PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY A MATHEMATICAL, PHYSICAL & ENGINEERING SCIENCES

Space: The Finance Sector

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Phil. Trans. R. Soc. Lond. A 1984 **312**, 75-81
doi: 10.1098/rsta.1984.0051

Phil. Trans. R. Soc. Lond. A **312**, 75–81 (1984) [75]
Printed in Great Britain

Space: the finance sector

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The paper will deal with the relative importance of finance. Analogies will be drawn with the financing of nuclear power and North Sea oil. The entities – public and private – involved in financing will be summarized including joint ventures, military funding and the impact of privatization. The various types of space expenditures to be financed will be reviewed including ground facilities, launch vehicles, satellites and space stations. The availability and appropriateness of different types of finance will be considered including defence and P.T.T. budgets, resources of Broadcasting Authorities, finance of equipment suppliers and export–import credit. In addition, funds available from national and international capital markets will be considered. The impact of risk and whether it can be insured or hedged will be examined together with the relevance of risk analysis to the availability of private sector funding. In this context the influence of interest rate changes, inflation rates and currency parities will be considered.

Introduction

I believe that finance for space is as crucial a problem as any of the other technical, political, or scientific issues that are discussed in the other papers. The sums involved are so huge and the competing claims for scarce capital resources so many that it is no exaggeration to claim that in the absence of medium to long-term commercial prospects, many technically feasible developments will never take place.

This conclusion is reinforced by the growing acceptance, at least in the mixed economies, that financial resources are ultimately homogeneous. In both national and international economies it is now widely recognized that the conventional distinction between public finance and private finance may be misleading when applied to the overall economic impact of funding major developments. Clearly public rather than private finance may be necessary in certain circumstances for non-economic reasons, but with the important exception of military requirements the acid test is increasingly the likelihood of economic returns.

The reasons for this important change are complex, but perhaps the single most important one is political. Broadly speaking there has, in recent years, been a significant political shift in the West, which has brought into power governments with a practical or philosophical will to control or, if possible, reduce the relative share of the public sector in both the G.D.P. as a flow, and the assets and liabilities of a given economy as a stock. Indeed, in some cases it has been the avowed intention of opposition politicians to adopt such policies that has secured their election; this may in retrospect come to be seen as one of the most profound political changes of the post-war era. The simple proposition underlying this complex change has two essential elements: the first is that what is spent, for example, on space represents a reduction on what can be spent elsewhere; and the second, that publicly-funded spending tends to be bureaucratic and less likely to achieve an economic return than privately funded spending.

What this means in practice varies from country to country and is dependent to an important extent on the influence of the military establishment in resisting the incursions of budget-

cutters, on the one hand, and the willingness and ability of private sector companies and mechanisms to pick up the risk and financing burden, on the other.

Relevant financing analogies

Two relevant analogies also serve to highlight the essential differences to which I have already referred. For nuclear power and its peaceful applications (and here I am specifically ignoring the current attempts to recreate a link between military and civil applications), there is no doubt that the extraordinary military, scientific and economic effort devoted to its development stemmed directly from wartime requirements. Equally, there is little or no dispute that the basis on which the technology was made available for civil uses was not strictly economic, financial or even commercial in the sense of implying a return on the original investment (even if that could have been properly costed). In the U.S.A. much of the technology was effectively passed on for development, at low or no cost to industry, for industrial purposes, and in the U.K., the research establishments in which the corpus of knowledge resided were gradually commercialized and benefits passed on to the private sector either directly or indirectly. Beyond the nuclear powers, however, the costing of commercial spin-off was even more extraordinary in that the unbelievably expensive military technology was passed on at very low apparent cost in its civil applications by means of joint venture or licensing agreements not only to France, Belgium and Holland, but also to Germany, Japan and Italy. It must be observed, however, that at this stage of technology transfer, the risks of commercialization were not perceived as being exceptionally high and the economic benefits, even at a time of what now appears to have been 'give away' oil prices, considerable.

The development of the North Sea provides another interesting analogy in terms of the total investment requirement, the level of risk and the régime imposed by Government. In the present context I believe that we will gain most by concentrating on differences rather than on similarities. Originally the oil sector was characterized by very large companies with a history of making huge speculative investments at high risk in the hope of high rewards. Secondly, the timescale was relatively short, and thirdly the market was more or less assured. Finally, it is important to note that the significant entities in the North Sea had considerable commercial freedom and, in particular, the freedom to move. In other words, when, after the initial phase, the Government started to put pressure on North Sea operating companies and introduced what the latter in general felt were 'unfair' taxation and related régimes, they not only threatened to move their rigs and best people to more hospitable offshore climes, but in some cases actually did so. They had in fact better places to go to and the Government decided to make some significant changes in the more controversial tax regulations. The immediate result has been renewed activity in existing blocks and considerable interest in applying for additional blocks in the recent licensing round.

In practice, however, it is very difficult to draw any precise conclusions from either nuclear power or the North Sea in terms of the commercialization of space. My immediate conclusion is intuitive rather than intellectual and consists of the simple proposition that it is essential to ensure that when it happens the U.K. has a significant involvement. This is entirely compatible, for example, with my view that the U.K. should be involved in the development of nuclear power, but that it is relatively unimportant whether we use advanced gas-cooled or pressurized water reactors, or remain abreast of fast breeder reactor technology by means of joint venture agreements.

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I have spent some time on the history of this type of major financing problem because I think there are important lessons to be learned in the context of space. Perhaps the most important of these is that once the initial expenditure has been made it is usually sensible to ensure the widest possible spread of commercial benefits by making the technology available as quickly and as cheaply as possible (subject always, of course, to military and political constraints).

Before leaving the broadly philosophical and policy areas I would like to make an observation about space in the context of financing. Space does, of course, represent a new dimension for most of us. Indeed, there are many who would claim that financial institutions have scarcely come to terms yet with earth and water let alone air and space! This elemental charge is not entirely fair but it does raise an important psychological point that has a bearing on the general reaction to financing problems by bankers and investors. Where the rate of change in technology is high and accelerating it does create particular problems for non-specialists in two specific areas; the first is the absence of any build-up of familiarity with the concepts and practices of the technology and the second is the development of statistical and related data on the basis of which commercial and financial risk can be assessed in relation to both historical and expected returns.

Some general criteria for the financing of space

If one now moves on to consider the current position on space financing in the context of the above comments the problems are clear, but the solutions less to. There are, however, some aspects that can be generally identified, for example:

(i) the massive size of investment involved;
(ii) the political importance of space;
(iii) the necessity or likelihood of military involvement;
(iv) the importance of international cooperation;
(v) the slight information on actual risk and return;
(vi) uncertainty about the level of competition from State or commercial entities.

In terms of aggregate investment globally it is evident that the overwhelming proportion of expenditure so far has been by governments either individually or inter-governmentally in jointly funded projects. Equally, most of the expenditure has been made on projects that have a direct or indirect military or political objective. These are projects that are ultimately financed by the taxpayer voluntarily or involuntarily in various parts of the world, but not generally by the private saver (except indirectly).

There are now, however, important developments as expenditure in space both matures and becomes more diversified. Some governments are anxious for both ideological and budgetary reasons to shift the space funding burden to the private sector to the greatest extent possible. The line is generally drawn at the point where the longer term military or political capacity of the State would be damaged by too great a withdrawal of public sector funding. Other governments with less concern about the growth of the State in either political or financial terms are still concerned about the budgetary consequences, particularly where this may be having an impact on the balance of payments and the exchange rate. The problem may be exacerbated where the principal industrial entities involved are themselves part of the public sector and the effective hiving-off of the financing burden becomes impossible because the ultimate guarantor for any form of capital remains the State. In such a case the only way to spread the

risk is by involving either foreign governments or commercial concerns in the projects. Similar considerations may apply where the principal users of space facilities are already in the public sector. Most P.T.Ts, for example, are either directly controlled by Departments of State or are publicly controlled corporations. Many broadcasting authorities are also directly or indirectly dependent on public sector funding. In such circumstances it is very difficult to arrange private sector finance, which does not rely ultimately on the guarantee of the State. These considerations are particularly relevant in a U.K. context where some of the entities involved have already been privatized, for example British Aerospace and Cable and Wireless, and others are in the process thereof, for example British Telecom. Furthermore, the B.B.C. (although there is no present intention to float it on the market) has to finance its proposed d.b.s. investment outside the framework of its licence income revenue and without resort to Treasury guarantee.

The principal areas requiring external capital

When consideration is given to the types of expenditure involved in commercial applications in space it is often difficult to distinguish clearly the relation between financing and return. Projects are not always discrete, either in their applications or their use of facilities. In the first instance this tends to mean that few space projects lend themselves to a project investment approach. Typically the involvement of private sector finance in space at present results from the major corporations already working as main contractors, deciding to make a risk investment themselves to participate in a particular project for which they are invited to tender. Such decisions in turn require funding by the corporations concerned by means of internally generated funds, additional debt or new equity funding. At this stage lenders or investors may or may not be required to assess the risk of the specific space project depending on its size in relation to the corporation as a whole.

At present most of the major facilities required for commercial applications in space are not privately funded nor does it seem likely that many of them will be bought out of the public sector or privatized in the foreseeable future. Some of these facilities represent massive public investments, which in many cases are subject to overriding military requirements that would in themselves create great difficulties in commercially financed or insured projects. The facilities typically required for the space projects generally regarded as commercially viable now and in the foreseeable future are:

(i) ground facilities, launch, landing and monitoring;
(ii) launch vehicles, including reusable vehicles;
(iii) satellites, for a variety of applications;
(iv) space laboratories;
(v) space stations and industrial parks.

Of the above facilities, satellites represent the area in which private sector funding is most highly developed, probably because the technology is well tried, the size of investment is manageable and the direct returns are reasonably predictable. Over the past two years or so there has been a great deal of interest in the possibility of privately funded launch vehicles, but so far no deals have actually been struck. At present I believe that General Dynamics has made a proposal to N.A.S.A. that an Atlas Centaur launch vehicle should be funded by the company at an estimated cost of approximately $50 million. An earlier proposal by McDonnell Douglas

to finance a Delta launch vehicle at a cost of approximately $30 million has now apparently been withdrawn as has a proposal to fund commercially a Titan launch vehicle. Even in an area as relatively proven as this with estimates of a market as high as $1 billion by 1990, therefore, it is not easy to finalize commercial financing proposals. For upper stage vehicles there have, however, been two interesting developments involving newly formed companies. The first was initiated by O.S.V., which has raised approximately $3 million of venture capital and is in the process of raising a further $30 million for a vehicle designed to carry larger payloads (2268–3175 kg). Another recently formed Corporation, The Cyprus Company, has been established with the initial objective of modifying the second stage of a Delta rocket so that it can be launched from the Shuttle. This second stage rocket would have a payload capability of 4.54 Mg to 6.8 Mg. In view of the fact that payloads of this mass have not yet been built, this project is likely to be longer term. In a related field, The Cyprus Company are also proposing to provide payload servicing facilities, i.e. final preparations for the payload immediately before launch. They claim to have considerable private financing available for this particular investment.

Perhaps the most disappointing aspect of private sector launch vehicle financing recently has been the apparent failure of all attempts to provide substantial private funding for the Shuttle. By this I mean the funding of one or a variety of trips. Approximately two years ago various efforts were made to put together private financing of the order of $1000 million (now probably of the order of $1200 million) to finance one Shuttle. The risks associated with a single launch were clearly enormous and even proposals to spread the investment over a series of launches did not reduce this materially in the minds of potential investors. It is important, however, to distinguish between the private funding of a total launch and the purchase by commercial entities from N.A.S.A. of capacity on a Shuttle vehicle. For the latter, considerable progress has been made in interesting a variety of industrial firms in taking space. This often represents a considerable investment by the companies concerned. McDonnell Douglas and Johnson and Johnson have an exciting joint venture for the manufacture of pharmaceuticals in space, which includes drugs for haemophilia, a one-shot diabetes cure, a blood-thinning drug and a human growth hormone drug. Clearly the markets for such products are enormous and may justify the investments involved, which over a period are likely to run into hundreds of millions of dollars. A company called Microgravity Research Associates is at present working with N.A.S.A. on the manufacture of gallium arsenide in space. This substance is one that may, according to some claims, eventually replace silicon for advanced computer chips. Both Union Carbide and John Deere are involved in the development of specialized materials manufacture in space and are already experimenting with metallurgical furnaces in these conditions. Fibre optics is another area of relevant technology where space conditions appear, in principle, to solve certain 'stringing' problems and a number of companies are working on this technology. Although most of the examples quoted refer inevitably to U.S. experience, there are in fact several European and other initiatives with launch vehicles, satellite construction and operation and Spacelab activity. So far, however, the funding for these applications has come either from State or quasi-State entities or from the contractors or users themselves, rather than from investors or direct third party project finance.

The whole subject of permanent stations with laboratories, space stations or industrial parks in space is one that has excited a good deal of attention. Theoretically, and to a degree in practice, there appear to be no reasons why such facilities should not be available before the

end of the century in substantial volume. What we are concerned about today, however, are the prospects for private sector financing of some or all of these facilities. Fairchild have a highly developed proposal to provide a space platform that would be available on a lease basis for customers with requirements going from quite small to large. The estimated cost of developing the first platform is approximately $200 million and there appears to be considerable industrial and financial interest in the project.

It is clearly no accident that the part of space financing that is most highly developed is that of satellites. The private sector financing of satellites is based on several of the key criteria already touched on, i.e.

(i) lengthy experience;
(ii) reliability;
(iii) good demand;
(iv) adequate investment return;
(v) low technical and financial risk.

When all these aspects are related to the fact that the users and builders are usually powerful entities with pressing needs for these services, for example Broadcasting Authorities, P.T.Ts and Aerospace Corporations, it is clear that a powerful momentum has been developed. Whether this encouraging pattern of public and private investment will continue on quite such an even keel in the future is more debatable because of the possibly giant strides in technology that may follow from some of the developments outlined above. There are also developments on Earth that paradoxically affect investment in space, for example in economic terms some of the fibre optic interactive cable systems now being proposed could cut into the estimated market for d.b.s. to an extent that would render the latter only marginally profitable or wholly unprofitable.

Types of finance available

I have already spoken of the homogeneity of aggregate financial resources and of the sometimes arbitrary distinctions between public and private financing. Nevertheless, it is still useful to summarize very briefly the types of finance that may be available. Apart from general budgetary allocations under a variety of headings, for example scientific research, there are more specific sources emanating from Departments of State or Government. A possible non-exhaustive list is now given:

(*a*) defence budgets;
(*b*) P.T.T. budgets;
(*c*) Broadcasting Authority budgets;
(*d*) equipment supplier funding;
(*e*) export–import credit from foreign suppliers;
(*f*) bank finance guaranteed by State entities;
(*g*) bank finance based on the project returns;
(*h*) capital from joint venture partners;
(*i*) customer down payments;
(*j*) risk or venture capital.

Conclusions

In summary, there is no doubt that an adequate volume of capital resources is available in aggregate to meet the estimated financing needs of space. The real problem arises in assessing

what type of capital is required and available, and from what existing uses it will be diverted (to the extent that new capital is not created in the short term). Once the funding of new fields of activity such as those in space begins to move into the private sector, different criteria for the evaluation of risk and reward start to apply, and at the very end of the private sector spectrum the non-specialist fund manager will seek to evaluate the risk:reward ratio on a particular space project against other opportunities available to him whether in gilt-edged securities or listed equity investments. In practice, of course, there are specialist funds that will invest solely in equities or solely in unquoted or solely in high technology investments. Over time it is likely that the financing of space will portray a similar profile to that of other mature but growing industries. In other words it will show, across a spectrum of risk and return, a variety of different funding methods appropriate to the particular project, company or industry. Two key factors will determine the evolution of this profile. The first is familiarity and the second uncertainty (risk). As I have already noted, one is seeing the first classical signs of involvement by risk money, most highly-developed for satellites, but beginning to develop, through the aerospace companies, in launch vehicles and space stations. In my opinion, it is highly likely that within 10 or 15 years most major financing institutions will employ staff with the necessary skills to evaluate risk in a wide variety of space applications with a view to providing capital on a lending or equity basis. In this growing business of evaluating risk and capital provision in space there will be the same need to consider currency factors, relative inflation rates and interest rates over a longer term, which are already used in the analysis of other forms of lending or investment whether traditional or high technology. I now end by uttering the ultimate heresy: space, in its financing aspects at least, will become in the longer term like any other business.

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