ECONOMIC AND BUDGETARY ASPECTS OF THE SUPERCONDUCTING SUPER COLLIDER

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This Staff Memorandum analyzes aspects of the economic spinoffs from previous particle accelerator efforts and outlines the current budgetary and fiscal potential of alternative sources of financing for the Superconducting Super Collider (SSC) in the United States. The first section reviews a study published by the European Organization for Nuclear Research (CERN) on the economic and commercial spinoffs of their particle accelerator program in Geneva, Switzerland. (CERN is the major European Community scientific competitor of the U.S. high-energy physics program.) The section outlines CERN's methodology and conclusions and discusses the applicability of the study to U.S. circumstances.

The second and third sections of the memorandum discuss alternative sources of funds for the U.S. particle accelerator program. The second section focuses on the costs to state governments of contributing to the SSC and places these costs in the context of the states' current indebtedness and their current revenue-raising efforts. (The section does not address the question of the appropriateness or the desirability of a formal state contribution or the precedent such an action might set. Nor does the section address the question of how much weight, if any, the Congress might wish to place on the willingness of any individual state to contribute in the site selection process now underway.1/) The third section looks at potential foreign donors to see how the SSC might fit into their high-energy physics budgets.

ECONOMIC SPILLOVERS FROM CERN

In 1984, CERN published a report on the economic spillover effects of its high-energy physics program.2/ This study (referred to as the

1. The Congress instructed the U.S. Department of Energy not to consider financial incentives in its site selection process.

2. M. Bianchi-Streit and others, Economic Utility Resulting from CERN Contracts (Second Study) (Geneva, Switzerland: European Organization for Nuclear Research, 1984). This study is independent of an earlier study, which covered similar topics

CERN Contracts Study) concentrated on the secondary economic effects of the procurement contracts let by CERN. The study's intention was to determine whether firms that sold high-technology goods to CERN experienced subsequent increases in non-CERN sales. The CERN Contracts Study concluded that CERN contracts generated three francs in non-CERN sales for every franc in CERN sales. The following sections show that the study substantially overstates the added value of CERN contracts to the economy, although not to the firms involved, and that, largely because of differences in technology, many of the report's conclusions may not be applicable to the United States.

Summary of the CERN Contracts Study

The CERN Contracts Study broke the economic effects of CERN into three categories: primary economic effects, secondary effects, and multiplier effects. The CERN Contracts Study focuses on neither the primary economic nor the multiplier effects.3/ Instead, it concentrates on the secondary effects, which are the benefits that come to the firms providing high-technology equipment under contract to CERN.4/

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for an earlier period. The Congressional Budget Office did not analyze the first study.

3. The primary category is the economic usefulness of the research results themselves. In the case of CERN or the U.S. Superconducting Super Collider (SSC), the research results are not expected to pay for themselves economically for decades, if ever. While early economic use of these results would be welcome, these projects are being undertaken purely for knowledge and any other use of the results should be considered fortuitous. The multiplier effects simply refer to a macroeconomic multiplier, which results from all government purchases of goods and services. These would be roughly the same whether the government were building a highway or a particle accelerator.

4. The CERN Contracts Study did not examine what may be the largest spinoff of pure research projects: the training of the next generation of scientists. Graduate students working on these projects are often unable to find academic jobs, and may therefore move into industry where much of their training may be useful. See Leon M. Lederman, "The Value of Fundamental Science," Scientific American (November 1984), pp. 40-47. However, this training would occur at any basic research site. In the case of the SSC, where the marginal dollar may very well come from other basic research, this effect may not result in any net benefit to the economy. In fairness to the CERN Contracts Study staff, they acknowledged that quantifying

The CERN Contracts Study used a straightforward methodology: 160 sample high-technology firms that received CERN contracts during the 1973-1982 period were asked how much in additional sales the CERN contracts had generated or would generate during the 1973-1987 period. (Since interviews for the study were conducted between May of 1982 and June of 1984, a substantial portion of the stated gain in sales was, in fact, a forecast.) While the questions asked covered a range of topics--such as how CERN contracts affected management practices, quality control, research and development, and production techniques--the heart of the questioning related to additional sales. For instance, a manager had to estimate how much CERN contracts had improved production techniques and then estimate how much the improved production techniques had increased, or would increase, sales by 1987. Furthermore, the answers were to be focused only on markets relevant to CERN. For example, unless specifically affected, consumer goods divisions of CERN contractors were excluded from the survey. While the survey intent was straightforward, the range of questions was complex enough to minimize deliberate exaggeration by the contractors.

Once tabulated, the results were screened for irregular data before being extrapolated to the universe of 519 high-technology CERN contractors.5/ The raw data results suggested that each franc in CERN sales produced 4.2 francs in added sales. Especially in the electronics, optics, and computer industries, however, there were outliers: here the CERN franc produced 7.2 francs. The extrapolated results were tabulated by sector (see Table 1). As noted above, the net corrected benefit of each CERN franc to recipient firms was 3 francs.6/ This spillover is to the high-technology suppliers exclusively, since they were the focus of the CERN study.

The CERN Contracts Study staff performed an additional test to determine the overall accuracy of the managers' sales forecasts. The study included 40 firms that had participated in an earlier study that used the same method. Comparing the forecasts made by these

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the secondary effects completely was impossible.

5. Of CERN's 6,000 suppliers, the CERN Contracts Study classified 519 as "high technology," although the study did not define this term. The subsequent tabulations included steel and welding, which are not often classified as high technology.

6. Among the other factors the CERN Contracts Study staff adjusted for was the effect of the CERN contracts prior to 1973. They assumed that non-CERN contracts won by CERN contractors during 1973-1975 resulted from previous CERN work and should not be counted in the 1973-1982 total. Such contracts turned out to be 15 percent of the total.

TABLE 1. CERN AND SPILLOVER SALES BY INDUSTRIAL CATEGORY
(In millions of 1977 Swiss francs)

	Electronics, Optics, Computers	Electrical Equipment	Vacuum, Cryogenics, Super-conductivity	Steel and Welding	Precisions Mechanics	Total
Net New Sales	2,245	1,025	400	255	155	4,080
CERN Sales	537	472	152	104	111	1,378
Ratio of Net New Sales to CERN Sales	4.7	2.2	2.6	2.4	1.4	3.0a/

SOURCE: CERN Contracts Study, p. 16.

NOTE: Details may not add to totals because of rounding.

a. Average of ratios.

firms' managers with the subsequent actual events indicated that, while individual forecasts were often wrong, the aggregate forecast was close to the actual aggregate. Tests suggested the differences between actual and forecasted sales were not statistically significant.

The CERN Contracts Study staff took this to mean that, on average, managers' forecasts would prove to be accurate.

Assumptions

The central, and perhaps flawed, assumption of the CERN Contracts Study is that 100 percent of the sales of CERN contractors are new sales to the economy; that is, these sales do not come at the cost of fewer sales going to firms that do not have CERN contracts. The CERN Contracts Study provides some supporting arguments for this 100 percent "additionality" assumption. It is nevertheless an assumption, and to the extent it is incorrect, CERN is merely rearranging sales rather than creating new sales. While such a rearrangement of sales is of great benefit to the firms doing the actual work, from a public policy perspective the question naturally arises of why a public agency, whether CERN or the U.S. Department of Energy, should spend money in order to shift sales to one favored group of firms. The following paragraphs discusses the CERN Contracts Study assumption and how it is contradicted throughout the study itself.

While the assumption of 100 percent additionality has some merit, it is given no statistical or anecdotal support in the study. It is a polar assumption in the sense that it is at the extreme end of the range of possibilities. At the other end of the range is the assumption that CERN contracts generate no additional sales in the aggregate and that the CERN contractors are merely diverting sales that would have gone to other firms.7/ This second polar assumption is the more conventional one, and thus the burden of proof lies with the CERN Contracts Study.

CERN Contracts Study staff argue that their assumption holds for two reasons:8/

- The relevant markets are growth markets, so no firm is actually taking sales from other firms.

- CERN buys only leading-edge products in these markets,

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7. An even more extreme position would argue that if the government crowded out private investment in the credit markets, CERN research and development spending would reduce the funds available for private investment and so reduce aggregate contracts.

8. CERN Contract Study, p. 5.

and, by improving the quality of its suppliers, forces the competitors to improve also.

The first argument ignores the concept of baseline rates of growth. If a market is growing independently of CERN sales, then firms in those markets should expect to see sales growth. Investors in these firms would normally regard the failure to grow as indicative that something was wrong with the firm's management, product mix, or marketing. While no European firm may lose sales to CERN contractors in an absolute sense, CERN contracts may very well depress sales growth of non-CERN contractor firms.

The second argument is simply overstated. Not every piece of equipment in CERN's laboratories leads the state of the art in its particular field. There will be certain components that are completely novel and other components that have substantial modifications and improvements. But to argue that CERN is simultaneously providing leadership in all aspects of the high technology it touches is to ignore the incremental and cumulative nature of scientific advance.9/ Like the first argument, this argument ignores improvements in technology that are occurring independently of CERN.

The assumption of 100 percent additionality is also regularly contradicted in the study. One of the major benefits the study claims for being a CERN contractor is that it can use CERN as a reference. The study cites one case where a firm used its CERN contracts as the basis for admission to a trade association, "and, as a result, was able to obtain an increased number of [non-CERN] contracts."10/ The use of CERN as a reference for admission to a trade association, however, suggests a rearrangement rather than an expansion of sales. An expansion would come from the introduction of new products or from cost reduction.

In another example cited by CERN, a small firm that supplied CERN with "standard, but specialized, hydraulic equipment" became the industry standard, increasing sales and exports. While there may be some increase in sales due to the benefits of standardization--consumers benefit by not having to compare and choose among competing equipment standards--these are offset by sales lost by the

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9. In the United States, many government programs involving high technology are not at the leading edge of their particular field. For instance, U.S. military systems lag commercial systems by two to seven years in integrated circuit usage, see Office of the Under Secretary of Defense for Acquisition, Very High Speed Integrated Circuits, Annual Report for 1986 (VHSIC Program Office, December 31, 1986), p.14.

10. CERN Contracts Study, p. 11.

purveyors of alternative standards.11/ In this case, therefore, there will be some net gain in aggregate sales, but there will also be some losses for other providers of standard, but specialized, hydraulic equipment, showing that sales are once again being redistributed.

In sum, CERN probably has, by pushing technology forward, increased aggregate sales in high-technology products. However, there is no supporting evidence offered for, and a substantial amount of evidence against, the assumption that all or any substantial portion of the new sales obtained by CERN contractors were not diverted from firms without CERN contracts.

Applicability to U.S. Circumstances

Is there reason to believe that the circumstances of the U.S. high-technology industries are substantially different from their European counterparts? Furthermore, are the circumstances of the SSC contracting substantially different from the circumstances of the CERN contracting? If the answer to both of these questions is yes, then CERN Contracts Study results may not be applicable to the SSC.

High-Technology Industry. In their justification of the additionality assumption, the CERN Contracts Study staff argued that it is "an efficient mechanism for keeping European industry abreast of international competition."12/ Simply put, the argument is that CERN contracts allow European suppliers to keep up with U.S. and Japanese suppliers of electronic goods and other high-technology products. The U.S. industry is in a very different position. While U.S. high-technology industries have lost part of their competitiveness to Japan's and other countries' high-technology industries, these losses have occurred to a large extent among products of lower technical sophistication, such as consumer products.

The microcomputer market is a case in point. (The emphasis is on the electronic and computer goods industries because over half of the added sales measured by CERN Contracts Study staff occurred in electronics, optics, and computers. See Table 1.) Imports to the United States from Korea and other newly industrialized Asian countries consist mainly of less sophisticated IBM-compatible personal computers. IBM, Compaq, Apple, SUN, and other U.S. companies still control the more technologically advanced segment of

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11. These losses could be magnified if the "wrong" standard, that is, one that forecloses or distorts future technology development, is chosen. See Paul David, "Some New Standards for the Economics of Standardization in the Information Age" (Stanford, CA.: Center for Economic Policy Research, October 1986), CEPR Publication No. 79.

12. CERN Contract Study, p. 5.

that market. Since scientists and technicians working on particle accelerator physics need the best equipment available, in the field of microcomputer technology they will be pushing for advances in the segment of the market the United States already dominates. Of course, not all markets divide as neatly as the microcomputer market: Japan, for instance, has made substantial inroads into leading-edge semiconductor and semiconductor manufacturing equipment markets.

One of the benefits of CERN contracts mentioned in the study is that they help small firms to export to other European Community nations. The barriers to interstate commerce in the United States are nowhere near as high as they are in Europe. U.S. industries share legal traditions and systems, language, professional and trade journals and magazines, and trade associations. Given this lack of internal barriers, small firms in the United States should need little help to ship elsewhere in the United States.

Procurement. Procurement of high-technology components for the SSC in the United States may differ from that for CERN in two major ways. First, it is quite possible that some of the main components, such as the magnets or the detectors, may be built and donated by foreign contributors. If so, the economy of the nation actually building those components will benefit, not necessarily the U.S. industry. In this regard the Congress faces a dilemma. If it pays for the whole project, the costs may be prohibitive. On the other hand, the major international interest in contributing financially has been expressed in precisely those areas, the superconducting magnets and the detectors, where spinoffs for contractors, whether through new products or reduced costs, are most likely.

The second way in which procurement for the SSC may differ from CERN procurement is that the market for superconductors is about to change dramatically. The development of high-temperature superconductors may make the market for superconductors much larger. At the same time, it may change many of the skills needed in handling superconductors. For instance, it is much less difficult to work with liquid nitrogen than with liquid helium. Consequently, much of the expertise required for current superconductors may become superfluous. It is too early to tell whether market presence in the low-temperature superconductor market will be of benefit in the emerging high-temperature superconductor market. For instance, none of the major vacuum tube makers successfully made an early transition into semiconductor manufacturing, despite the similarity of uses. Since $1.2 billion (in fiscal year 1986 dollars) allocated to the SSC is being spent on the superconducting magnets and associated infrastructure, a substantial portion of the high-technology components of the SSC may quickly become commercially obsolete and hence produce very few spinoffs.13/ On the other hand, they may

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13. SSC Central Design Group, Conceptual Design of the Superconducting Super Collider (September 1986), p. 697.

not. In rapidly changing circumstances, it is inappropriate to extrapolate from studies made under conditions of more stable evolution.

SOURCES OF FUNDING IN THE UNITED STATES

The process of selecting the site for the SSC in the United States is currently well underway. After examining submissions by many states regarding their geological, infrastructure, and educational resources, the National Academy of Sciences site selection panel chose eight finalist states.14/ After one state, New York, withdrew its application, seven were left: Arizona, Colorado, Illinois, Michigan, North Carolina, Tennessee, and Texas. The Department of Energy (DOE) is conducting further studies, including a study of environmental impact, to determine which state provides the best combination of qualities for the SSC site. Later this year the Secretary of Energy is expected to recommend a single state to the President.

The Administration currently projects that the SSC will cost $5.3 billion to build. The desire to reduce the federal costs of the SSC has raised questions regarding possible financial contributions from the state government for the construction of the SSC, although the Congress directed the DOE to ignore possible state financial contributions to the construction of the SSC in its selection process. The following discussion outlines the costs of contributing to the construction of the SSC and the limits on states' capacities to contribute. Alternative measures of state revenue-raising capacity are then discussed. Ultimately, however, the funding decision is political, not technical: do the people and government of the designated state want to spend their limited resources on the SSC?

The Cost of Debt

The states could incur substantial costs in helping to pay for the SSC, depending on the amounts contributed. As with other capital expenses, a designated state is likely to pay for its contribution with long-term debt as a means of spreading the cost of its contribution over a long period. This section discusses the cost to the states of issuing $1 billion in debt.

A $1 billion bond issue to pay for the SSC would cost a state between $105 million and $109 million per year in debt service. This analysis assumes that SSC bonds will be amortized over 20 years. The interest rate will be between 0.5 and 1.0 percentage points below the Congressional Budget Office's (CBO) 1989 forecast of 9.5 percent

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14. National Academy of Sciences, Siting the Superconducting Super Collider (Washington, D.C., 1988), p.1.

for the 10-year U.S. Government note.15/ The finalist states have good credit ratings, and it would serve little purpose to attempt to differentiate the interest rates each might have to pay on a hypothetical bond.

The annual cost per capita of SSC bonds would vary between a low of $6.50 in Texas and a high of $33 in Arizona, because of Texas' larger population. This would represent 0.05 and 0.27 percent, respectively, of before-tax personal income in those states. (See Table 2 for a listing of all the states.)

State general obligation bonds and most state revenue bonds are exempt from federal taxes. Consequently, when states issue bonds the federal government forgoes some income. In the case of bonds to pay for the SSC, the assumption must be made either that SSC bonds would increase the aggregate number of bonds the state in question is issuing, or that they would merely substitute for other functions the state might perform. If a state decides not to increase its indebtedness, but rather decides to reduce other services in order to contribute to the SSC, then the state's contribution may not cause any new revenue losses for the federal government. On the other hand, if the state decides to expand its services to include the SSC and must increase its debt and taxes to do this, then there is the potential of increasing federal revenue losses.16/ A state could also finance its contribution through a mixture of some new indebtedness and some reduction of other projected debt. It is impossible to know how states will act in this regard. Consequently, the results of any revenue loss calculations should be considered as upper bounds and not necessarily the most likely occurrence.

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15. Congressional Budget Office, The Economic and Budget Outlook: Fiscal Years 1989-1993 (February 1988), p. 41. For purposes of simplicity, this analysis do not include the effects of call and other such provisions on the valuation of the bonds. This analysis also assumes there are no costs attached to floating the bond, other than the interest and principal payments. Because state public purpose bonds have been exempt from federal taxes, state general obligation bonds have offered an interest rate that averaged 1.7 percentage points below the 10-year Treasury bill rate during the 1980s. Since tax reform, the difference has decreased: it was 0.7 percentage points in 1987.

16. For the sake of computational simplicity, this argument ignores the effect SSC bonds might have on the interest rates of other tax-exempt state and local bonds. SSC bonds would represent only a small fraction of total state issues. In 1986, for instance, states and local governments issued $142 billion worth of tax-exempt bonds, see The Bond Buyer, 1987 Yearbook (American Banker-Bond Buyer, 1987), p. 11.

TABLE 2. COST OF $1 BILLION OF SSC BONDS

State	Annual Cost per Capita (In dollars)		Share of Personal Income (In percents)	
	At 8.5 Percent	At 9.0 Percent	At 8.5 Percent	At 9.0 Percent
Arizona	31.61	32.77	0.26	0.27
Colorado	32.09	33.77	0.22	0.23
Illinois	9.07	9.41	0.06	0.06
Michigan	11.46	11.88	0.08	0.09
North Carolina	16.56	17.17	0.14	0.15
Tennessee	21.83	22.63	0.20	0.20
Texas	6.28	6.52	0.05	0.05

SOURCE: Congressional Budget Office, calculated from Bureau of the Census, State Government Finances in 1986 (October 1987), p. 56.

NOTE: Cost assumes $1.0 billion amortized over 20 years at 8.5 percent and 9.0 percent rates of interest, with semiannual interest payments.

Over the life of the bonds, the states would pay between $1.1 billion and $1.2 billion in interest income. Assuming the investors are in the 28 percent tax bracket, the federal government could forgo as much as $307 million to $328 million in tax revenues in order to receive a $1 billion contribution from the state. The present value of these losses would vary with the discount rate.17/ At a 5 percent discount, the present value would range between $210 million and $230 million. At a 10 percent discount, the present value would range between $160 million and $170 million.

State Constitutional Limitations on State Borrowing

Each state's constitution defines how much general obligation (GO) debt (backed by the full faith and credit of the state) the state government can incur and under what conditions.18/ These terms vary widely among states. The principal types of limitations include limits on amounts, requiring referendums or extraordinary majorities in the state legislatures (usually 60 or 66 percent) if the limit is to be exceeded. Consequently, in most states, issuing GO debt is time-consuming and difficult.

In response to these limitations to GO debt, state agencies have devised alternative debt instruments, which do not technically encumber the state credit yet provide lenders with access to a relatively secure stream of funds from state activities. These alternative instruments have much less stringent authorization requirements. In many cases, a simply majority in the state legislature (coupled occasionally with approval by a state treasurer or bond board) will suffice for authorization. Often, these alternative debt instruments come in the form of revenue bonds or certificates of participation in lease purchase agreements and are used to pay for a wide variety of capital construction projects. For example, in one instance a state issued certificates of participation to build a prison. The state would lease the prison and, through the lease payments, repay the debt. While technically not an encumbrance to the state income (if the state did not need the prison, it was only held by the

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17. While the Congressional Budget Office forecasts a 9.5 percent interest rate for the 1989 10-year federal government bond, these high interest rates may not hold for the entire 20 years of losses. Therefore, this analysis uses a range of discount rates reflecting both CBO and Administration forecasted interest rates over the next few years.

18. This discussion is largely taken from the Advisory Commission on Intergovernmental Relations, Significant Features of Fiscal Federalism, 1988 Edition, Volume I (December 1987), pp. 102-103.

terms of the lease), the state was not likely to end the lease.19/ Similarly, revenue bonds are usually paid for by the stream of revenue coming from a project, not directly through state coffers.

As can be seen from Table 3, these alternative debt instruments have come to represent the majority of state debt. The highest level of GO debt (as a percentage of all debt) is in Tennessee, at 40 percent. Other states have lower figures, and two states cannot issue long-term GO debt at all.

CBO has found two finalist states that are currently authorized to issue debt for the SSC. The Texas state government is authorized to issue $500 million in GO debt and $500 million in revenue bonds should Texas be selected as the site. The State of Illinois is authorized to issue $180 million in GO debt.20/ These two states, however, may not be unique in their willingness to incur debt for the SSC: other states may merely be paying for SSC-related improvements, such as access roads, water and the like, through their highway and water works bond issues.

Measures of Revenue-Raising Capacity

The Advisory Commission on Intergovernmental Relations (ACIR) developed two types of measures of states' fiscal capacity in a recent report (referred to as ACIR Fiscal Capacity Report).21/ The first type measures the taxpayers' ability to pay taxes and other levies; the second measures the state governments' ability to collect revenues. The first approach depends on macroeconomic variables, such as state personal income, while the second looks at statutory tax or revenue bases, such as retail sales. This discussion concentrates on the second approach.

The central capacity concepts used in this section are the Representative Tax System (RTS) and the closely-related

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19. On the other hand, most states have balanced budget requirements. Shifting from capital accounts to ordinary spending accounts could run into other limits.

20. In late February, Governor Thompson proposed $539.3 million in bond funds for the SSC and the legislature could increase the authorization.

21. This section is largely derived from the Advisory Commission on Intergovernmental Relations, Measuring States Fiscal Capacity, 1987 Edition (December 1987). The purpose of examining these measures is not to bias the site selection process, but rather to examine the general fiscal capacities of the states and the indicators used to measure them.

TABLE 3. STATE GOVERNMENT LONG-TERM INDEBTEDNESS, FISCAL YEAR 1986

	Total	Type (In millions of dollars) General Obligation	Other	Per Capita (In dollars)	Percentage of Personal Income
Arizona	1,472	0	1,472	444	3.6
Colorado	1,998	0	1,998	612	4.2
Illinois	11,979	3,758	8,221	1,037	7.0
Michigan	7,050	622	6,428	771	5.7
North Carolina	2,593	768	1,826	410	3.6
Tennessee	1,978	753	1,225	412	3.7
Texas	5,432	1,970	3,462	326	2.5

SOURCE: Bureau of the Census, State Government Finances in 1986, (October 1987), pp. 34 and 56.

NOTE: Details may not add to totals because of rounding.

Representative Revenue System (RRS). These measures start with the commonly used statutory tax and revenue bases (such as retail sales), and weight these by national average tax rates. Included in the RTS are general sales taxes, selective sales taxes, licenses, personal income taxes, corporate net income taxes, and property taxes. The RRS adds to the RTS by also including nontax revenue sources, most notably user charges.22/

These are conventional measures, representing national averages. Individual states, because of their political histories and citizens' preferences, may have tax rates far above or below the average or "representative" rates used by ACIR.23/ While this analysis may refer to one or another state as being above or below the average or representative tax rate, this does not imply a judgment about the desirability of movement toward the average. Because the RTS and RRS are derived from statutory bases they will not capture all the potential sources of state revenue and income. However, it is unlikely that financing for the SSC will be a motivating factor for major breakthroughs in state financing. On the other hand, states with current high levels of taxation may be perceived as worse risks by bond rating agencies if they have to take on substantially more debt for the SSC.

ACIR has collected and published estimates only until 1985. Many changes have occurred since then to make these already crude measures even more suspect. For instance, the Congress has enacted tax reform and the states have responded by changing their tax systems. In many cases, the states were attempting to capture the windfall provided to states by tax reform. Other states returned this surplus to taxpayers. These changes may alter rankings for different revenue-raising efforts. On the other hand, despite the dramatic drop in oil prices in early 1986, personal income in Texas has not declined substantially since the data for the ACIR numbers was collected.24/ Texas raised and expanded its general sales tax after 1985 in response to a state deficit.

As can be seen from Table 4, states vary in their per capita revenue-raising efforts. Michigan has the highest level of effort of any of the finalist states: in both the RTS and RRS, the state revenues are above the state's "capacity," where capacity is defined

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22. ACIR Fiscal Capacity Report, p. 113.

23. For an early discussion of local preferences for taxes and government services, see Charles M. Tiebout, "A Pure Theory of Local Expenditures," Journal of Political Economy, vol. 64 (October 1956).

24. Personal income by state for 1987 is not yet available. In 1985, Texans had a before-tax personal income of $221 million. This rose to $225 million in 1986.

TABLE 4. COMPARISON OF STATE FISCAL CAPACITY, FISCAL YEAR 1985

State	Fiscal Effort (National Average = 1)	
	RTS	RRS
Arizona	0.96	0.95
Colorado	0.85	0.88
Illinois	1.06	0.97
Michigan	1.20	1.17
North Carolina	0.93	0.92
Tennessee	0.82	0.89
Texas	0.76	0.81

SOURCE: Congressional Budget Office, calculated from Advisory Commission on Intergovernmental Relations (ACIR), Measuring State Fiscal Capacity, 1987 Edition (December 1987).

NOTE: RTS = Representative Tax System; RRS = Representative Revenue System.

using "representative" tax rates. By contrast, Texas has the lowest tax effort measured by either the RTS or the RRS. (Texas is the only finalist state without a personal income tax, accounting for its lesser revenue-raising effort.)

INTERNATIONAL EFFORTS IN HIGH-ENERGY PHYSICS

Both opponents and proponents of the SSC agree that the federal government should seek international funding to spread the cost of the SSC over as many science budgets as possible. The paragraphs below discuss the current high-energy physics budgets of potential contributors and outlines their current science budgets.

Japan

According to the U.S. Department of Energy, in fiscal year 1984, Japan had a high-energy physics budget of roughly $150 million per year. Since then, while the value (in dollar terms) has risen, the effort (in physicists) has remained relatively constant. By comparison, the total research and development budget of the Japanese Government for fiscal year 1984 was $6.2 billion.25/ Between fiscal years 1984 and 1987 (ending in March 1988), that budget increased (in yen) by 14.2 percent.

The European Community

According to the U.S. Department of Energy, the European Community as a whole had a high-energy physics budget of $660 million dollars in fiscal year 1984.26/ CERN accounted for $340 million, or roughly half of this. CERN members are currently committed to a rival of the SSC--the Large Hadron Collider--which they feel is cost efficient when compared to the SSC.27/ Most notably, Italy, which is often mentioned as a potential source of funding, is already participating in three high-energy physics programs--CERN, DESY in West Germany, and its own Gran Sasso

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25. The value of the yen was calculated to be 234.4 to the U.S. dollar in fiscal year 1984 and 248 in 1985. This estimate excludes local and semi-governmental agency expenses. Including these would increase the total by roughly 25 percent. See Japan Economic Institute Report (August 1, 1986 and November 13, 1987).

26. This analysis assumes 2.256 Swiss francs to the U.S. dollar in fiscal year 1984.

27. Herwig Schopper, the head of CERN, testified before the Congress last year, "The hadron collider in the LEP [large electron-positron] tunnel would cover the interesting energy range at a fraction of the projected cost of the SSC."

National Laboratory. Since the current five-year planning cycle in Italy is already well underway, if not completed, it is unclear how much of Italy's current budget remains uncommitted. The total Italian science budget was $1.2 billion in fiscal year 1986.

Soviet Union

According to the U.S. Department of Energy, the Soviet Union has committed as many resources in terms of people and equipment as the United States has to the development of high-energy physics. However, it is unclear what the budget is in terms of money.

Canada

There are currently less than 100 high-energy physicists in Canada. Although the Canadian government participates in the projects at CERN, DESY, Fermilab, and Brookhaven, among others, it has few facilities of its own. It also spends little on high-energy physics: estimates range between $10 million and $50 million per year. (The variation in the estimates is largely a function of whether medium-energy physics and low-energy physics, which include Van De Graaf generators, are counted in particle physics.) The Canadian government is currently contemplating one major particle accelerator--TRIUMF--which is projected to cost $500 million to upgrade and which it may ask the United States to participate in. The Canadian contribution to HERA, a hadron collider at DESY, is reported to have been less than $20 million.28/

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28. HERA construction costs were originally estimated to be $400 million in 1984 dollars. More recent reports suggest much higher costs. William Boesman, World Inventory of 'Big Science' Research Instruments and Facilities (Congressional Research Service, 1986), p.68.