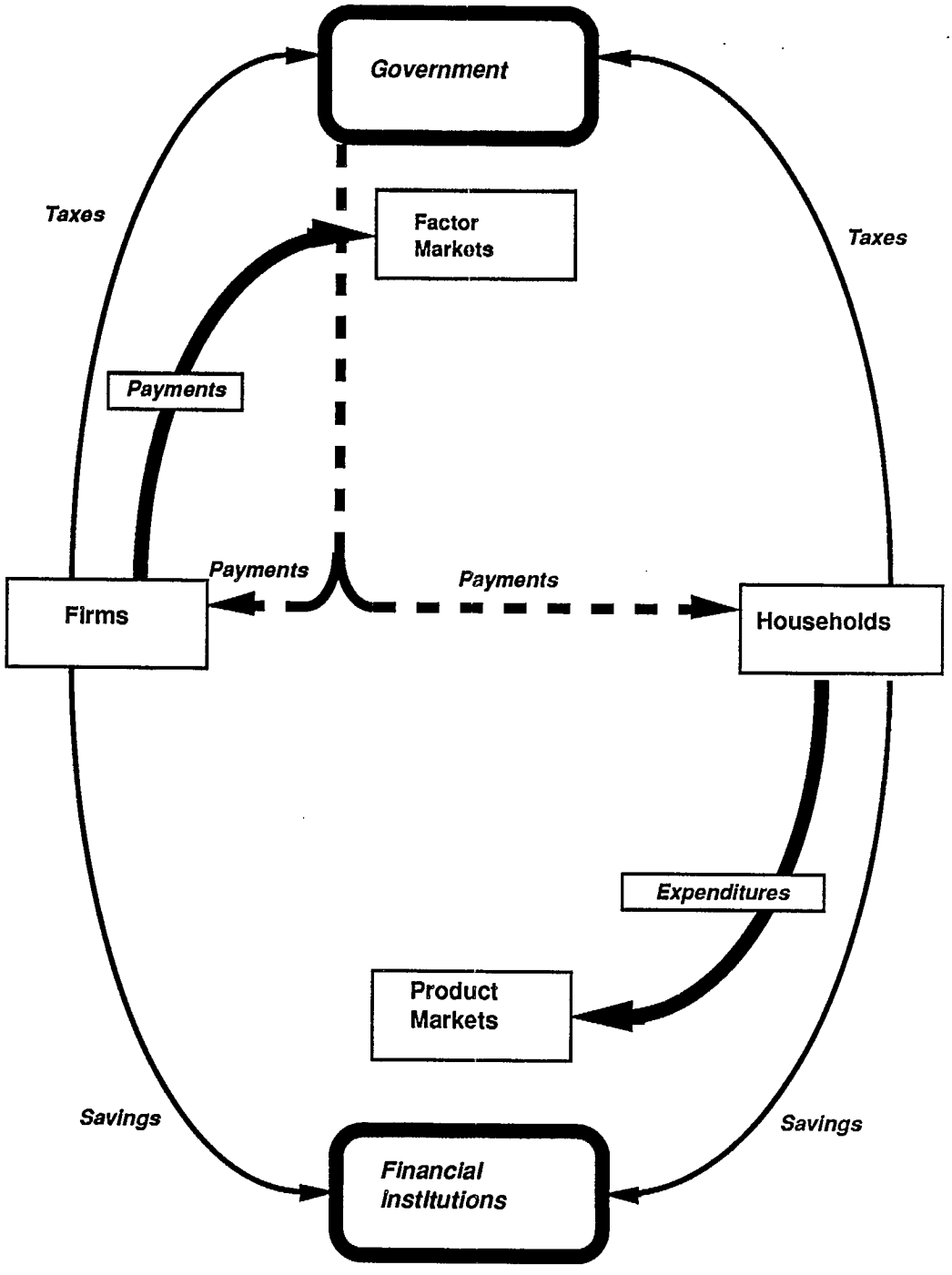

Figure 5.4: Secondary effects in the modelled resource flow. Following the initial injection of federal and provincial recovery funds into firms and households (dashed arrows), some funds are spent in product and factor markets (contributing to additional spending and taxation), and the remainder saved or returned to government through taxes.

5.3 Case Study: New Brunswick Flooding, 1987

The complexity of real-world economic systems makes the realistic modelling of resource flow through a national or provincial economy extremely difficult. Instead of a general treatment, a study of a specific event is provided using records from available audit trails. The diffusion of funds into different sectors of the provincial economy is followed, and estimates of increased revenue (multiplier effect), taxation revenue and leakage of resources out of the province, are given using available Statistics Canada data.

The Event

In April 1987, spring flooding caused extensive damage to parts of New Brunswick. Flooding of the St. John River caused significant damage to both private and public riverside property near Perth-Andover, Woodstock, Stanley, Jemseg, Maugerville and Upper Gagetown. A provincial request for assistance under the DFAA was made by the Minister of Municipal Affairs and Environment on April 10, 1987, and agreed to by the federal Minister Responsible for Emergency Preparedness on April 14, 1987.

The Assessment

After several rounds of clarification, final audit figures for eligible expenses as a result of flooding were released early in 1989. Total eligible expenses and their division into the public and private sectors are shown below. DFAA sharing is based on the current plan, using a provincial population of 712,300 for New Brunswick as of 1 June 1987 (provided by Statistics Canada).

Sharable eligible expenses:	$7,872,284.00.

Eligible expenses were divided between the public and private sectors:

Public Sector:	$4,146,421.00	(53%),
Private Sector:	$3,725,863.00	(47%).

Under current DFAA sharing plan, federal and provincial assistance calculated from this population base was:

Federal Share:	$5,660,456.00	(72%),
Provincial Share:	$2,211,828.00	(28%).

Breakdown by sector

A breakdown of private sector expenses was available from a preliminary audit report (Appendix 5.1). The information provides a detailed breakdown of sharable expenses, ranging from structural repairs to private residences ($1.5M) down to minor purchases (therapeutic services ($300)).

Multiplier Estimates

Estimates of the multiplier effect were derived from the most current Statistics Canada data available.[6] This was from the 1986 census, compiled and published in 1989. Data appears as a table of over 100 different sectors of the economy, with contributions to each sector from 50 different sources. For each item in Appendix 5.1, the total multiplier from the closest corresponding category was taken and a weighted average one-year multiplier found to be (Appendix 5.2):

$$K \sim 1.83 \text{ / year.}$$

That is, each federal or provincial dollar of assistance in response to the disaster generated (on average) an additional $0.83 over the course of the next year.

Using the estimate

Flooding and other storm-related damage is the most common disaster scenario in Canada. Floods tend to affect the entire spectrum of economic activity, rather than a few specific sectors. Because of this, the multiplier figure (K = 1.8) found here will be used throughout the study. However, it is important to recognize that the *precise* value of this figure is, to a large extent, meaningless. Exact values of the multiplier will vary with the event's size, location, and time of occurrence. The figure used here is intended only as a representative estimate, associated with an 'average' disaster occurring in an 'average' province at an 'average' time.

---

6 Source: 'Input/Output Structure of the Canadian Economy 1986', Statistics Canada 15-201 (1989).

5.3 Economic Effect: Option A

The effect of secondary economic factors from DFAA were examined for several event scenarios, under the current sharing formula. A sharing matrix of small, medium and large disaster events (eligible expenses before secondary factors: $5.0M, $25M and $50.0M respectively), occurring in small, medium and large provinces (populations 0.5M, 3.0M and 8.0M, respectively) was constructed, and the economic effects considered. Table 5.2 shows the sharing matrix after secondary factors .

Eligible expense (per capita provincial pop)	**Federal/Provincial sharing ratio**
$0-$1	0% / 100%
$1 - $3	50% / 50%
$3-$5	75% / 25%
>$5	90% / 10%

Table 5.2: Option A of the DFAA sharing formula (current formula).

Provincial population	**Event size**					
	Small ($5.0M)		Medium ($25.0M)		Large ($50.0M)	
	$M	%	$M	%	$M	%
Small (0.5M)	2.25 / 0.8	(74/26)	15.3 / -0.1	(101/-1)	31.5 / -1.1	(103/-3)
Medium (3.0M)	-0.25 / 3.3	(-8/108)	10.3 / 5.0	(67/33)	26.5 / 3.9	(87/13)
Large (8.0M)	-0.13 / 4.3	(-41/141)	2.6 / 12.6	(17/83)	16.5 / 13.9	(54/46)

Table 5.3: The sharing matrix after accommodating secondary economic factors, under Option A of the DFAA sharing formula (current formula). Figures show the estimated effective federal and provincial assistance after one year. Negative amounts indicate an effective gain. For example, in a small disaster in a large province the federal government provides no assistance, yet makes over $0.1M in taxation revenue from provincially-provided funds.

Trends

Using the figures shown results in a relative advantage to the province in five of the nine scenarios considered. The advantages are less than 10% in three of these cases, and less than 20% in all cases. Advantages of less than 10% are essentially 'lost in the noise' arising from imprecisely known economic factors and should not be interpreted as a 'real' advantage. The federal government has a greater than 10% relative advantage in three scenarios.

All events occurring in a small province are to the province's advantage: the province recovers a larger percentage from secondary sources than the federal government. In contrast, all events occurring in a large province are to the federal government's benefit.

Increasing the event size increases the relative provincial advantage. This is a result of the increased federal burden accompanying higher sharing levels.

Event	Province	Initial F/P ratio	Final F/P ratio	% advantage
Small	Small	70 / 30	74/26	4% (prov)
	Medium	20 / 80	-8/108	28% (fed)*
	Large	0 / 100	-41/141	41% (fed)*
Medium	Small	86 / 14	101/-1	16% (prov)**
	Medium	66 / 34	67/33	1% (prov)
	Large	35 / 65	17/83	18% (fed)
Large	Small	88 / 12	103/-3	16% (prov)**
	Medium	78 / 22	87/13	9% (prov)
	Large	58 / 42	54/46	4% (fed)

Table 5.4: The relative advantages to provincial or federal governments arising from adjustments due to secondary economic factors, including the multiplier effect, leakage and federal and provincial taxes on income and material. The actual numbers are not as important as the direction of the change.
* - events generating a net positive federal revenue,
** - events generating a net positive provincial revenue.

5.4 Economic Effect: Option B (Twice Current Thresholds)

The effect of secondary economic factors upon federal/provincial sharing burdens was examined for all scenarios of the standard sharing matrix. The resulting sharing matrix appears as Table 5.6. The percentile change in relative sharing burdens is summarized in Table 5.7 (See Appendix 5.3 for calculation details).

Eligible expenses (per capita prov pop)	**Federal/Provincial sharing ratio**
$0-$2	0% / 100%
$2-$8	50% / 50%
$8-$12	75% / 25%
>$12	90% / 10%

Table 5.5: Option B for DFAA sharing formula: cost sharing thresholds of the current formula are increased by a factor of two.

Provincial population	**Event size**					
	Small ($5.0M)		Medium ($25.0M)		Large ($50.0M)	
	$M	%	$M	%	$M	%
Small (0.5M)	1.25/ 1.79	41/59	14.25 / 0.95	93 / 7	30.5 / -0.1	101 / -1
Medium (3.0M)	-1.25 / 4.29	-41/141	5.0 / 10.2	33/67	20.5 / 9.9	67 / 33
Large (8.0M)	-1.25 / 4.29	-41/141	-1.75 / 17.0	-11/111	5.0 / 25.4	16/84

Table 5.6: DFAA sharing matrix for Option B of sharing formula after compensating for secondary economic factors.

Trends

There is a significant (greater than 10%) relative provincial advantage in two of the nine scenarios considered. Advantages of less than 10% are essentially 'lost in the noise' arising from imprecisely known economic factors and should not be interpreted as a 'real' advantage. The federal government has a greater than 10% relative advantage in five of the nine scenarios.

Sharing ratios after secondary effects under Option B are compared with those under the current formula in Figure 5.5. The figure shows the percentage difference in the relative federal/provincial sharing burdens. In all scenarios considered the advantage was to the federal side, under the new option. In general, the relative benefit decreases with increasing event size, although there are several exceptional cases, which occur when a province reaches a given sharing level under one option, but not the other.

Event	Province	Initial F/P ratio	Final F/P ratio	% advantage
Small	Small	50 / 50	41 / 59	9% (fed)
	Medium	0 / 100	-41 / 141	41% (fed)*
	Large	0 / 100	-41 / 141	41% (fed)*
Medium	Small	82 / 18	94 / 6	12% (prov)
	Medium	45 / 55	33 / 67	12% (fed)
	Large	18 / 82	-11 / 111	30% (fed)*
Large	Small	86 / 14	101 / -1	14% (prov)**
	Medium	66 / 34	67 / 34	1% (prov)
	Large	35 / 65	16 / 84	19% (fed)

Table 5.7: The relative advantages to provincial or federal governments arising from adjustments due to secondary economic factors, including the multiplier effect, leakage and federal and provincial taxes on income and material. The actual numbers are not as important as the direction of the change.
* - events generating a net positive federal revenue,
** - events generating a net positive provincial revenue.

Event	Province	Final sharing (Current)	Final sharing (Option B)	Per cent Difference
Small	Small	74/26	41 / 59	33
	Medium	-8/108	-41 / 141	33
	Large	-41/141	-41 / 141	0
Medium	Small	101/-1	94 / 6	7
	Medium	67/33	33 / 67	34
	Large	17/83	-11 / 111	28
Large	Small	103/-3	101 / -1	2
	Medium	87/13	67 / 34	20
	Large	54/46	16 / 84	38

Table 5.8: Comparison of the current formula with Option B after secondary economic factors are considered. The percentage difference in final sharing ratios under the two sharing formulae appears in the rightmost column.

5.5 Economic Effect: Option C (Three Times Current Threshold)

The effect of secondary economic factors upon federal/provincial sharing burdens was examined for all scenarios of the standard sharing matrix. The resulting sharing matrix appears as Table 5.9. The percentile change in relative sharing burdens is summarized in Table 5.10 (See Appendix 5.3 for calculation details).

Eligible expenses (per capita prov pop)	**Federal/Provincial sharing ratio**
$0-$3	0% / 100%
$3-$9	50% / 50%
$9-$15	75% / 25%
>$15	90% / 10%

Table 5.9: Option C for DFAA sharing formula: cost sharing thresholds of the current formula are increased by a factor of three to compensate for both reduced Canadian dollar purchasing power and mean national population increase.

Provincial population	**Event size**					
	Small ($5.0M)		Medium ($25.0M)		Large ($50.0M)	
	$M	%	$M	%	$M	%
Small (0.5M)	0.65 / 2.39	21 / 79	13.25 /1.95	87 / 13	29.5 / 0.9	97 / 3
Medium (3.0M)	-1.25 / 4.29	-41 / 141	1.75 / 13.45	12 / 88	14.5 / 15.9	48 / 52
Large (8.0M)	-1.25 / 4.29	-41 / 141	-5.75 / 20.95	-38 / 138	0.5 / 29.9	2 / 98

Table 5.10: DFAA sharing matrix for Option C of sharing formula after compensating for secondary economic factors.

Trends

There is a significant (greater than 10%) relative provincial advantage in only one of the nine scenarios considered. Advantages of less than 10% are essentially 'lost in the noise' arising from imprecisely known economic factors and should not be interpreted as a 'real' advantage. The federal government has a greater than 10% relative advantage in six of the nine scenarios.

Sharing ratios after secondary effects under Option C are compared with those under the current formula in Table 5.12 and Figure 5.6. The figure shows the percentage difference in the relative federal/provincial sharing burdens. In all scenarios considered the advantage was to the federal side, under the new option. In general, the relative benefit decreases with increasing event size, although there are several exceptional cases, which occur when a province reaches a given sharing level under one option, but not the other.

Event	Province	Initial F/P ratio	Final F/P ratio	% advantage
Small	Small	38 / 42	21 / 79	13% (fed)
	Medium	0 / 100	-41 / 141	41% (fed)*
	Large	0 / 100	-41 / 141	41% (fed)*
Medium	Small	78 / 22	87 / 13	9% (prov)
	Medium	32 / 68	12 / 88	20% (fed)
	Large	2 / 98	-38 / 138	40% (fed)*
Large	Small	84 / 16	97 / 3	13% (prov)
	Medium	54 / 46	48 / 52	6% (fed)
	Large	26 / 74	2 / 98	24% (fed)*

Table 5.11: The relative advantages to provincial or federal governments arising from adjustments due to secondary economic factors, including the multiplier effect, leakage and federal and provincial taxes on income and material. The actual numbers are not as important as the direction of the change.
* - events generating a net positive federal revenue,
** - events generating a net positive provincial revenue.

Event	Province	Final sharing (Current)	Final sharing (Option B)	Per cent Difference
Small	Small	74 / 26	21 / 79	55
	Medium	-8 / 108	-41 / 141	33
	Large	-41 / 141	-41 / 141	0
Medium	Small	101 / -1	87 / 13	14
	Medium	67 / 33	12 / 88	55
	Large	17 / 83	-38 / 138	55
Large	Small	103 / -3	97 / 3	6
	Medium	87 / 13	48 / 52	39
	Large	54 / 46	2 / 98	52

Table 5.12: Comparison of the current formula with Option C after secondary economic factors are considered. The percentage difference in final sharing ratios under the two sharing formulae appears in the rightmost column.

5.6 Economic Effect: Option D (Twice Current Formula with Additional Level)

The effect of secondary economic factors upon federal/provincial sharing burdens was examined for all scenarios of the standard sharing matrix. The resulting sharing matrix appears as Table 5.5. The percentile change in relative sharing burdens is summarized in Table 5.6 (See Appendix 5.3 for calculation details).

Eligible expenses (per capita prov. pop.)	**Federal/Provincial Assistance**
$0-$1	0% / 100%
$1-$2	25% / 75%
$2-$6	50% / 50%
$6-$10	75% / 25%
>$10	90% / 10%

Table 5.13: Option D of DFAA sharing plan: cost sharing thresholds modified by a factor of two, with a new level added to permit entry at current threshold.

Provincial population	**Event size**					
	Small ($5.0M)		Medium ($25.0M)		Large ($50.0M)	
	$M	%	$M	%	$M	%
Small (0.5M)	1.35 / 1.7	44 / 86	14.35 / 0.85	94 / 6	30.6 / -0.2	101 / -1
Medium (3.0M)	-0.75 / 3.8	-25 / 125	5.75 / 9.45	38 / 62	21.3 / 9.1	70 / 30
Large (8.0M)	-1.25 / 4.3	-41 / 141	0.25 / 14.9	2 / 98	4.2 / 23.4	23 / 77

Table 5.14: DFAA sharing matrix for Option D of sharing formula after compensating for secondary economic factors.

Trends

There is a significant (greater than 10%) relative provincial advantage in two of the nine scenarios considered. Advantages of less than 10% are essentially 'lost in the noise' arising from imprecisely known economic factors and should not be interpreted as a 'real' advantage. The federal government has a greater than 10% relative advantage in five of the nine scenarios.

Sharing ratios after secondary effects under Option D are compared with those under the current formula in Figure 5.7. The figure shows the percentage difference in the relative federal/provincial sharing burdens. In all scenarios considered the advantage was to the federal side, under the new option. In general, the relative benefit decreases with increasing event size, although there are several exceptional cases, which occur when a province reaches a given sharing level under one option, but not the other.

Event	Province	Initial F/P ratio	Final F/P ratio	% advantage
Small	Small	53 / 47	44 / 86	8% (fed)
	Medium	10 / 90	-25 / 125	37% (fed)*
	Large	0 / 100	-41 / 141	41% (fed)*
Medium	Small	82 / 18	94 / 6	12% (prov)
	Medium	48 / 52	38 / 62	10% (fed)
	Large	26 / 74	2 / 98	24% (fed)*
Large	Small	85 / 15	101 / -1	14% (prov)
	Medium	67 / 33	70 / 30	2% (prov)
	Large	39 / 61	23 / 77	16% (fed)

Table 5.15: The relative advantages to provincial or federal governments arising from adjustments due to secondary economic factors, including the multiplier effect, leakage and federal and provincial taxes on income and material. The actual numbers are not as important as the direction of the change.
* - events generating a net positive federal revenue,
** - events generating a net positive provincial revenue.

Event	Province	Final sharing (Current)	Final sharing (Option B)	Per cent Difference
Small	Small	74 / 26	44 / 86	30
	Medium	-8 / 108	-25 / 125	17
	Large	-41 / 141	-41 / 141	0
Medium	Small	101 / -1	94 / 6	7
	Medium	67 / 33	38 / 62	29
	Large	17 / 83	2 / 98	15
Large	Small	103 / -3	101 / -1	2
	Medium	87 / 13	70 / 30	17
	Large	54 / 46	23 / 77	31

Table 5.16: Comparison of the current formula with Option D after secondary economic factors are considered. The percentage difference in final sharing ratios under the two sharing formulae appears in the rightmost column.

5.7 Economic Effect: Option E (Three Times Current Thresholds with Additional Level)

The effect of secondary economic factors upon federal/provincial sharing burdens was examined for all scenarios of the standard sharing matrix. The resulting sharing matrix appears as Table 5.5. The percentile change in relative sharing burdens is summarized in Table 5.6 (See Appendix 5.3 for calculation details).

Cost (per capita)	**Federal/Provincial**
$0-$1	0% / 100%
$1-$3	25% / 75%
$3-$9	50% / 50%
$9-$15	75% / 25%
>$15	90% / 10%

Table 5.17: Option E of DFAA sharing plan: cost sharing thresholds modified to take account of modifying factors, new level added to permit entry at current threshold.

Provincial population	**Event size**					
	Small ($5.0M)		Medium ($25.0M)		Large ($50.0M)	
	$M	%	$M	%	$M	%
Small (0.5M)	0.9 / 2.1	31 / 64	13.6 / 1.65	89 / 11	29.7 / 0.7	98 / 2
Medium (3.0M)	-0.8 / 3.8	-25 / 125	3.25 / 11.9	21 / 79	16.0 / 14.4	53 / 47
Large (8.0M)	-1.25 / 4.3	-41 / 141	1.75 / 16.9	-12 / 112	4.5 / 25.9	15 / 85

Table 5.18: DFAA sharing matrix for Option E of sharing formula after compensating for secondary economic factors.

Trends

There is a significant (greater than 10%) relative provincial advantage in two of the nine scenarios considered. Advantages of less than 10% are essentially 'lost in the noise' arising from imprecisely known economic factors and should not be interpreted as a 'real' advantage. The federal government has a greater than 10% relative advantage in six of the nine scenarios.

Sharing ratios after secondary effects under Option B are compared with those under the current formula in Figure 5.5. The figure shows the percentage difference in the relative federal/provincial sharing burdens. In all scenarios considered the advantage was to the federal side, under the new option. In general, the relative benefit decreases with

increasing event size, although there are several exceptional cases, which occur when a province reaches a given sharing level under one option, but not the other.

Event	Province	Initial F/P ratio	Final F/P ratio	% advantage
Small	Small	43 / 57	31 / 64	13% (fed)
	Medium	10 / 90	-25 / 125	35% (fed)*
	Large	0 / 100	-41 / 141	41% (fed)*
Medium	Small	79 / 21	89 / 11	10% (prov)
	Medium	38 / 62	21 / 79	17% (fed)
	Large	18 / 82	-12 / 112	30% (fed)*
Large	Small	85 / 15	98 / 2	13% (prov)
	Medium	57 / 43	53 / 47	9% (fed)
	Large	34 / 66	15 / 85	19% (fed)

Table 5.19: The relative advantages to provincial or federal governments arising from adjustments due to secondary economic factors, including the multiplier effect, leakage and federal and provincial taxes on income and material. The actual numbers are not as important as the direction of the change.
* - events generating a net positive federal revenue,
** - events generating a net positive provincial revenue.

Event	Province	Final sharing (Current)	Final sharing (Option B)	Per cent Difference
Small	Small	74 / 26	31 / 64	33
	Medium	-8 / 108	-25 / 125	17
	Large	-41 / 141	-41 / 141	0
Medium	Small	101 / -1	89 / 11	12
	Medium	67 / 33	21 / 79	46
	Large	17 / 83	-12 / 112	29
Large	Small	103 / -3	98 / 2	5
	Medium	87 / 13	53 / 47	33
	Large	54 / 46	15 / 85	41

Table 5.20: Comparison of the current formula with Option E after secondary economic factors are considered. The percentage difference in final sharing ratios under the two sharing formulae appears in the rightmost column. Negative differences indicate an overall federal benefit.

5.8 Summary

This annex developed a simple input-output model of resource flow through both provincial and federal economies, which allowed a study of the economic effect of possible alterative DFAA sharing formula options. The model simulated the initial influx of assistance funds into public and private sector elements. The model also included several economic mechanisms which act to redistribute the initial injection of money, including federal/provincial taxation, leakage of funds and resources out of province, and the multiplier effect, by which each dollar spent generates additional federal and provincial tax revenue. A case study of a recent disaster event led to a reliable estimate of the multiplier factor, determined to be approximately 1.8 /year.

The model was used to examine the effect of different DFAA sharing strategies: a total of five sharing formula options (including the currently used formula) were tested. The sharing matrix was used to examine how secondary effects shifted the federal/provincial sharing ratio. The results are summarized in Table 5.21. Ranked in order of *decreasing* federal advantage, they are:

Option C - Three times current formula
Option E - Three times current formula with additional level
Option B - Twice current formula
Option D - Twice current formula with additional level
Option A - Current formula.

That is, Option C (three times the current formula) had the greatest overall advantage to the federal government from secondary factors, and Option A (the current formula) the least.

		% advantage				
Event	**Province**	**Option A**	**Option B**	**Option C**	**Option D**	**Option E**
Small	Small	4% (prov)	9% (fed)	13% (fed)	8% (fed)	13% (fed)
	Medium	28% (fed)	41% (fed)	41% (fed)	37% (fed)	35% (fed)
	Large	41% (fed)	41% (fed)	41% (fed)	41% (fed)	41% (fed)
Medium	Small	16% (prov)	12% (prov)	9% (prov)	12% (prov)	10% (prov)
	Medium	1% (prov)	12% (fed)	20% (fed)	10% (fed)	17% (fed)
	Large	18% (fed)	30% (fed)	40% (fed)	24% (fed)	30% (fed)
Large	Small	16% (prov)	14% (prov)	13% (prov)	14% (prov)	13% (prov)
	Medium	9% (prov)	1% (prov)	6% (fed)	2% (prov)	9% (fed)
	Large	4% (fed)	19% (fed)	24% (fed)	16% (fed)	19% (fed)

Table 5.21: Summary of advantages derived from secondary economic factors, showing the relative advantages to provincial or federal governments arising from secondary factors, including the multiplier effect, leakage and federal and provincial taxes on income and material. The actual numbers are not as important as the direction of the change. The options include:
Option A: Current formula
Option B: Twice current formula
Option C: Three times current formula
Option D: Twice current formula with additional level
Option E: Three times current formula with additional level