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5 Some Comments on "NRC University Grants and  
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Some Comments on "NRC University Grants and Scholarship Program. A Perspective 1969-70 to 1974-75"  
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SOME COMMENTS ON "NRC UNIVERSITY GRANTS AND SCHOLARSHIP PROGRAM.  
A PERSPECTIVE 1969-70 TO 1974-75"

1.0

Summary

The basic points made in "A Perspective" are correct. The growth of funds available to the NRC for grants and scholarships has been much less than for the total federal expenditures on natural sciences. Indeed the amount of money available has been decreasing in real terms. Also the size of individual grants and scholarships has decreased in real terms since 1969-70. It would appear that the growth of funds available for direct funding of R&D in the natural sciences in universities has been less in Canada than in the USA, the UK or France.

Although the publication contains nothing but statistics it is biased in its presentation. The most obvious bias is in the choice of base year. In any such presentation it must be decided how many years are relevant to the present situation. By using the type of graph which plots growth from a base of 100 there is an implicit implication that the base year should be considered the norm. Choosing 1965-66 as the base year and thus including the spectacular growth in university research funding of the late 60's changes the picture but not the facts.

The international comparisons included in "A Perspective" are subject to the usual considerations which affect such comparisons. These include things such as variations in granting policy, variations in the nature of university research and variations in growth of university enrolment.

A comparison of the growth of federal payments to universities and non-profit institutions for R&D in the natural sciences deflated using the GNE implicit price index, and the growth of student enrolment shows that these have paralleled each other since 1970-71 after the amount spent per student had dropped 13% from the high in 1968-69.

If one examines the proportion of the federal natural science R&D budget spent in each of the four sectors - intramural, universities, industry and others - over the last six years one finds that the amount expended by Canadian industry and by other performers has risen at the expense of the other two sectors. In 1969-70 intramural expenditures accounted for 57.0%

of the budget. The figure for the universities was 21.6%, for industry 20.4%, and for other 1.0%. In 1974-75 the figures are expected to be 56.0%, 17.8%, 22.1% and 4.1% respectively.

This paper considers each graph or table of "A Perspective" in turn in order to aid the user in responding to enquiries. Emphasis is placed on a discussion of the two graphs and tables 1 and 8 rather than on the other tables, as the latter display internal priorities of the NRC.

As others are commenting on "A Perspective" as well this paper is restricted to primarily numerical analyses.

2.0

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3.0

Comments on Figure 1. Comparison of Growth Rates of G.N.P. and Federal Expenditures on R&D in Canada 1969-70 to 1973-74.

### 3.1 The display technique

As noted in the title, the method of display used compares growth rates and not absolute growths. On such a chart a shift in emphasis which would be small if compared to the total would, if applied to a small base, cause a rather spectacular shift of the line in question away from the norm. For example, a drop in the proportion of the GNP expended by the federal government on R&D in the natural sciences from 0.68% in 1969-70 to 0.61% in 1973-74, a relatively minor shift in the economy as a whole, shows as total federal expenditures on R&D in the natural sciences falling behind by 10%. See lines A and B in Chart 1-1, attached. However, lines C and D representing payments to universities and non-profit institutions do represent expenditures of similar magnitudes and thus are legitimately comparable.

The choice of base year is crucial in this type of display. It does not affect the truth of the graph but it does affect rather drastically the impression one gains. An example of shift of base year can be obtained by comparing charts 1-2 and 1-4, attached. Analyses of the significance of these graphs follows.

### 3.2 Analysis of Figure 1 itself

Chart 1-2 shows the same data as Figure 1 of "A Perspective" with the addition of two lines - E, showing growth in total payments to Canadian universities and non-profit institutions for R&D in the natural sciences (the sum of C and D) and F, showing the growth in total university enrolment.

I suggest that it is only really legitimate to compare the growth of R&D funding to universities<sup>1</sup> to that of total federal expenditures on R&D either in whole or in part. To do that total R&D funding to universities should be shown. Chart 1-2 displays this as line E.

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<sup>1</sup> in the interests of conciseness I employ the phrase R&D funding to Universities rather than the more correct "direct federal payments to Canadian universities and non-profit institutions for R&D in the natural sciences". Similar shorthand notations are used elsewhere in this paper.

Figure 1 of "A Perspective", chart 1-1, shows only NRC support and non-NRC support. The assumption implicit in this is that the growth in NRC support should be the same as that for other funders. While it is understandable that NRC should take this view it is not necessarily valid. This may have some implications for the balance between basic and applied science and this is discussed in section 3.3.

Considering the growth in total university enrolment, line F, it is possible that that of total federal funding to universities, shown in line E, is perhaps not inappropriate. It is inappropriate, however, to compare firm quantities such as people with flexible quantities such as current dollars. A proper comparison can only be made with constant dollars. An attempt to do this is made in section 3.3.

### 3.3 The application of a deflator to Figure 1

In chart 1-3 an attempt has been made to express the expenditure figures shown in charts 1-2 and 1-1. To do this the GNE implicit price index has been used. While this is not a valid deflator for science expenditures<sup>1,2</sup> it is the most suitable one readily available. The Consumer Price Index gives almost identical results.

The most significant piece of information to be drawn from chart 1-3 is that after 1970-71 the total R&D funding to universities has paralleled the total enrolment. Note that no conclusion can be drawn from the fact that the line for enrolment runs above the line for funding except that funding per student is now less than it once was. The appropriateness of this or any level of funding is a policy matter and outside the scope of these "comments". This applies also as to whether the real level of funding should or should not drop in a time of declining enrolment.

<sup>1</sup> "Federal Government activities in the natural sciences 1973-1975", Statistics Canada. Catalogue 13-202.

<sup>2</sup> "Deflating expenditures in the natural sciences" a feasibility study by F. McGuire, MOSST, September, 1974.

Two things should be noted concerning the use of enrolment statistics in this comparison. First, total enrolment is used rather than the more appropriate graduate enrolment or natural science enrolment as those are the only figures readily available for 1973-74 at this time. Any shift in enrolment from the natural sciences to the human sciences is thus not reflected in the graphs. Second, the expenditure figures for support of R&D in universities, E, are in fact for payments to non-profit institutions as well. However this latter forms a small proportion of the whole and as long as the growth of this component is not radically different from that for the university component this fact can be neglected.

Unfortunately there are no figures available for support of basic versus applied research in universities. Thus it is not possible to draw any firm conclusions whether the real decline in NRC funding compared to the increase in non-NRC funding implies a shift from basic to applied research. Presumably there is a shift from free to mission-oriented research however.

#### 3.4 Comparison of growth rates: 1965-66 to 1974-75

Chart 1-4 which shows the same information as chart 1-2 except that it uses 1965-66 as a base year instead of 1969-70 gives quite a different impression. It is only the impression that is different. The same story of how growth of university funding has virtually stopped evident in chart 1-2 is still there; it is merely lost in the spectacular growth of the 1960's.

The choice of 1965-66 as a base year is an arbitrary one. By this or any choice a decision is made between what is ancient history and what is relevant to today.

The particular choice of 1965-66 for a base year is dictated by the fact that the most recent Statistics Canada historical series in the natural sciences starts in that year. The choice of 1966-67 instead of 1965-66 as the base would have placed NRC no longer in the possibly embarrassing position of leading the pack.

Comparison of line A and B show that while during the late sixties the growth of federal expenditures on R&D in the natural sciences was



greater than that of the GNP it has been less than that of the GNP in the early seventies. This also applies to an even greater extent to support of R&D in universities.

3.5 The effect of a deflator on the growth rates:  
1965-66 to 1973-74

Chart 1-5 shows the same data as chart 1-4 except that expenditure figures have been deflated using the G.N.E. implicit price index.

This graph shows that the ratio of total federal R&D funding per student has changed over the period. If the ratio of funding per student is taken as 100 in 1965-66 the ratio climbed to a high of 169 in 1968-69 and has dropped to 147 in 1973-74. Once again no comment can be made here about the appropriateness of any level of funding.

4.0

Comments on Figure 2. Growth Rates of Expenditures by Agencies Supporting University Research; International Comparisons 1969-70 to 1973-74

#### 4.1 Choice of Agencies

In Figure 2 of "A Perspective" (reproduced here as chart 2-1) it is implied that the NRC, SRC, NSF and CNRS are equivalent agencies and that they should be assigned equal relative importance by their respective countries at least as far as growth rates are concerned. The latter point is beyond the scope of these comments. However some light can be thrown upon the issues involved through discussion of the alleged equivalence of these agencies.

In the UK there are a large number of specialized granting councils of which the SRC is only one. If the total of all of the budgets of these councils is considered the growth is slightly less than for the SRC above. 1973-74 shows a level of 148 instead of 156. This growth is still substantially more than that of the NRC.

The growth of the NSF budget shown in chart 2-1 appears to be for the total budget. Their budget for scientific research projects was only 40% of the total in 1972-73. This represents an increase from 36% in 1970-71. If the budget for scientific research projects is plotted the figure for the NSF rises to 166 from 146. The NSF is also not the sole funder of university R&D in the US and thus the matter of the changing importance of various funding agencies remains.

The CNRS appears to be quite a different agency from the NRC, funding as it does such programs as fast breeder reactors. The growth shown for the CNRS in chart 2-1 is for the total CNRS budget. It does not appear that any of the CNRS budget is used for university research grants similar to those of the NRC. Figure for total university R&D funding are available up to 1971-72<sup>1</sup> which indicate a growth to 120 in 1971-72 from a base of 100 in 1969-70. This is substantially below the growth of CNRS but still well ahead of the NRC

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<sup>1</sup>1972 - France, Science Research and Development, Eurofab Engineering.

#### 4.2 A more correct international comparison?

Chart 2-2 shows a comparison of the growth of total Canadian support of R&D with that for France and all granting councils in the UK as well as showing the growth in expenditures on research projects by the NSF.

There is a minor repositioning of the lines for each country in this graph as compared with chart 2-1, but the story remains the same. Canada remains at the bottom of the list.

The inclusion of additional countries in this comparison is desirable but efforts to obtain sufficiently up-to-date data have not been successful at this time.

There are several possible explanations for the differences in growth rate shown in chart 2-2. For example, a detailed study of the growth of student enrolments in the countries may shed light on these differences as may a detailed study of the university R&D funding systems. A cursory look is taken at student enrolment figures in section 4.4.

#### 4.3 The use of exchange rates and consumer price indices in international growth comparisons.

Chart 2-3 shows the same data as chart 2-2 corrected for inflation in each country using the consumer price indexes.<sup>1</sup> While the CPI's are not valid deflators for science expenditures they do provide some indication of the relative increases in costs in each country. This chart shows some closing of the gap but the story remains the same as that in charts 2-1 and 2-2.

Chart 2-4 shows the same data as chart 2-2 with expenditures expressed in current Canadian dollars<sup>2</sup>. This brings the line for the other three countries down slightly but does not change the story. It should be noted that following 1972-73 France's exchange rates moved above the 1969-70 level in terms of the Canadian dollar. Thus if more recent figures were available the disparity would be larger than in chart 2-2.

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<sup>1</sup> CPI's are for the annual average for the calendar year corresponding to that first named in the fiscal year. Source: Economic Review, Department of Finance, April 1974.

<sup>2</sup> Exchange rates are for January averages. Source: Economic Review, Department of Finance, April 1974.

Note that exchange rates and CPI's are not independent variables so it is not valid to combine both on one graph.

4.4 International comparisons of growth of student enrolment.

Chart 2-5 shows the growth in R&D funding per full-time student in Canada, the U.S., the UK and France. The CPI deflated expenditures shown in chart 2-3 are used. As figures are not available for the total period under consideration it is not possible to draw any firm conclusions from this data. However, it would appear that in Canada university R&D has a declining importance relative to that given it in the other countries listed.

It should be noted that this comparison makes no allowance for the relative shifts in subject area chosen by students. For example, it is possible that the proportion of students in Canada opting for the humanities has increased more than it has in the UK. To examine this sort of effect would require a full study.

5.0

Comparison of the Funds Available to the Three Councils for Grants and Scholarships 1969-70 to 1974-75.

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The funds shown in Table I of "A Perspective" for the three councils are sufficiently equivalent to make comparison valid. The choice of a 6% per annum deflator appears to be arbitrary. Its actual magnitude is unimportant as far as the comparison is concerned.

If the GNE implicit price index is used as a deflator the changes 1969-70 to 1973-74 are -12.4% for the NRC, +8.1% for the MRC and -2.5% for the Canada Council. Note that these numbers are for the changes to 1974 rather than 1975. If the CPI is used the figures are -11.2%, +9.1%, -1.6% respectively for the changes 1969-70 to 1973-74.

Neither the GNE implicit price index nor the CPI are more valid than the straight 6%.

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NRC Allocation of Resources

Tables 2 to 7 of "A Perspective" show the evolution of the NRC grants over the past six years. Given that the total funds available to the NRC has grown little during that time it follows that individual programs will tend to show similarly small increases unless there are substantial shifts in emphasis.

Table 2 shows that there has been a major decline in the amount allocated to equipment and major equipment grants and that operating grants have shown modest growth: a possible indication of a holding pattern.

Tables 3, 5 and 6 show that the average value of grants, scholarships, bursaries and fellowships has declined in real terms using a 6% per year deflator. The choice of 6% appears to be arbitrary but it is not unreasonable.

For the most part each table tells a clear story and no comment need be made here.

7.0

Federal Expenditures 1969-70 to 1973-74

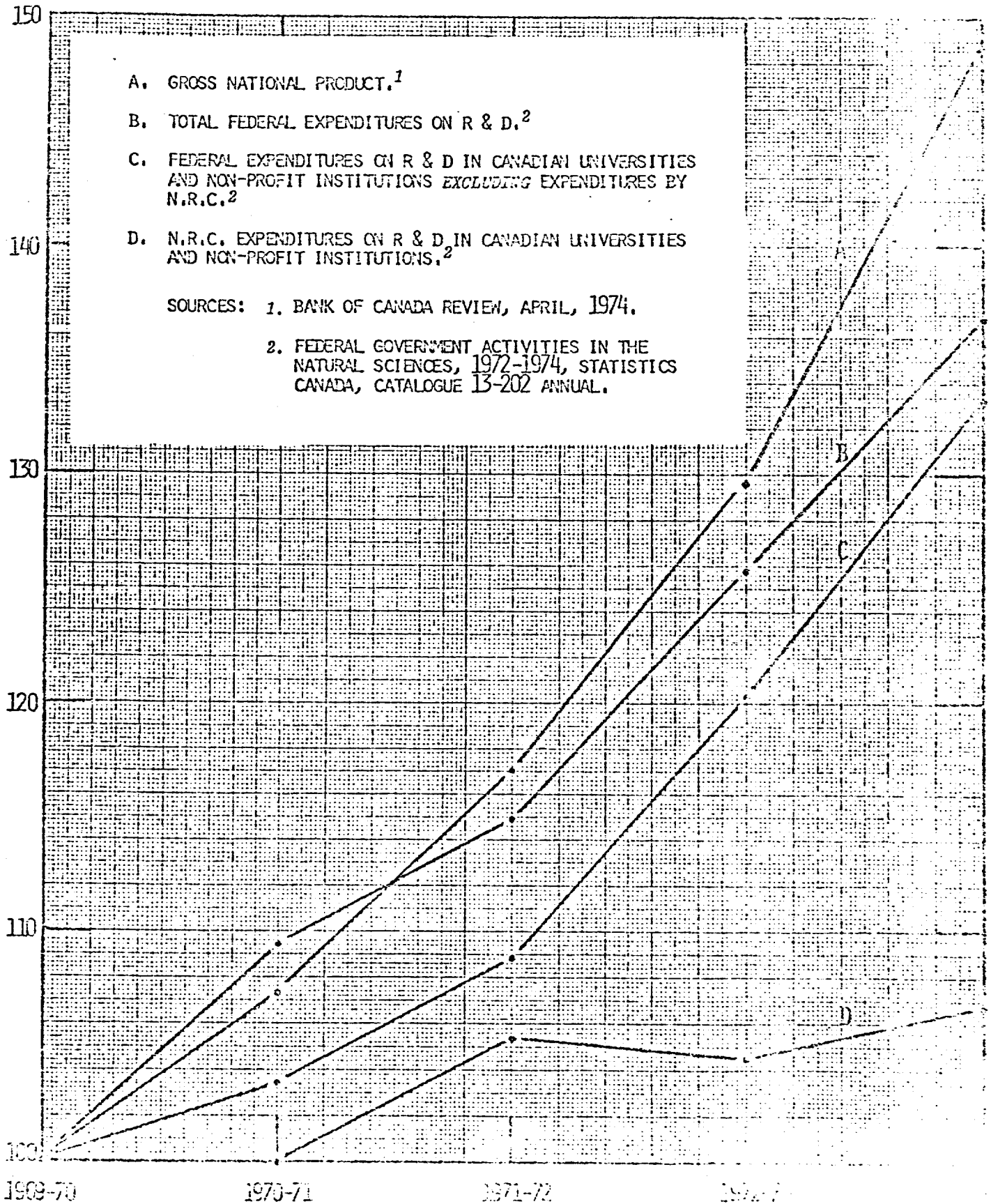
Table 8 of "A Perspective" shows the funds expended on each of a number of categories in the natural sciences as a percentage of the total federal budgetary estimates.

Some additional and more recent figures may be of interest. These are shown in Chart 3-1.

The largest growth in R&D during this period was in federal payments in support of R&D in the natural sciences in Canadian industry. A growth of +90.0% occurred in related scientific activities during the period.

COMPARISON OF GROWTH RATES OF G.N.P. AND  
FEDERAL EXPENDITURES ON R & D IN CANADA  
1969-70 TO 1973-74

1969-70 = 100





Comparison of Growth Rates of GNP, Federal Expenditures on R&D in Canada, and University and College Enrolment

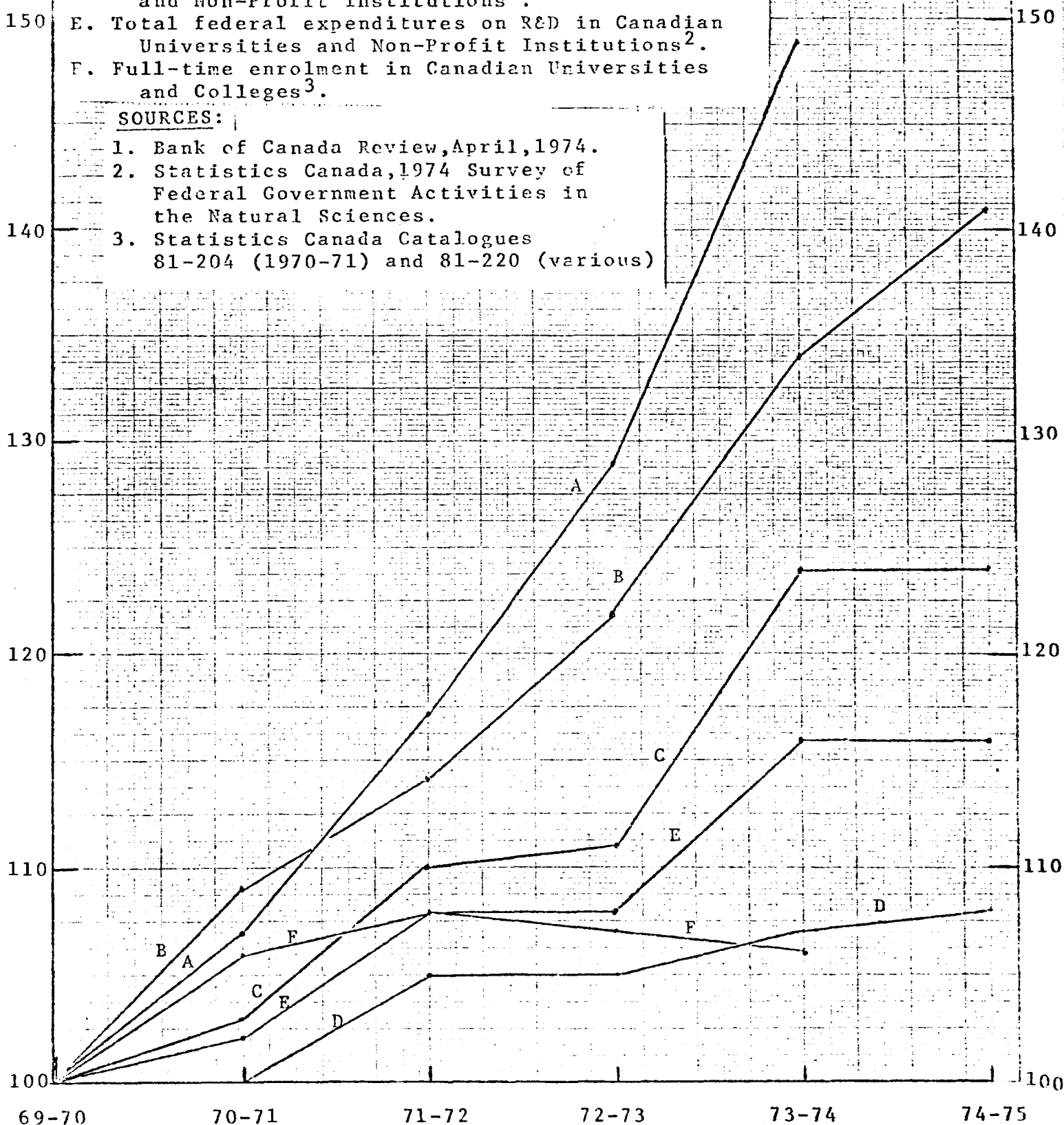
1969-70 to 1974-75

RT 1-2

- A. Gross National Product<sup>1</sup>.
- B. Total federal expenditures on R&D in the Natural Sciences<sup>2</sup>.
- C. Federal expenditures on R&D in Canadian Universities and Non-Profit Institutions<sup>2</sup> excluding expenditures by NRC<sup>2</sup>.
- D. NRC expenditures on R&D in Canadian Universities and Non-Profit Institutions<sup>2</sup>.
- E. Total federal expenditures on R&D in Canadian Universities and Non-Profit Institutions<sup>2</sup>.
- F. Full-time enrolment in Canadian Universities and Colleges<sup>3</sup>.

SOURCES:

- 1. Bank of Canada Review, April, 1974.
- 2. Statistics Canada, 1974 Survey of Federal Government Activities in the Natural Sciences.
- 3. Statistics Canada Catalogues 81-204 (1970-71) and 81-220 (various)

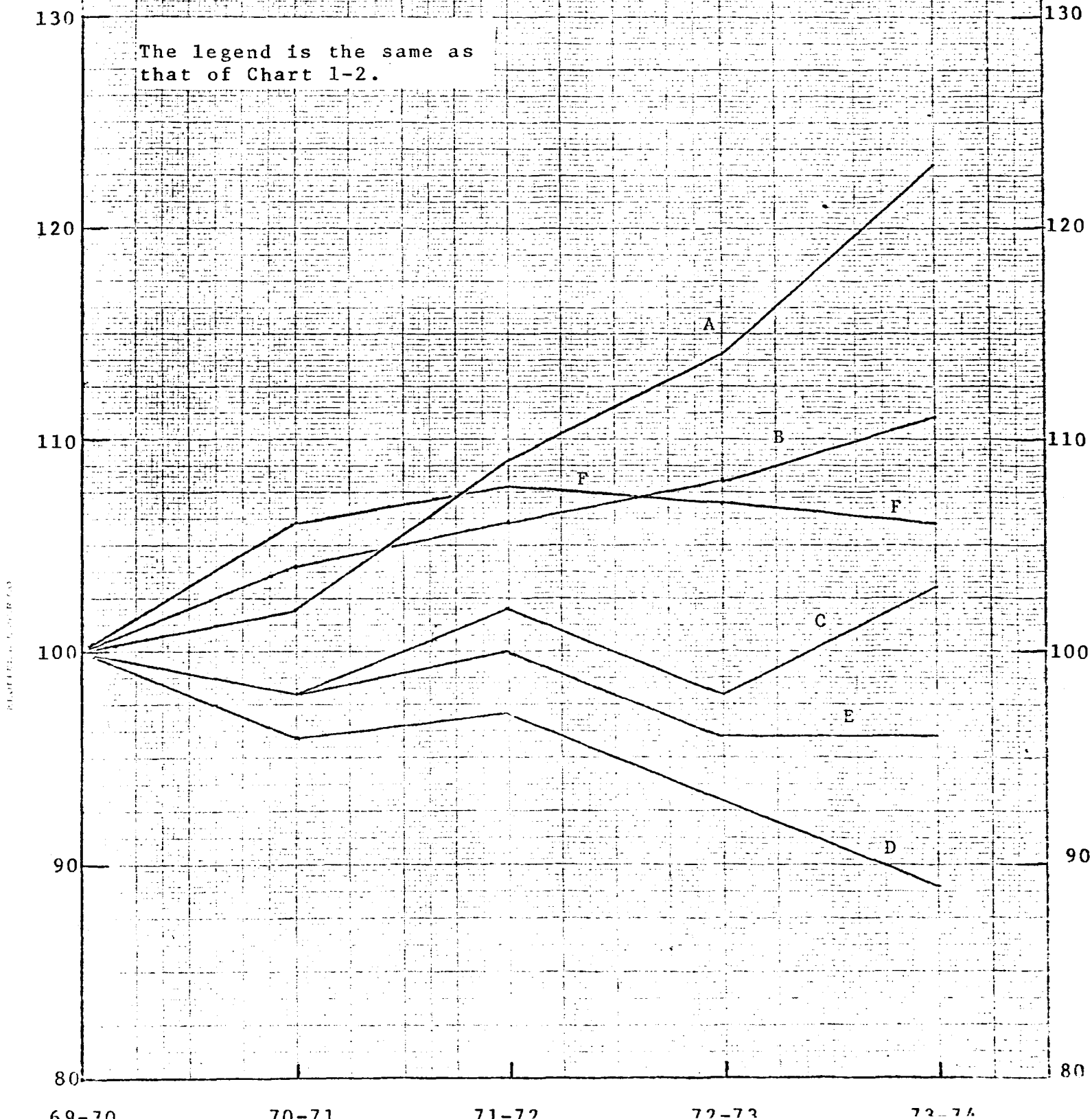


Comparison of Growth Rates of GNP, Federal Expenditures  
on R&D in Canada (adjusted by Implicit GNE Deflator<sup>1</sup>) and University Enrolment  
1969-70 to 1973-74

T 1-3

<sup>1</sup>Department of Finance, Economic Review, April, 1974.

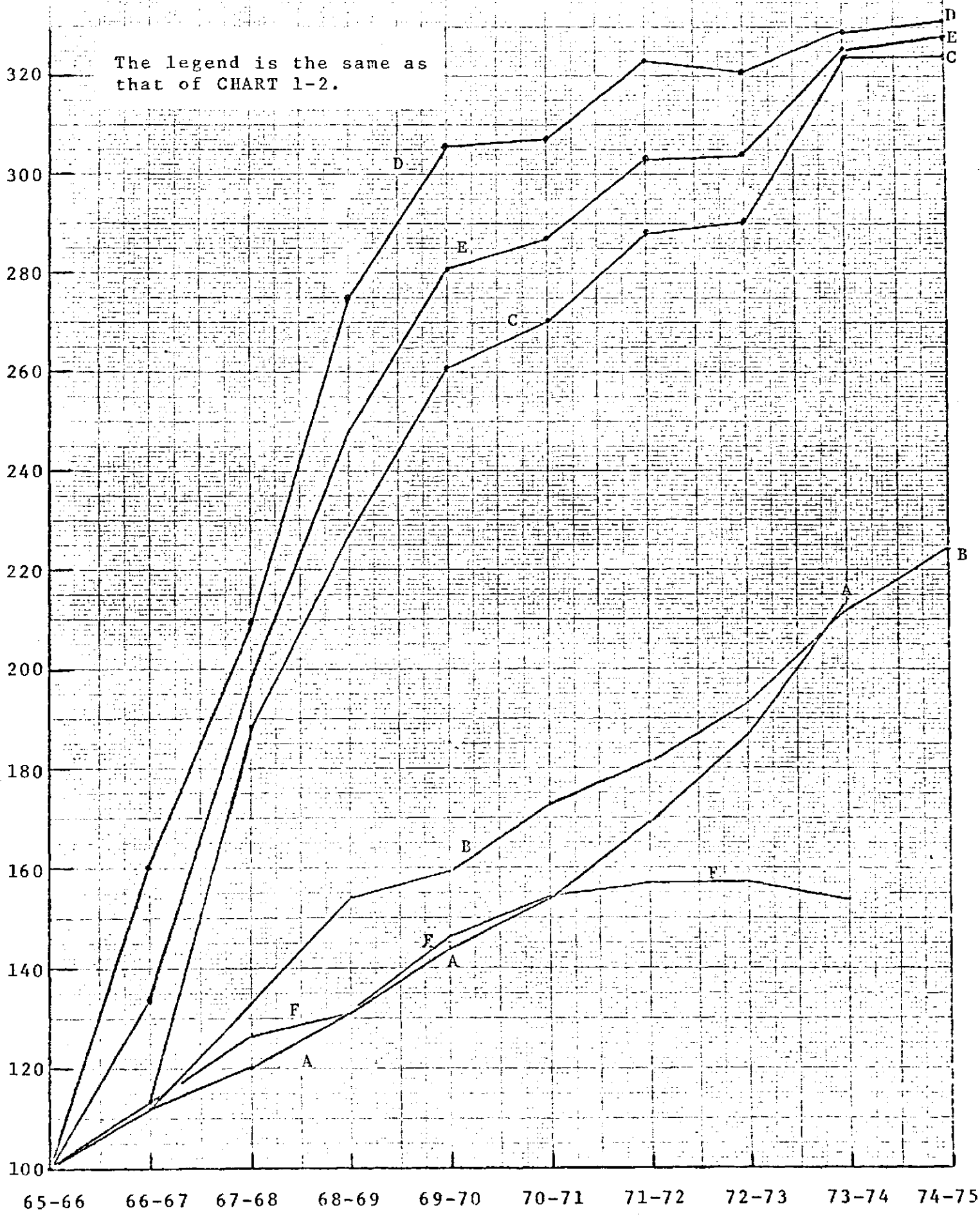
The legend is the same as that of Chart 1-2.



Comparison of Growth of GNP, Federal Expenditures on R&D  
in Canada and University and College Enrolment

1965-66 to 1974-75

ART 1-4

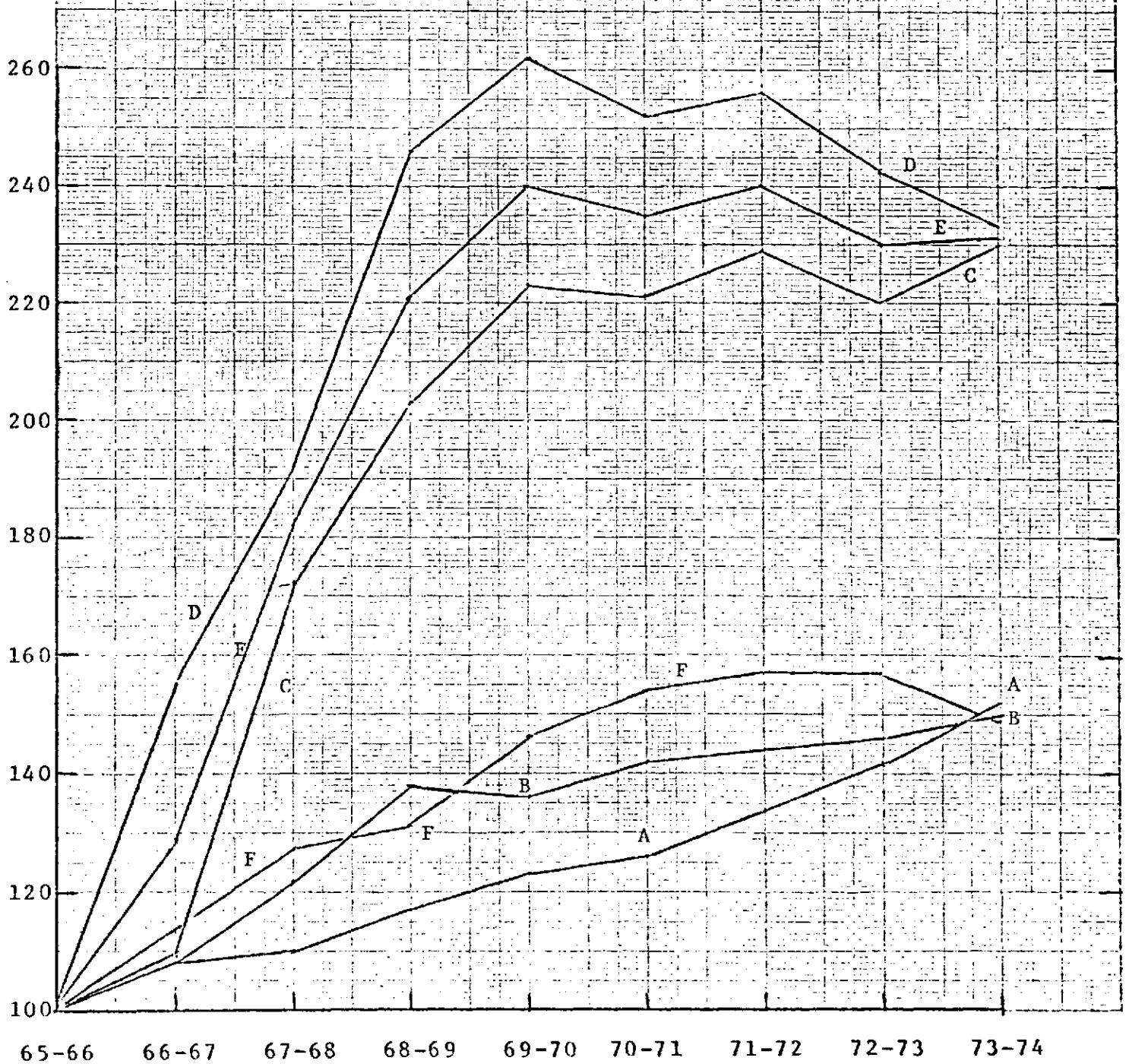


Comparison of the Growth Rates of GNP, Federal Expenditures on R&D in Canada (adjusted by Implicit GNE Deflator<sup>1</sup>) and University Enrolment 1965-66 to 1973-74

RT 1-5

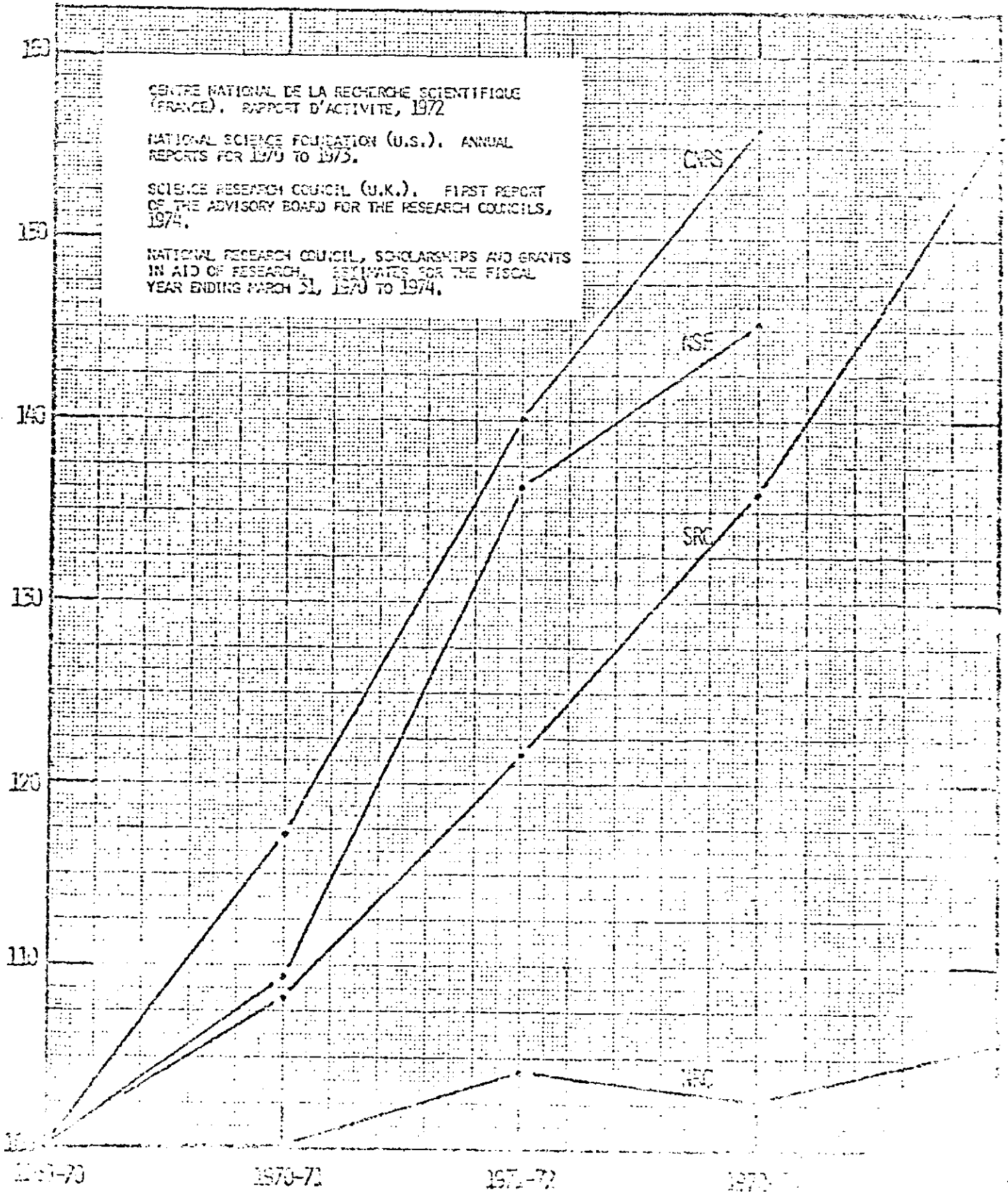
<sup>1</sup>Department of Finance, Economic Review, April, 1974.

The legend is the same as that of Chart 1-2.



COMPARISON OF GROWTH RATES OF EXPENDITURES BY AGENCIES  
SUPPORTING UNIVERSITY RESEARCH IN FRANCE, U.S.A., U.K., AND CANADA  
1969-70 TO 1973-74

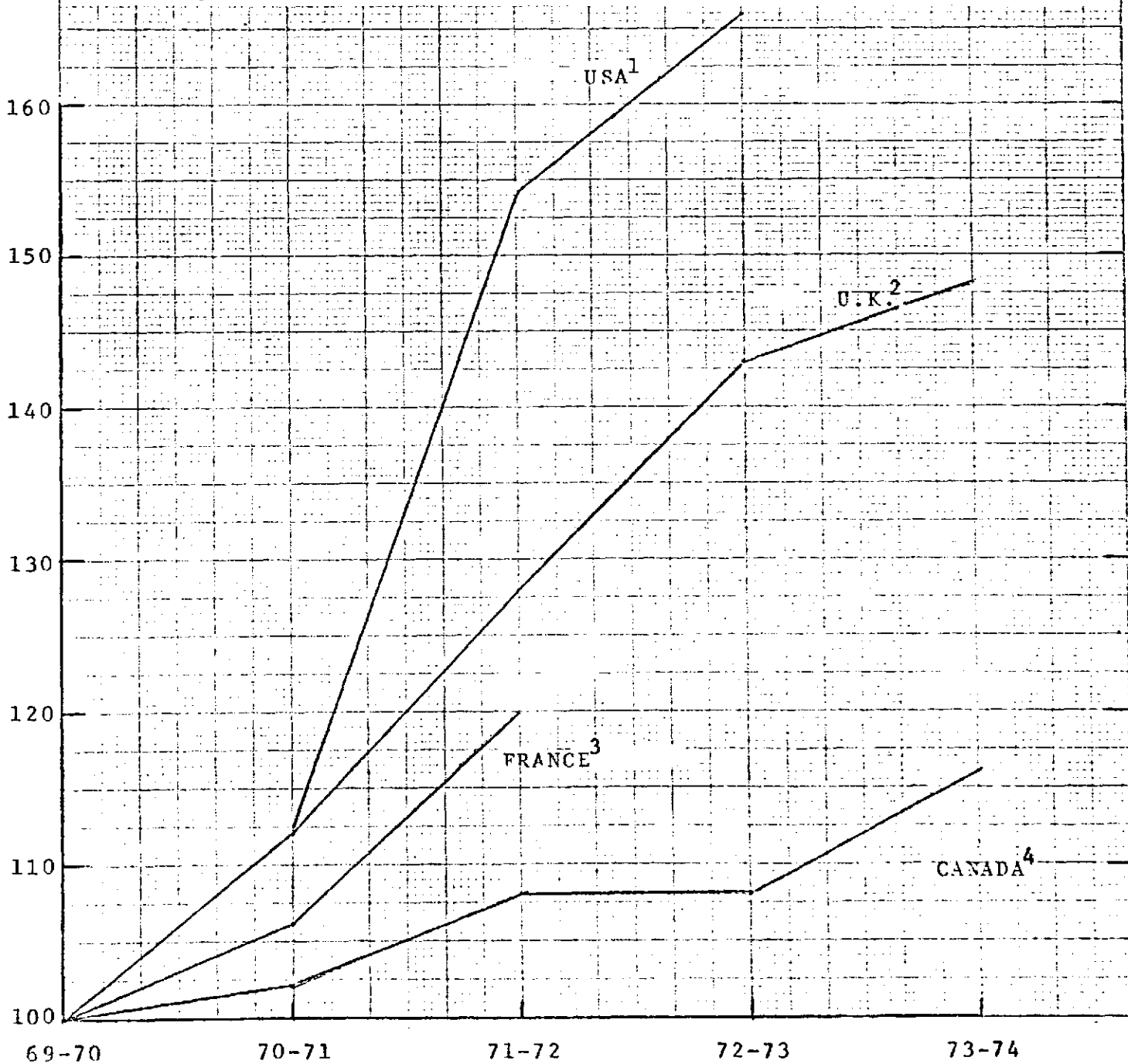
1969-70 = 100



INTERNATIONAL COMPARISONS

Comparison of the Growth Rates of Expenditures  
in Support of R&D in Universities and Non Profit Institutions  
in France, USA, UK and Canada  
1969-70 to 1973-74

- 1 Support of scientific research projects by the National Science Foundation. Source: National Science Foundation Annual Reports 1971 and 1973.
- 2 Total science budget. Source: First Report of the Advisory Board for the Research Councils, Cmnd. 5633.
- 3 Overall state expenditure on university research in the natural sciences. Source: 1972 - France, Science Research and Development, Eurofab-Engineering.
- 4 Federal support of R&D in the natural sciences in universities and non-profit institutions. Source: Statistics Canada, 1974 Survey of Federal Government Activities in the Natural Sciences.



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INTERNATIONAL COMPARISONS

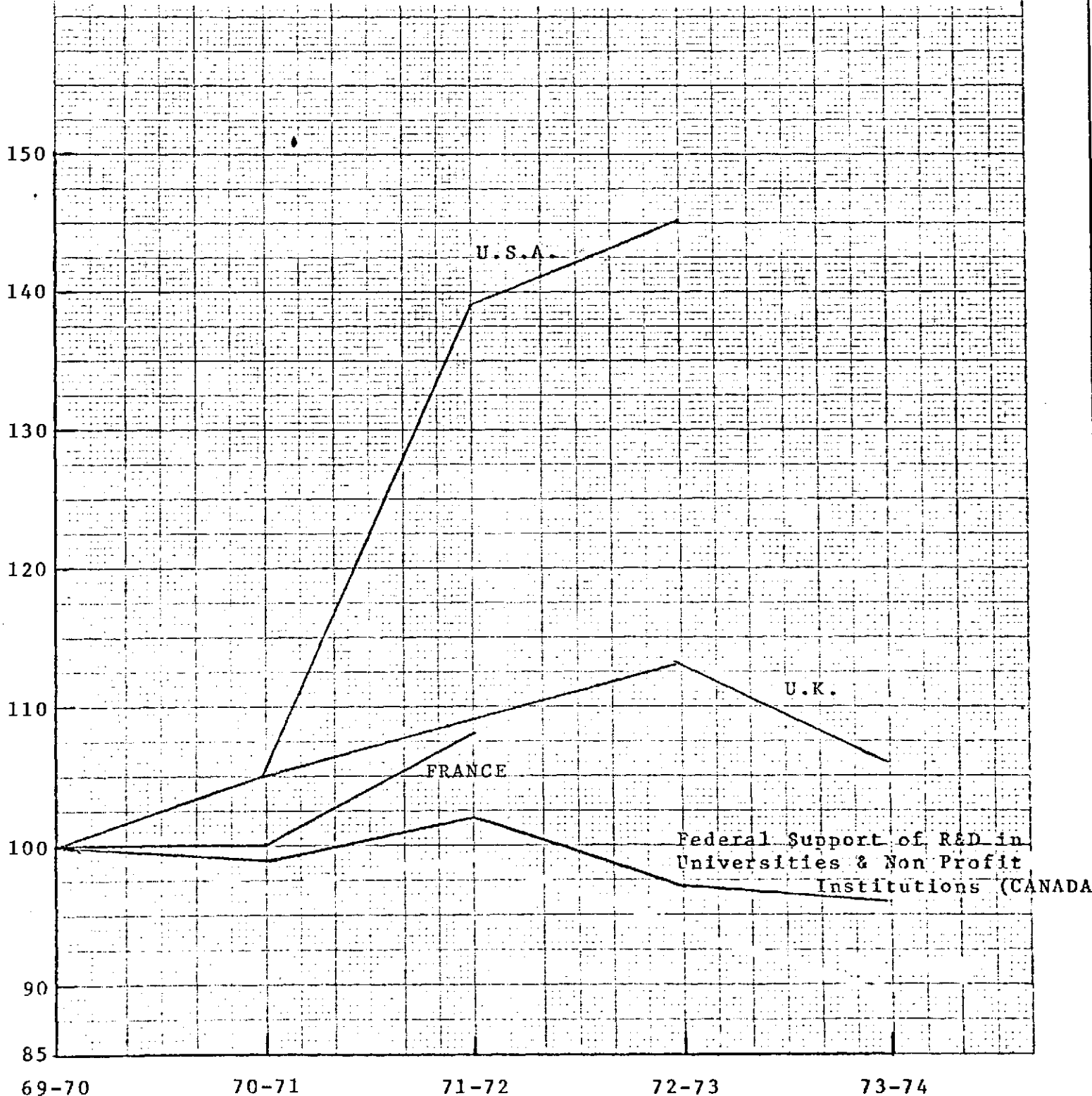
ART 2-3

Comparison of the Growth Rates of Expenditures  
in Support of R&D in Universities and Non Profit Institutions  
in France, USA, UK and Canada  
1969-70 to 1973-74

(1969-70 equals 100 and  
figures adjusted by national Consumer Price Index)

Consumer Price Indices are the average for the calendar year  
corresponding to the first part of the fiscal year. Source:  
Economic Review, Department of Finance, April 1974.

The legend and notes are the same as those of Chart 2-2.



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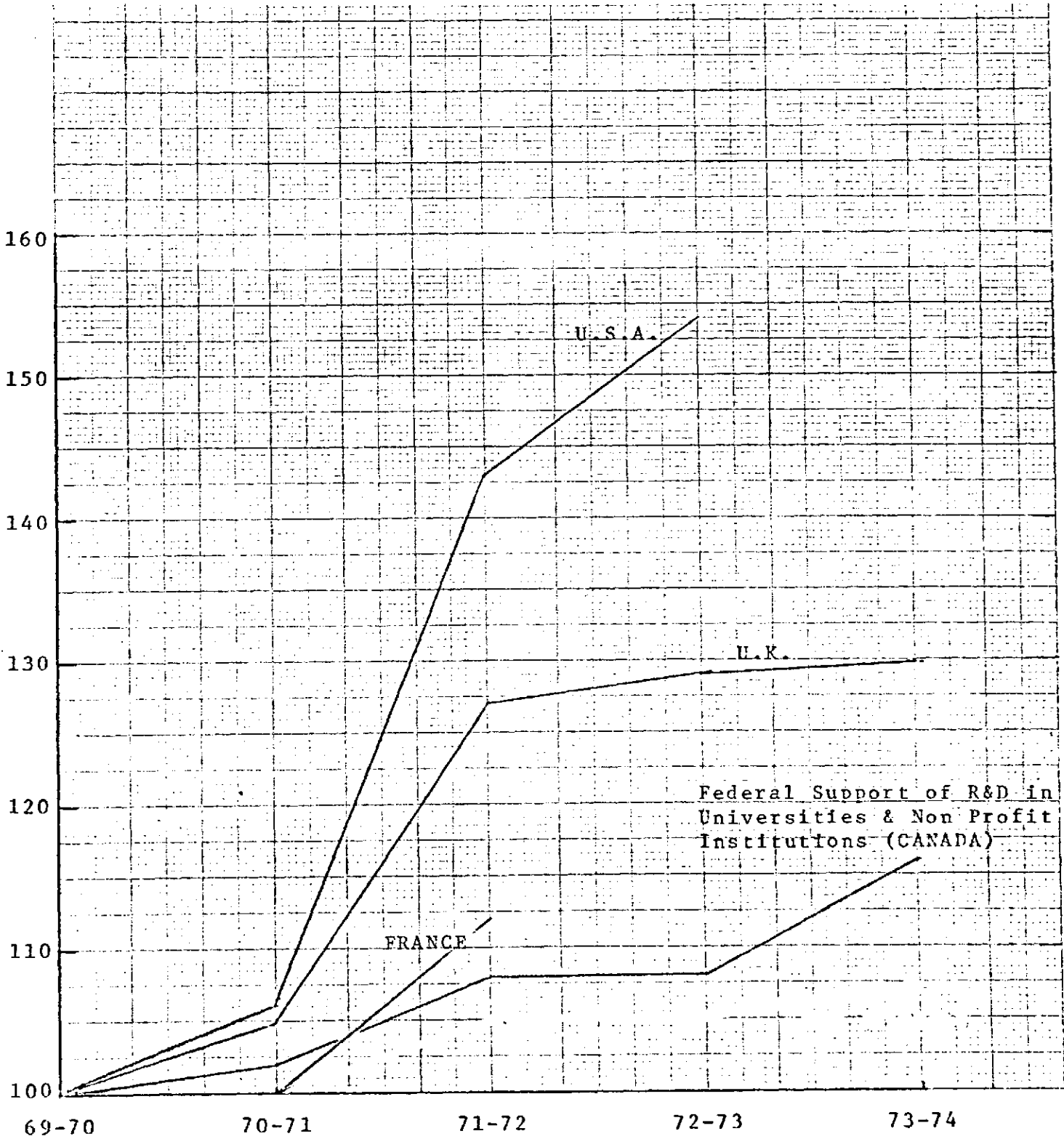
INTERNATIONAL COMPARISONS

Comparison of the Growth Rates of Expenditures  
in Support of R&D in Universities and Non Profit Institutions  
in France, USA, UK and Canada  
1969-70 to 1973-74

(1969-70 equals 100 in Canadian Currency)

Exchange rates are the average for January of the calendar year  
corresponding to the last part of the fiscal year. Source:  
Economic Review, Department of Finance, April 1974.

The legend and notes are the same as those of Chart 2-2.



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INTERNATIONAL COMPARISONS

Comparison of the Ratio of Expenditures in Support of R&D in Universities and Non Profit Institutions/Enrolment in Universities and Colleges in France, USA, UK and Canada 1969-70 to 1972-73

(1969-70 equals 100 and figures are adjusted by national Consumer Price Index)

Expenditure figures are those expressed in Chart 2-3.

Enrolment are national totals.

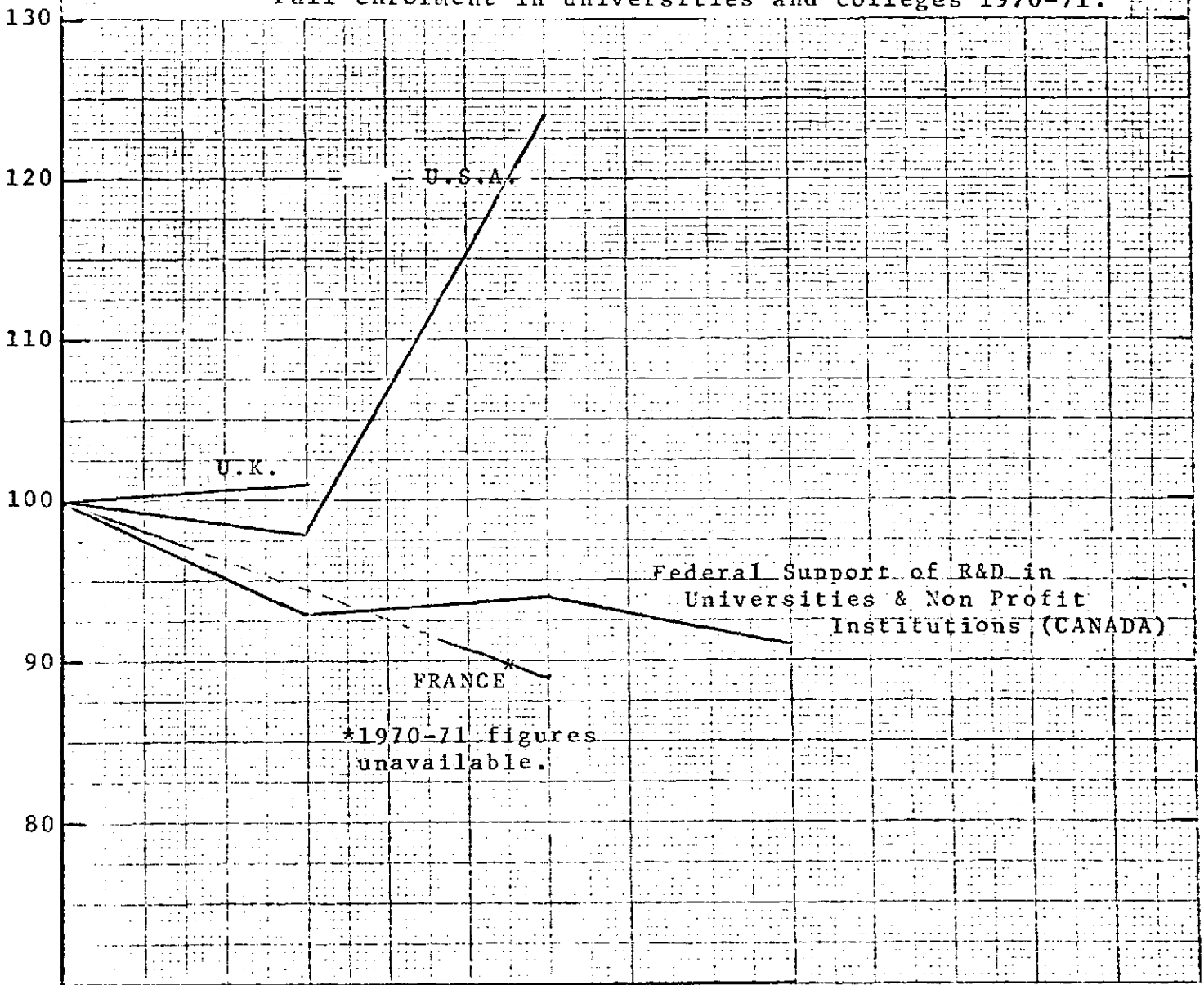
Sources:

U.S.A.; 1973 Statistical Abstract, U.S. Office of Education "Institutions of Higher Education".

U.K.; Education in Britain BIS R4751/71, Universities in Britain BIS R5520/73.

France; Documentation française, actualité de service, Government Information Service.

Canada; Statistics Canada publications, Advanced statistics of education 1971-72 and 1973-74, and Fall enrolment in universities and colleges 1970-71.



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U.S. GOVERNMENT PRINTING OFFICE: 1973

Chart 3-1

## Federal Expenditures 1969-70 to 1974-75

	1969-70		1970-71		1971-72		1972-73		1973-74		1974-75		Change 1969-70 to 1974-75 (%)
	\$ Millions	(%)	\$ Millions	(%)	\$ Millions	(%)	\$ Millions	(%)	\$ Millions	(%)	\$ Millions	(%)	
Budgetary Estimates <sup>(1)</sup>	12,140	(100.0)	13,471	(100.0)	15,195	(100.0)	16,548	(100.0)	20,080	(100.0)	22,023	(100.0)	+81.4
Scientific Activities <sup>(2)</sup>	700	( 5.8)	777	( 5.8)	836	( 5.5)	920	( 5.6)	1,010	( 5.0)	1,066	( 4.8)	+52.3
R&D <sup>(2)</sup>	539	( 4.4)	588	( 4.4)	615	( 4.1)	655	( 4.0)	722	( 3.6)	760	( 3.5)	+41.0
R&D in Canadian Universities and non-profit organization <sup>(2)</sup>	116	( 0.96)	119	( 0.88)	125	( 0.82)	126	( 0.76)	135	( 0.67)	136	( 0.62)	+17.2
NRC Grants and Scholarships <sup>(3)</sup>	64.8	( 0.53)	64.8	( 0.48)	67.5	( 0.44)	66.5	( 0.40)	68.6	( 0.34)	69.3	( 0.31)	+ 6.9
R&D in Canadian Industry <sup>(2)</sup>	110	( 0.91)	144	( 1.1 )	139	( 0.91)	146	( 0.88)	167	( 0.83)	168	( 0.76)	+52.7
Federal in-house R&D <sup>(2)</sup>	307	( 2.5 )	320	( 2.4 )	342	( 2.3 )	370	( 2.24)	400	( 2.0 )	426	( 1.9 )	+38.8

(1) Estimates for the Fiscal Year Ending March 31, 1975.

(2) Statistics Canada, 1974 Survey of Federal Government Activities in the Natural Sciences.

(3) NRC University Grants and Scholarship Program; a Perspective 1969-70 to 1974-75.

