Public Funding of Agricultural Research: Competitive Versus Non-Competitive Mechanisms*

CLEM TISDELL

ABSTRACT *A substantial portion of agricultural research and development (R&D) is publicly funded. It is therefore, important to give attention to the socially ideal allocation and administration of funds for agricultural R&D as is done here. The types of mechanisms used to allocate these public funds and administer their uses can be expected to influence the research results produced and ultimately the level of returns or benefits obtained from this expenditure. Different public mechanisms for allocating and administering agricultural research funding are discussed from this point of view, paying attention to economic considerations. The non-competitive allocation of block grants to institutions is compared with their competitive allocation. Possibilities for allocation to sections of institutions or to individuals are also considered. Centralized versus decentralized mechanisms for allocating and administering R&D within organizations are discussed. In designing appropriate mechanisms for the allocation and administration of the use of public agricultural R&D funds, account needs to be taken of such factors as transaction costs, knowledge limitations, the importance of learning by doing, the accretion of institutional capital and the collective accumulation of knowledge and skills within organizations. These factors together with market failures, limit the scope for efficient use of competitive mechanisms in allocating funds for agricultural R&D.*

Keywords: research, funding, agriculture, competitive, block grants

Introduction

Huffman and Just[1] draw attention to the importance of re-examining public mechanisms for the funding of agricultural research and in fact, many of their considerations apply to public funding of all types of research. The trigger for their concern is the decline in public funding of agricultural research as a proportion of its total funding in the US, as demonstrated by Huffman and Evenson.[2] Their concern is heightened by the recent decline in real funding for state agricultural experiment stations in the US. While the US institutional situation is not the same as that in Australia and elsewhere, there is little doubt that availability of public funds for agricultural R&D is becoming tighter, and that similar problems to those observed by Huffman and Just are developing worldwide.

The situation is unlikely to improve in the near future. In fact, indications are that public funds for R&D may become scarcer as structural adjustment policies such as those

*A revised version of an invited paper for the International Economics Conference on 'Global Agricultural Science Policy in the 21st century' organised under the auspices of The Crawford Fund for International Agricultural Research and held in Melbourne 26–28 August 1996. The author thanks Dr Peter Hall and Dr Tom Mandeville for their comments. The usual *caveat* applies.

0810-9028/97/020197-12

advocated by the World Bank, are more widely applied. These policies favour a smaller government sector, lower levels of public finance, and the greater use of market mechanisms or competitive mechanisms for the allocation of available public funds. In addition, the decline in the relative size of the agricultural sector, particularly in terms of employment, is reducing the political power of agriculture and one might, expect (therefore) a decline in its share of the political cake, that is of political rents.

However, the ability of agriculture to obtain political support goes beyond the mere mechanics of political power.[3] It has been supported by the social legitimation of agriculture as a way of life. This social legitimation rests on the 'place in the heart' of modern industrial man:

> ...for pastoral land landscapes, family farming and close-knit rural communities. This remains true despite the fact that industrialized agriculture is increasingly diverging from idealized images of close-knit families, neighbourly cooperation, traditional seasonal rituals, and virtuous toil in harmony with nature.[4]

Nevertheless, public perceptions are changing. The general public is increasingly recognizing that industrialized agriculture can be far from environmentally friendly (leading to demands for the 'greening' of agricultural policy), and that some of the virtues associated with agriculture have become myths. Thus agriculture is no longer perceived to warrant a special place in the sun. These changes in community values will undoubtedly impact on the public funding of agricultural research. They have already done so to some extent—for example, by increasing the relative funding of environmentally-related agricultural research.

Because of the growing scarcity of public finance for agricultural R&D, research institutions undertaking such work have had to compete harder for these funds, and for funds from other sources. Consequently, the power of providers of funds to control the type of research undertaken has grown and providers' influence over the allocation of funding may have increased. In the US, at least, there has been a move away from block grants, a relatively stable type of funding based on formulae, to a more competitive system of grants. This has also occurred in Australia, with research agencies such as the Commonwealth Science and Industry Research Organisation (CSIRO) having minimum targets for obtaining finance from outside sources.[5] The CSIRO and The Australian Science and Technology Council (ANSTO) had targets for earning 30 per cent of their income from external sources in the late 1990s. In addition, universities are struggling to increase their share of competitive R&D funding.

Public mechanisms for allocating funds for agricultural R&D raise a number of issues: Do such mechanisms provide an ideal allocation of available funds for agricultural R&D? What are the socio-economic effects of actual and proposed mechanisms for allocating funds for agricultural R&D? To what extent are centralized or decentralized methods of allocation and management of agricultural R&D effort to be preferred? Why are competitive and market-related mechanisms for allocating public funds for agricultural R&D likely to be of limited worth from an economic and scientific point of view? Let us consider these questions.

The Ideal Allocation of Funding for Agricultural R&D

If we are to assess alternative mechanisms for allocating and administering public funds to agricultural R&D, it is useful to have some notion of the objective or ideal which ought to be pursued. One approach to policy-making popular amongst economists is to maximize an objective function, subject to resource constraints.

In relation to public funds for agricultural R&D, some possible objectives are to:

(1) maximize benefits to the agricultural sector;
(2) maximize benefits to agricultural suppliers and consumers of agricultural products;
(3) maximize benefits to a wider community than the above, even the 'whole' community; and
(4) maximize benefits taking account of not only individualistic values, but also community- or meta-values.

However, defining such objective functions and obtaining community agreement about their appropriateness is not easy. There may, for example, be no agreement on how benefits should be measured. Furthermore, different groups may be in conflict about whose benefits should be maximized, or to what extent the benefits of different groups should be taken into account.

Even if a narrow view of who should benefit from agricultural R&D is accepted, namely agriculturalists, the increased return to agriculture as a result of investment in agricultural R&D may not be an entirely acceptable measure of benefits, even to farmers. They may for example have an interest in the impact on income distribution of an innovation, as well as its consequences for the sustainability of their incomes.

When public funding supports agricultural R&D, a case can be made for public benefits to be taken into account in conducting the work, unless the public funding involved is regarded as a pure income transfer to agriculture. The community-wide benefits of agricultural R&D were formally recognized by agricultural economists (to a limited extent) in the 1970s.[6] Agricultural economists began to measure the social economic benefits of the productivity-enhancing effects of agricultural R&D in terms of its impact on producers' and consumers' surplus. This development attained a high degree of refinement in the 1980s,[7] but the approach is still relatively narrow and raises a number of unresolved questions.

Limitations of this approach include the following:

(1) The modelling involved is of a partial nature and focuses on *marketable* products.
(2) Social benefits are measured using the Kaldor-Hicks principle. Consequently income distribution and equity questions are not given full consideration, and no regard is paid to sustainability issues, environmental externalities and some community values.
(3) The benefits to consumers and producers are weighted equally, and the consequences for those not involved in the market or interested in non-marketed goods are ignored. In addition, in this context, there is little or no discussion of the relative weights that should be put on benefits to consumers and to producers *taking account of the source of funds* for agricultural research.[8]

In relation to the last point, several positions are possible, all of which may have different consequences for agricultural science policy. These include:

(1) Beneficiaries should pay.
(2) Those who pay should 'call the tune' (assuming they benefit to some extent).
(3) Those who pay merely regard their payment as an earmarked pure income transfer, and should opt out of detailed supervision of expenditure of the funding.

Consumers of a product often benefit to some extent from productivity-enhancing agricultural R&D for example, consumers' surplus may rise because the post-innovation price of agricultural produce has fallen as a result of the R&D. This has been proposed as a reason for governments to contribute financially to agricultural R&D.[9] In some cases, most or all of the benefits are captured by consumers and farmers themselves

receive little of the total benefit from agricultural R&D. This occurs when agricultural prices fall, and demand responses are inadequate to ensure farmers significant gains. Additionally, scientific and technological externalities occur when research in a particular agricultural sector provides spillover benefits to other sectors. If this occurs, there is a further reason for public support for agriculture.

Another consideration in agricultural science policy is to determine which groups are to count in the social assessment of agricultural R&D). Are only *national* consumers and producers to be counted? There is little doubt that these are the reference groups for the bulk of economic assessments. In most countries, agricultural R&D is intended to foster the international competitiveness of a nation's agriculture and to provide national benefits. This is especially likely to be the focus when national agricultural industries are contributing funds for the R&D.

Nevertheless, a dual situation exists in many high income countries. A portion of funding for agricultural research is earmarked as a vehicle for foreign aid to low-income countries. In such cases, the benefit to the recipient is likely to be the major concern, but spinoff benefits to donor nation's agricultural industry may also be taken into account in allocating funds. For instance, in Australia, the Australian Centre for International Agricultural Research attached to the Department of Foreign Affairs and Trade fosters agricultural research and development of benefit to low-income countries on a co-operative basis, but also takes into account any spinoff benefits to Australia.

Representation on bodies governing the allocation of funds for agricultural R&D is likely to be or should be affected, by the above considerations. An apposite example is membership of R&D corporations (RRDCs) for rural industries in Australia.[10] If there is a public contribution to the funding of agricultural R&D, it is relevant to determine the extent to which interests other than those of the agricultural industry concerned should be represented on bodies governing the allocation of R&D funds? Furthermore, communities value objects beyond those exchanged in the commercial marketplace. Non-marketed or incompletely marketed commodities (e.g. environmental amenities), have value and their value maybe reduced by innovations arising from agricultural R&D. In addition, health, disease and animal-welfare effects may enter the valuations of communities. To what extent should the public interest in these matters be represented on bodies involved in allocating funds for agricultural R&D? The case for their representation is stronger, the greater is the public contribution to the funding of agricultural R&D, but even when this contribution is not large, it needs to be recognised that political pressure for taking account of such community values is increasing.

R&D Corporations are a significant source of funding for agricultural research in Australia and directly fund about one-sixth of that research.[11] Approximately a half of their funds are obtained from agricultural industries and the remainder from the government. Furthermore, when their funds are allocated to institutions such as the CSIRO, state governments and universities, the use of these funds may be supplemented by other government funds available in-house to those institutions. Some RRDCs look for 'matching' contributions by research performers. This means that the decisions of the boards of directors of RRDCs have a *multiplicative* effect on the allocation of rural research funding and effort, and through this leverage they actually obtain more than a 50% government subsidy for the research involved, so providing them with a dominant position in deciding the direction of rural research in Australia.

Despite the government's funding contribution and the importance of rural agricultural research to the health and welfare of the general public, public representation on rural RDCs seems woefully inadequate. The Industry Commission reports that 'the Government—and therefore the community—is represented on the Board of each RDC

by the government member'.[12] Thus minority (even token) representation occurs. Consequently, there appears to have been little emphasis on reporting on the public good element of the research funded by the RRDCs.[13]

Furthermore, a list of the common criteria used for assessing research outcomes of research projects sponsored by the RDCs suggest that the interests of their agricultural client group is the overriding consideration. The most common criteria[14] used for such assessment are:

- potential benefit to growers;
- anticipated effect on quality and/or competitiveness;
- potential for commercialisation;
- extent to which the project will enhance sustainable resource use; and
- contribution to priority areas.

RRDCs are able to apply the customer-contractor principle and they as 'customers' are able fundamentally to determine agricultural research agendas. The 'success' of agricultural R&D therefore depends heavily on their priorities, since to a large extent the system is a top down one. Poorly devised priorities will result in inferior agricultural R&D outcomes. To the extent that board members of RDCs are limited in their vision or wish to pander politically to their main client group by being able to point to quick results, this can reduce their effectiveness in allocating funding for rural research. In fact, some universities during the Industry Commission inquiry into research and development in Australia claimed that RRDCs operate in a way which encourages short-term, possibly superficial, projects at the expense of more valuable longer-term projects.[15] Allocations may also be too mechanistic or formalistic in nature.

Although it may be possible to identify some types of agricultural science policy as inferior, it is doubtful if an ideal allocation of funds for agricultural R&D can be achieved. There are many reasons for this. Both individuals and institutions involved in agricultural R&D are subject to bounded rationality.[16] They are limited in their capacity to solve problems rationally and in the information available to them. To a large extent, research is an exploratory process and its output can only be poorly predicted in advance, and this limits the use of cost-benefit analysis in evaluating scientific effort in advance.[17] The process of scientific advance and knowledge accretion is to a large extent evolutionary. This being so, it may be more important to establish the types of institutions which will avoid inferior development paths and foster superior types of evolution than to try to prescribe the path of scientific advance too rigidly. Mechanical, deterministic models are likely to be of little value in planning and managing agricultural scientific effort.

Mechanisms (Actual and Proposed) for Public Funding of Agricultural R&D and the Allocation of Funds

Huffman and Just[18] in their important contribution to the discussion of mechanisms for allocating public funds to agricultural R&D, distinguish between block grants and competitive grants and claim that with growing scarcity of public funds for R&D, the proportion of public funds allocated to institutions by competitive grants is increasing. They argue that this increasing emphasis on competitive allocation of funds for agricultural research is reducing the returns from agricultural research, thus actually lowering the degree of economic efficiency associated with this research. To do so, they draw on modern economic concepts such as transaction costs.[19] Similarly, competitive bidding for research funds can lead to economic inefficiencies.[20] Although many

traditional neoclassical economists regard naked competition for resources and economic efficiency to be synonymous, in reality such competition *can be* a serious source of economic inefficiency.[21]

Drawing on US practice, Huffman and Just[22] treat block grants to research institutions as ones relatively steady in magnitude, determined in many cases by a formula, which may involve a base component plus a variable one. Although available research funds may vary over time, their supply does not change erratically, and changes may be dampened by a moving average of the independent variables in the formula. The formula may be productivity-based, (e.g. based on measures of publications, inventions, etc.) and when it is long-term *competition* exists between institutions for available funds. It should be emphasized, that while much of the American literature suggests that block grants or appropriations are non-competitive, the competitive element is not in fact entirely absent, but operates in long-term with a 'smoothing' element being present. For instance, supporting grants may be guaranteed to institutions for say 10 years, at the end of which reallocation occurs on a competitive basis. The length of time for which funding is guaranteed for R&D may of course vary, and may well have important implications for the productivity of R&D. Allocation of funds using short-term competitive mechanisms can involve erratic levels of funding, and assured funding is received usually only for a relatively limited period of time; a period in some cases insufficient for the gestation of the research project to be completed.

Just and Huffman[23] criticize competitive mechanisms especially those with a short term focus. The types of mechanism which they seem to have in mind, are (1) competitive grant applications subject to peer review; (2) regular allocation through competition using political processes; and (3) economic bidding or tendering methods of securing funding for R&D. These are considered, in turn, below.

Competitive grant applications subject to peer review may superficially seem fair and efficient, but there are problems. Peers are not always unbiased, may have knowledge limitations, and may be drawn from a relatively limited circle. Considerable transactions costs are involved in drawing up applications, in assessing these, and in processing applications. For dedicated and superior researchers the opportunity costs of involvement in the process can be high and the benefit small. There is a risk of better researchers (as well as the poorest) withdrawing from the process, leaving only the mediocre. An alternative is to fund the research of individuals, units, institutions and so on by a formula related to their previous research productivity. New arrivals who have no history or only a short history in research may be given establishment grants for a period of time. In comparison to competitive methods, this approach involves lower transaction costs, reduces uncertainty and allows for better long-term planning of research projects. Furthermore, most of the administration or transaction costs involved in this system fall on administrators rather than researchers.[24] This is likely to be advantageous from a comparative cost point of view.

Research funding according to a formula based on past productivity as, say, measured by an index of publications does not mean that funds are allocated equally to all. In fact, R&D funds are liable to be allocated unequally if a measure of previous research productivity is used to allocate funds. In fact, some university faculties and departments in Australia allocate a portion of their research funds using a formula of this type. There can be controversy about the adequacy of research productivity indices, such as those used by Australia's Department of Employment, Education, Training and Youth Affairs which allocates part of the universities' research budgets according to a formula which effects performance in grant winning, publication and PhD completions. But there is much to be said for their use rather than relying solely

on 'peer' reviews. Formulae can of course be devised which puts weights both on R&D productivity indices and peer reviews. I suggest that there ought to be a high weight on the former and lowweight on the latter, for efficiency reasons, and sometimes for reasons of justice or fairness. The main problem arises for those researchers who have not had a chance to prove themselves. They can, however, be given temporary support to allow them to do so.

Political mechanisms for obtaining research funds by lobbying can also be used. But this source of funds is likely to be erratic and the allocation of research funds relatively inefficient from the point of view of the wider community. Lobbying involves considerable effort and cost, and resources used in these activities are not productive *per se*. Also, tendering for research projects can result in economic inefficiency if *potential* rents are available. The number of bidders, and the effort put into their bids, is likely to be such as to dissipate any potential rent and the process may be such as to deter better researchers from bidding.[25] A further difficulty is that due to the impracticality of completely specifying contracts (especially research contracts), low price-bidders may fail to deliver the product(s) expected, and not be in breach of contract, or there may be a higher probability that they will fail to meet the conditions of the contract. This can impose costs (opportunities forgone) on the party awarding the contract. Furthermore, any attempt at legal redress may further add to cost and uncertainties. When such factors are taken into account, it becomes clear that a simple competitive mechanical approach to the R&D allocation problem is unlikely to be optimal.

The idea that publicly funded and publicly performed research should be increasingly demand-driven rather than say supply-driven, obtained public expression at least 25 years ago. In 1971, The Rothschild Report set out the customer/contractor principle, and this framework was adopted in 1972 to provide direction to the public funding and performance of research in the UK.[26] Under these arrangements, increased emphasis was placed on government research establishments, units and laboratories 'tendering' for research contracts. Government bodies were encouraged both to contract out research and to bid for contracts. With a lag, this also became the practice in New Zealand, and has been increasingly favoured in Australia. In Australia, research institutions such as the CSIRO, were required to achieve a minimum target of funding from external sources. Due to tightening financial constraints, universities have been increasingly encouraged to engage in joint projects or research with industries, and to seek research funding of a contractual nature.

This approach to the public funding of research was not without criticism in the UK when it was introduced.[27] First, it was said to add greatly to transaction costs. In addition, it supported a new layer of public administrators concerned with specifying contractual obligations, the formulation of research contracts, and the seeking of research contracts. The impact of the system in many cases is to divert the attention of scientists from research to contract negotiation, and to reduce their research productivity, especially if the in-house measure of 'scientific progress' becomes research funding obtained from external sources or income earned, rather than scientific output. Furthermore, public funds may be diverted from research activities to be used for seeking research contracts with external parties. And public grants might be used to cross-subsidise research undertaken in pursuit of external funds. Problems of a similar nature were also observed in the Australian Science and Technology Council (ASTEC) review of the operation of external earnings targets for CSIRO, the Australian Nuclear Science and Technology Organisation (ANSTO) and the Australian Institute for Marine Science (AIMS).[28]

The CSIRO in particular must take very seriously the nature of its relationship with potential providers of external funds. In connection with its rural R&D about a half of

its sponsored rural research comes from the RRDCs and the CSIRO performs about one-quarter of all research undertaken by the RRDCs.[29] As mentioned above, RRDCs are in a position to exert leverage on institutions allocated their research funds to supplement or match these with funds from other sources, usually public funds. To a large extent, RRDCs are in a position to do this because they have *monopsony* power in relation to their research areas.

The CSIRO has become increasingly dependent for its funding of rural research on sponsorship. The remainder is from government appropriation and can be considered to be block-type grant given the terminology used here. Although the CSIRO has diversified its sources of sponsored funding for agricultural R&D, *market* demand for the performance of R&D is thin. It has been argued that the movement away from block funding has reduced the quality of rural R&D by CSIRO by encouraging an emphasis on short-term results and raising overhead costs involved in seeking and administering competitive grants.

There is a risk that through research contracts with external parties, private interests may to a large extent capture public research organizations. Public research bodies then pursue the will of private interests using partly private funds as well as public grants. In such circumstances, externalities or spillovers from research using public funds are likely to be increasingly ignored and research of higher social value may be left undone. The situation is worsened by pressure to commercialize the research results of public research institutions, including universities. In universities in Australia for example, research centres have been established in co-operation with industry (Cooperative Research Centres), with a view to these becoming financially self-supporting, after a period of time. Thus emphasis is on generating income in the long-term from commercial sources and, naturally, industry financial-backers want an adequate return on their contributed capital. This may result in significant portions of the knowledge generated by this research activity being kept secret, or secret until they can be embodied in a patent or a marketable product. This may not be in the public interest. In addition, they give rise to a clash between university research-culture and commercial research-culture. Academic research-culture supports the rapid sharing of knowledge through publication, whereas commercial research-culture opposes publication if it is not the most profitable course of action for the commercial interests involved.

The commercialization of public research does not give us the best of all possible worlds. Competitive systems for allocating funding for public research, can be quite inefficient in comparisons to alternatives. They can result in capture of public research institutions by commercial interests and to objectives being pursued by public research institutions that are not in the public interest. Proponents of competitive and contractual systems for allocating research funds overlook the bounded rationality of individuals and organizations; that is the costs associated with decision-making, limits to rationality and the evolutionary nature of research. These limit the scope for the efficient use of competitive mechanisms for allocating funds for R&D.

Centralized Versus Decentralized Mechanisms for Funding and Administering R&D Within Organizations

The efficiency with which agricultural R&D is conducted within organizations depends on the way in which the funding and management of research is undertaken, including the degree of centralization of these functions. While some central control over publicly funded activities is inevitable, a high degree of such control with its attendant bureaucratization is likely to be inefficient. The problem is to design organizational structures to

give an appropriate balance between the centralized and decentralized management of research activities. While it may be impossible to identify the most appropriate organizational form, inferior or relatively inefficient forms can often be identified. Policywise, it is useful to identify the inefficient forms and reject these.

In large organizations, relatively decentralized forms of management such as multidimensional forms (M-forms) rather than unitary forms (U-forms) or pyramid-type management structures are likely to be superior.[30] However, with growing shortages of funds for agricultural research, research organizations are increasing their central control over funds by the more rigorous setting of priorities centrally[31] and are giving greater attention to vetting research proposals. This is evidenced by mission statements emanating from the centre and by the growing proportion of research funds allocated by committees, especially committees above grassroots level. Through such means, the organization concerned gives an impression to the outside world of great rationality and purposiveness. This may be supported by increased expenditure by the organization on publicity and propaganda as part of its competitive campaign. To some extent such expenditure can be wasteful from a social viewpoint. Furthermore, the process involved increases the power of those at the top of the organization. This undermines motivation and morale of staff, and gives top management greater power to set priorities. Since top managers are not omniscient, there is a risk of their backing losers, or they may set priorities mainly from the point of view of their ability to attract funds rather than take adequate account of social returns and the scientific value of research. There is no reason to believe that central science administrators have no tendency towards 'empire-building'.[32]

Apart from the above possible inefficiencies, other inefficiencies are likely to arise from a relatively centralized administration of research. These include:

(1) Increased transaction costs within the organization. Scientists are likely to be involved in a greater amount of paperwork and this has an opportunity cost R&D outcome. In the case of RRDCs, the Industry Commission[33] observed that evaluation (one form of paperwork) can be very costly and reduce the funds available for undertaking research itself.
(2) Individual researchers and research units may face considerable uncertainty about funding which can hamper long-term research projects and reduce the morale of research staff.
(3) A reduction in the flexibility to respond to emerging opportunities as research staff discover new possibilities and learn.
(4) Those at the centre often lack knowledge about what is possible at lower levels. This reduces their ability to direct research staff effectively.
(5) Asymmetry of knowledge exists between higher-level management and management at lower levels. Consequently, strategic transfer of information may occur between groups in an organization. Furthermore, there is scope for moral hazard to increase with centralization, that is for researchers to become slack or to pursue goals different to those of central management.

The above suggests that even within institutions, funding by rules or by formula can be useful both for research units and in some cases, individuals. This is not to say that it is optimal to allocate all funds by formula. Some funding needs to be provided from special sources for new initiatives such as new research units. Thus elements of stability and of flexibility need to be combined in funding research within organizations.

Further Notes on Competitive Mechanisms' R&D and Technological Progress

Evolutionary economics claims that technological progress is likely to benefit from a diversity of research organizations and variety in experimentation with technological and economic possibilities.[34] Standardisation tends to stultify the processes of creating new technological and economic opportunities. The control of public research funding by an oligarchy using similar priorities could increase standardisation of research effort and reduce the rate of technological progress, as scientists and scientific institutions compete for available funding according to the given structure of priorities.

In most cases, scientists need a degree of security in funding to be highly productive. In this respect, there is a danger in putting funding at the whim of short-term competitive forces. Stability of funding allows long-term learning to take place, knowledge and research infrastructure to be accumulated, and experience to be passed on, all of which are valuable in contributing to long-term research productivity.

Romer has suggested that it would be efficient to have (competitive) self-organizing research boards of a type which for example could invest in agricultural R&D[35] However, it may be argued that this approach is likely to create organizational instability and result in free-riding. It is thus unclear that competition of this nature is efficient.[36]

Romer believes that rural research boards would tend to come into existence whenever a collective benefit was perceived by a group of agricultural producers and that the boards would be dissolved when they no longer served the collective interests of the group. Such boards would thus encourage freedom of association and disassociation for the purpose of collective benefit from R&D activity. However, government would need to put institutional rules in place for the formation and dissolution of such bodies to prevent free-riding. Beneficiaries might fail to contribute funds, relying on the efforts or the hoped-for contributions of others.[37] If sufficient group support existed for collective contributions for R&D, levies might need to be made compulsory by the government. The exact political mechanisms for the formation, operation and dissolution of these boards would need to be considered to assess their social benefit. Furthermore, if industry R&D boards could form on a regional basis, each might emphasize agricultural research of greatest regional relevance, and generic agricultural research of relevance to all regions may be left undone.[38] It is possible that the various regional boards could bargain and voluntarily contribute funds for generic research. However, these allocations could be subject to considerable and continuing political disagreement and the system thus potentially inefficient in allocating R&D. It is also not clear how the economic interests of the general community would be taken into account by self organising boards.

This is not to say that organizational systems should be ossified. Elements of long-term competition play a useful role in economic development but myopically-based short-term competition can be destructive.[39] It appears that there is increasing emphasis on short-term competitive mechanisms in Western societies motivated by the belief that unrestrained competition invariably promotes economic efficiency, a proposition which remains open to debate. Schumpeter[40] pointed out that continual cut-throat competition may not be favourable to technological progress. He saw a degree of short-term market security under conditions of imperfect market competition as a major factor favouring technological progress and economic development. Competitive mechanisms are present in the ideal types of system envisaged by Schumpeter, but are of a long-term nature.

Systems, including scientific research systems, may perform less well under continuous intense competitive pressure than those protected in the short-term from such pressures. This is not to say that in the longer term scientific researchers and research

units should be free of having to compete for public funds. There is a strong case for adjusting levels of research funding on the basis of long-term research performance.

To some extent, 'superior' systems might operate like ones with punctuated equilibria. Stability might be the usual order of the day, but with sharp changes being made to the allocation of funds at discrete points in time. Such systems may be more productive than ones which concentrate on short-term competition.

Conclusions

As public funds for agricultural R&D (and other types of R&D) become scarcer, competition for these funds has intensified and greater attention is being given to mechanisms for their allocation. There is a growing feeling in some quarters that these funds should be more efficiently used. This has led some policy-makers to recommend demand-driven mechanisms for allocating research funds, the greater use of the customer/contractor principle, tendering for use of public research funds where possible, and pressure on public research institutions to obtain a greater share of their funds externally by competitive means. It has been argued in this paper that such mechanisms are unlikely to be as efficient and/or socially beneficial as other mechanisms. They basically involve short-term competitive processes of a relatively destructive nature. On the other hand, formula and block grants preserve short-term stability of research funding, but can allow for significant re-allocation of research funds in the longer term. Nevertheless they need to be supplemented by mechanisms for funding new researchers and institutions. Some 'infant-industry' funding may be justified for these researchers and institutions for a period of time.

Notes and References

1. R.E. Just and W.E. Huffman, 'Economic principles and incentives: structures, management and funding of agricultural research in the United States', *American Journal of Agricultural Economics*, 74, 1992, pp. 1101–8; and W.E. Huffman and R.E. Just, 'Funding, structure and management of public agricultural research in the United States', *American Journal of Agricultural Economics*, 76, 1994, pp. 744–9.
2. W.E. Huffman and R.E. Evenson, *Science for Agriculture*, Iowa State University Press, Ames, Iowa, 1993.
3. D. Vail, K.P. Hasund and L. Drake, *The Greening of Agricultural Policy in Industrial Societies: Swedish Reforms in Comparative Perspective*, Cornell University Press, Ithaca, 1994.
4. Vail *et al.*, *op. cit.*, Ref. 3, p. 3.
5. Australian Science and Technology Council (ASTEC), *On Target? Review of the Operation of External Ernings Targets for CSIRO, ANSTO and AIMS*, Australian Government Publishing Service, Canberra, 1994.
6. R.C. Duncan and C.A. Tisdell, 'Research and technical progress—the return to producers', *Economic Record*, 47, 1971, pp. 124–9; M. Akino and Y. Hayami, 'Efficiency and equity in public research: rice breeding in Japan's economic development', *American Journal of Agricultural Economics*, 57, 1975, pp. 1–10; R.K. Lindner and F.G. Jarrett, 'Supply shifts and the size of research benefits', *American Journal of Agricultural Economics*, 60, 1978, pp. 48–58.
7. J.S. Davis, P.A. Oram and J.G. Ryan, *Assessment of Agricultural Research Priorities: An International Perspective*, Australian Centre for International Agricultural Research, Canberra, 1987.
8. Duncan and Tisdell, *op. cit.*, Ref. 6.
9. *Ibid.*
10. Industry Commission, *Research and Development*, Australian Government Publishing Service, Canberra, 1995, Volume 2, Part E.
11. Industry Commission, *op. cit.*, Ref. 10.

12. Industry Commission, *op. cit.*, Ref. 10, p. 750.
13. *Ibid.*
14. Industry Commission, *op. cit.*, Ref. 10, p. 746.
15. See, for example, the comments of Keith Entwistle, Professor, University of New England, Industry Commission Research and Development inquiry hearings, Canberra: Transcript of Proceedings, 9 December, 1993, p. 1455.
16. C.A. Tisdell, *Bounded Rationality and Economic Evolution*, Edward Elgar, Aldershot, 1996.
17. C.A. Tisdell, *Economic Development in the Context of China*, Macmillan, London, 1993, Ch. 7.
18. Huffman and Just, 1994, *op. cit.*, Ref. 1.
19. For a discussion, see T. Mandeville, S. Macdonald and D. M. Lamberton, 'The cost of merit in university research', *Australian Journal of Education*, 26, 3, 1982, pp. 279–91.
20. C.A. Tisdell, 'Transaction costs and markets for science, technology and know-how', *Australian Economic Papers*, 34, 1995, pp. 136–51.
21. C.A. Tisdell, *op. cit.*, Ref. 16, Ch. 13.
22. Huffman and Just, 1994, *op. cit.*, Ref. 1.
23. Just and Huffman, 1992, *op. cit.*, Ref. 1.
24. *Ibid.*
25. Tisdell, *op. cit.*, Ref. 20.
26. Lord Privy Seal, *Framework for Government Research and Development*, HMSO, London, 1972, Cmnd Paper 5046.
27. C.A. Tisdell, *Science and Technology Policy: Priorities of Governments*, Chapman and Hall, London, 1981.
28. ASTEC, *op. cit.*, Ref. 5.
29. Industry Commission, *op. cit.*, Ref. 10, p. 702.
30. O.E. Williamson, *Markets and Hierarchies*, Free Press, New York, 1975.
31. See Just and Huffman, *op. cit.*, Ref. 1, and the comments of the Industry Commission, *op. cit.*, Ref. 10, p. 405, on priority-setting by the Australian Research Council.
32. W. Niskanen, *Bureaucracy and Representative Government*, Aldine, Chicago, 1971.
33. Industry Commission, *op. cit.*, Ref. 10, p. 747.
34. R.R. Nelson, *Understanding Technical Change and Evolutionary Processes*, North Holland, Amsterdam, 1987.
35. P.A. Romer, 'Implementing a national technology strategy with self organising industry investment boards', *Brookings Papers: Microeconomics*, 2, 1993, pp. 345–90.
36. Z. Griliches, 'Comment by Zvi Griliches', *Brookings Papers: Microeconomics*, 2, 1993, pp. 391–5.
37. Tisdell, *op. cit.*, Ref. 16, Ch. 3.
38. Griliches, *op. cit.*, Ref. 36.
39. Tisdell, *op. cit.*, Ref. 16.
40. J.A. Schumpeter, *Capitalism, Socialism and Democracy*, 2nd edn, Harper, New York, 1942.