Innovation and policy

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Economics of innovation

Introduction

The subject of policy towards innovation is a huge one and all we can do in this lesson is give a brief introduction.

We shall start by trying to answer the question ‘why have an innovation policy?’

We shall see that part of the answer is to do with market failure.

- We give a brief summary of what is meant by market failure.
- We then describe which features of the innovation process may lead to market failure and why.
- We then summarise the three generic approaches to correcting these market failures, and these three approaches underpin most approaches to innovation policy.
- The next three sections give a little more detail on each of these generic approaches to innovation policy.
- The final section offers a postscript on why innovation policy in future may be different from how it is today.

MARKET FAILURE - The Concept of Market Failure

While the economist's idea of perfect competition is something of an abstraction in that it can rarely be found, it is of interest as a limiting case because under some conditions it embodies certain desirable properties.

1. In perfectly competitive markets, all willing to pay the marginal cost of production will be able to buy a product, which is equitable and efficient.
2. In a perfectly competitive market, the right things are produced and sold, in the sense that products or services valued at or above their cost of production will be produced, while products or services valued below their cost of production will not.
3. A perfectly competitive market is Pareto efficient – meaning that any rearrangement of production activities can only make one consumer better off at the expense of another.

MARKET FAILURE - The Concept of Market Failure

There are, however, certain circumstances in which this rosy picture does not apply.

In particular, in these circumstances, the desirable properties described are not obtained. We refer to this as market failure.

When there is market failure, some profitable activities do not take place, and/or some unprofitable activities do take place.

Moreover, it is not necessarily true that the right things are being produced, nor will the free market outcome be Pareto efficient.

There are three generic reasons why market failure occurs:

1. economies of scale,
2. asymmetric information,
3. externalities.

Economies of Scale

Scale economies allow consumers to buy products at much cheaper price than would be found if there were no scale economies, and hence are a sign of economic success rather than failure. Nevertheless, the economist would still argue that economies of scale mean that competitive markets fail to perform in the desirable ways set out above.

- The main reason for this is that if there are economies of scale, arising for example because there are fixed costs of production, then it is not profitable to sell products at marginal cost. The fixed costs must be recovered, and prices set must rise to reflect that. This means that some consumers, at least, who are willing to pay at or above marginal cost, are priced out of the market.
- The second reason why economies of scale lead to market failure is simply that where there are continuing economies of scale, the large scale producer will always be able to undercut a smaller scale producer. This is a force towards monopolisation of the market, because ultimately a monopolist producer will have lower average cost than any smaller scale competitor. And we know from our discussion of market structure that monopolists will often try, if they can, to raise prices some way above minimum average cost. Monopoly is in itself a market failure.

Economies of Scale - corrections

The traditional solution to market failure caused by scale economies is not of course to get rid of the scale economies which are quite desirable.

Rather, the solution is to recognise which markets are natural monopolies, and to allow such monopolies to emerge, but to place them in the public sector with non-profit maximising objectives, or to regulate them.

Asymmetric Information

This second generic source of market failure occurs in quite a wide variety of settings, but here we shall concentrate on one well-known example, from Akerlof (1970).

- Take the case of the second-hand car market, where each seller is well informed about the quality of the car they are selling, while any one buyer does not know for certain which are the good cars and which are the bad.
- The buyer may know, roughly speaking, what is the probability that any particular car is good, but he does not know for certain whether a particular car is reliable or not.
- This asymmetric information means that the buyer faces a risk that the seller does not.
- It also creates a problem for the seller of a good car: unless he can demonstrate that his car is good, there is no obvious reason why the buyer will be prepared to pay a price premium for that car. Indeed, if buyers cannot distinguish good from bad, then both good and bad cars will sell at the same price – which will be some sort of average of the 'right' price for good cars and the 'right' price for bad cars. Without any method of certifying that his car is good, moreover, the seller of good cars may withdraw his/her car from the market: he will consider this market price to be unacceptable. If sellers of good cars withdraw from the market in this way, then the average quality will decline, and so will the market price. That makes it even more unattractive for the owners of good cars to try and sell their car in this market, and so even more withdraw from the market. Ultimately, we get a repetition of Gresham's Law: bad drives out good.

The market has failed here because the price mechanism has failed to attach a higher price to the good quality car than to the bad quality car. And this failure means that good quality cars may not be traded at all.

Asymmetric Information - corrections

There are of course various mechanisms to correct for this problem.

- Reputable car sellers invest in a brand name for reliability, and may back that up by guarantees. There are independent agencies who will (for a fee) give an informed assessment of the value of a second car.
- More generally, developed economies have a system of standards and certification, which allows manufacturers to demonstrate that their products conform to certain standards, and are therefore worthy of a price premium.

All these devices help to ensure that price and quality are more closely connected, thus removing some of the information asymmetries. This reduces the risk to buyers, but also makes it possible for the seller to get a fair price for a high quality product, and hence corrects (in part at least) the original market failure.

Externalities

- The third source of potential market failure is the externality.
- If A carries out some activity which has a material effect on B, but B is neither compensated for nor charged for this, then we say that A's activity has generated an externality for B. This externality can be negative for example when A's activity generates pollution of some sort, which is a loss of amenity for B. Or it could be positive – for example when A's gardening activity generates a pleasant environment for B, but which B enjoys for nothing.
- In either case, there can be market failure. If externalities are negative, then markets will make certain activities look privately profitable when they are socially costly. If externalities are positive, then they can make certain activities look privately unprofitable when they are in fact socially desirable. Either way, there is market failure either because the market will permit some 'wrong' activities to take place, or because the market prevents some 'right' activities from taking place.

Externalities - corrections

Corrections for this sort of market failure tend to be of one of three sorts.

1. socially desirable but privately unprofitable activities are run in the public sector (e.g. postal services to remote parts of the country).
2. the government may subsidise activities that generate significant positive externalities, and control or tax activities with negative externalities (e.g. pollution).
3. the provider of positive externalities may try to define property rights over these externalities and charge the beneficiaries a royalty, while those who suffer from negative externalities may sue the producer of these externalities for loss of amenity. Each of these is an attempt to internalise the externalities, and hence correct for market failure.

FEATURES OF INNOVATION ACTIVITIES THAT MAY LEAD TO MARKET FAILURE

- We are going to see some important features of certain aspects of R&D and some other aspects of innovation activity and information exchange which are claimed to distinguish them for commodity. These features can lead to some kind of market failure, or sub-optimality in market allocation.
- The market outcome may be sub-optimal in two ways:
  - first there may be too little R&D or innovation;
  - second there may be the wrong mix of R&D projects or innovation activities.

Economies of Scale – Increasing Returns

It is argued that there are significant economies of scale in certain aspects of R&D: in particular in the production and collection of information.

Information, interpreted in a pure sense, is generally taken to have one of the classic public good properties. The cost of producing information by R&D is predominantly a fixed cost: information can be reproduced at very low marginal cost.

As we know from basic first year economics, when there are strong economies of scale in the production of a good, then there is a strong tendency towards monopoly in the supply of that good. Indeed, some have argued that a wide variety of information activities have an element of natural monopoly to them.

The fact that information can be reproduced at practically zero marginal cost means that perfectly competitive markets for the provision of information will fail since competitive firms could never cover their costs in such circumstances. This tendency towards monopoly will probably lead to a tendency towards monopoly pricing and all the attendant inefficiencies.

There is another reason for scale economies in information collection. If information gathering activities are to be worthwhile, they should be done on a large scale.

Economies of Scale – Increasing Returns

It might be argued that if information can be reproduced at low marginal costs, then diffusion is not such a serious problem for technology policy, and for information purely interpreted as suggested, this is probably true;

- slow diffusion suggests to some extent that transmission costs are significant. It should be noted of course that in many practical cases the assimilation of information cannot necessarily be achieved at zero marginal cost and in some cases assimilation costs can be substantial.

Indeed, to some extent, this idea of R&D as production of information is misleading. Some of the knowledge produced by R&D is tacit rather than codified and cannot be expressed as simple bits of information.

Moreover, while information may be duplicated at low marginal cost, this is not to deny the scope and necessity for adding value by 'repackaging' information.

- For many users, less is more: the value of information depends on concise presentation, and so there is scope for adding value by customising information in a way that facilitates assimilation. While pure information provision has aspects of natural monopoly about it, selling packaged information is more like the sale of a conventional product. So while there may be market failure in the former, this need not apply to the latter.

Positive Externalities

Following the classic work of Arrow (1962) in the context of perfectly competitive markets, it is often argued that certain aspects of R&D and information production and collection are subject to significant positive externalities.

- That is to say, one firm's R&D has positive benefits for other firms with related spheres of business. In fact, the spheres of business need not be that related: collaborative R&D may benefit companies with very different product ranges. When such externalities arise, the innovating firm is not able to appropriate the full social benefits of its innovations: in other words the private benefits of R&D or information collection are less than the social benefits. This may act as a constraint on socially valuable R&D programmes. Even though the combined social benefit (to the innovator and those who benefit from externalities) exceeds the cost of R&D, the innovator does not recover enough benefit to cover his R&D costs, and so cuts back on his R&D.

We use the term informational externalities describe the information a firm yields to others by undertaking a particular activity.

- One example would be a firm's R&D programme in a particular area: the very fact that the firm is conducting R&D in that area can convey information about technical feasibility or potential profitability. Or, one firm's R&D or information collection may spill over to rivals as a consequence of personnel mobility, and the fact that information is embodied in products and services produced by that firm.

- Again, we note that if one firm's R&D creates benefits for neighbouring firms, then it could be argued that for that group as a whole there is no problem of diffusion because the information spills out all too readily.
- Rather, the problem of market failure is that the company paying for the R&D may not recover enough financial benefit to justify the R&D expenditure – even though the R&D is socially beneficial.

Positive Externalities

These observations highlight a dilemma in the economics of innovation policy that continually surfaces when we are assessing the policy options.

- The fact that information can be reproduced at low marginal cost is in a sense a good thing, since it means that many can benefit from an investment; but as we see this property can pose problems for market allocations. If information is ‘commoditised’, that is individual agents have property rights over it and can trade in it, this removes the problems for market allocation in one sense, but means that fewer agents benefit from an investment in information gathering. And, in general, it seems undesirable to commodify and charge for something that would naturally flow around at zero marginal cost.

While such positive externalities can undoubtedly be expected to exist, it is not clear empirically how important they are.

- There is relatively little economic research on the identification and measurement of externalities in R&D and information gathering.
- And it should be noted, of course, that firms in markets can institute joint ventures and ‘clubs’ to internalise some of the mutual externalities from their separate R&D programmes, and develop property right schemes to improve appropriability. Of course, while this is an understandable strategy in the face of spillovers, it may also encounter resistance from governments concerned with anti-competitive practices; and again, there can be a tension between policies to promote R&D and competition policy.

Negative Externalities

- By examining competitive R&D in an oligopolistic context, Dasgupta and Stiglitz (1980a, b), amongst others, have shown that showed that one firm's R&D could yield negative externalities for rivals – by reducing their market shares, for example. This is particularly relevant in the analysis of patent races, for example, where the winner takes all. This is sometimes called a common pool problem. A similar result would be found with innovations in a context of minimal product differentiation and discerning consumers: one firm's product innovation can leverage market share off the rival.
- In such cases, the private benefit of R&D expenditure to the innovating firm can exceed the social benefit: the innovator benefits by increasing market share while other firms lose. And, although the consumer or user can benefit from such innovation, these increased consumer benefits are not as great as the private gains to the innovator. Loosely speaking this is a result of duplication of R&D effort, which is socially wasteful while privately profitable. More specifically, the losses to the now uncompetitive firm exceed the benefits to the consumer. Net negative externalities of this sort will be most important in the context of oligopolistic competition between firms producing very similar products. They will not be especially important when one firm's R&D activity relates to a product that is not produced by any others.
- It is difficult to know whether this outcome, though theoretically possible, is really important in practice. Some writers, for example Stoneman (1987, p. 209), have expressed doubt that the 'common pool' problem has seriously led to excessive privately funded R&D in Britain.
- It is of course possible in a particular market structure that positive and negative externalities might be found simultaneously, and to some degree they may offset each other – though it is unlikely that they would exactly cancel each other out. In fact a more likely outcome is a bias in the mix of R&D and information collection activities undertaken. In particular, we might find that there is excessive similarity in rival firms' R&D programmes (Dasgupta and Maskin, 1987).
- A simple example will show how this might happen. Suppose firm A makes two products X and Y, while firm B makes products X' and Z, where X and X' are very similar products but Y and Z are very different products. Then there will be a bias in A and B's R&D activity towards research related to X and X', where the negative externalities are relatively important (see previous section) and away from Y and Z, where they are not. This is a recurrent theme in the economic analysis of product competition: firms tend to over-invest in innovation when product competition with rivals is intense and under-invest when it is not.
- It should be noted that these arguments apply to explicitly oligopolistic markets, and not to perfectly competitive ones. It is also important to note that arguments here suggesting excessive duplication in R&D assume that R&D is undertaken to create information. But, as Pavitt (1987) points out, if the R&D expenditure is undertaken to assimilate existing technological knowledge, then duplication may not be wasteful, but may instead be essential for diffusion.

Information as a Stock which Appreciates with Use

- Information has some of the characteristics of a capital good, in the sense that it is more like a stock that yields services rather than a flow which disappears after consumption. Yet unlike other capital goods, it does not depreciate with use; indeed, as Dasgupta and Stoneman (1987) amongst others have noted, information is a stock that can appreciate with use. By this, we mean that the quality of the information – i.e. its accuracy and conciseness – appreciates with use. On the other hand, the competitive value of information does not usually increase with use because competitive edge depends on a degree of exclusivity: if potentially valuable information is shared too widely, its competitive value declines.
- The quality of information improves with more frequent use by the 'owner' of that information, and in addition the quality of information is improved when it is passed around a network of users who can hone and refine it. A clear example of this can be seen with Wikipedia, the open source encyclopedia, where users are encouraged to update and improve information. Because of this, information gathering, exchange, and use are subject to special and rich network effects: these are positive mutual benefits between collectors and users of information.
- The fact that a stock of information appreciates as it is used by other firms can imply a mutual positive externality. Market failure may manifest itself in the form of information networks that are too small because agents deciding whether or not to join are not rewarded for the externalities they may generate by being part of that network.

Information Asymmetries

- It is often argued that information has one very special property that is not shared by most other goods: namely that the value of information to a particular user often cannot be assessed without having temporary access to the information (on a trial basis, as it were). But when the buyer has had access to the information (even on a temporary basis), there is no need to buy. And after access, there is no incentive for the buyer to reveal his/her true willingness-to-pay for the information. The argument implies, therefore, that information cannot really be described without 'giving it away'. In such cases, there is an informational asymmetry between buyer and seller, and an element of moral hazard. In such circumstances, markets will fail.
- This is undoubtedly true of many kinds of information. Thus the potential value of a document giving (for example) the detailed formula of a revolutionary new pharmaceutical product cannot really be assessed from the statement: 'this document gives the precise formula of a revolutionary new pharmaceutical product'. But this phenomenon is not unique to information. It can indeed be difficult to assess the value of all sorts of goods before purchase, even if trial periods are offered – and this is particularly true in an environment of very rapid change. The marketing and sale of all sorts of commodities requires the use of language to convey relevant information about the product (Bacharach, 1990), without 'giving it away' free, and while language may be fairly well adapted to describe a car, a computer, or a cake, there is still an element of incompleteness about the description, and a degree of information asymmetry.
- With information asymmetries, we find that the seller knows the potential value of a piece of information, while the buyer is uncertain about it. In such cases, a market for information may not work efficiently. The best known examples of this are Gresham's Law and the lemon effect described by Akerlof (1970). The existence of bad information (of little value) reduces the market clearing price, which may in turn lead the supplier of good information to withdraw his/her supply so further reducing the average value of available information. Sometimes the existence of reputation effects will be sufficient to ensure that 'good' information (from a trusted supplier) can trade at the necessary premium. And this is why, as Metcalfe (1986) points out, seller reputation and buyer goodwill are so important in information exchange.

GENERIC APPROACHES TO POLICY

- Market failure may be a necessary condition to justify government having an innovation policy, but it is not a sufficient reason. It is necessary that government can find policy devices which might actually improve upon the market outcome and in a cost-effective way. This is not unproblematic. First, there is the whole matter of appropriate policies in a second best world. We may know what the optimum compensatory policy will be when there is only one market imperfection (e.g. one source of externalities), but in a world where there are many inter-dependent market imperfections, then we can no longer say that this is the optimal policy.
- In a world of very poor information, with little or no prior knowledge about the full extent of market failure, some would argue that the best policy is no intervention, even if one market imperfection can be clearly identified.
- As one example of this difficulty, Stoneman (1987) examines the effects of subsidies and information provision schemes on diffusion. He shows that depending on the expectations of users and the relevant market structure, the market may generate a diffusion path that is too slow or too fast from a social welfare point of view. So in these circumstances, it is not clear whether information provision and/or adoption subsidies are appropriate. It is also important to note at the outset that when a programme of government intervention is being evaluated, the policies are unlikely to appear profitable in an accounting sense. The reason for this is obvious enough. The policies are trying to make certain activities happen that are not privately profitable but are nevertheless socially profitable.
- Nevertheless, all these possible problems in designing effective innovation policies have not deterred most governments, and we find in practice that there are many policies designed to increase innovation in the economy. Dasgupta (1987, 1988) distinguishes three broad groups of government policy to correct for market failure in innovation:
- 1) subsidies to reflect the positive externalities arising from R&D activities and other innovation activities
- 2) institutions to create and enforce property rights to ensure there are no free spillovers to third parties
- 3) government expenditure or procurement to promote activities that the market fails to support adequately.
- The subsidy approach is sometimes called the Pigou approach since it follows in the tradition of policies advocated by the early twentieth-century economist, Pigou. The system of property rights is sometimes called the Lindahl approach, after the Swedish economist Lindahl. And when government gets directly involved in R&D and other innovation activities, that is sometimes called the Samuelson approach after the Nobel-Prize winning economist, Paul Samuelson

SUBSIDIES

- These can take two forms: subsidies on provision or subsidies on use. Subsidies raised from general taxation are paid to compensate those who create positive externalities through their R&D for those externalities. Or, in the case of subsidising diffusion, the user is subsidised to adopt a new technology to compensate him/her for the positive externality (s)he creates in adopting the technology.
- Subsidies can be general or specific. General subsidies, such as tax breaks on R&D expenditure are administratively fairly straightforward, but their effects can be to promote a range of additional activities – not all of which the government is keen to encourage. Specific subsidies, by contrast, might be given for particularly promising areas of R&D or to promote adoption of a particularly promising new technology. These are administratively more complex and costly, but their effects will be more clearly focused on a specific range of activities which the government is indeed keen to encourage.
- The main question to be asked of such schemes is whether they promote additionality. That is, to what extent is additional R&D activity (or technology adoption) generated by such schemes? Or, alternatively, do the subsidies simply turn into an increased surplus for those who are already happily undertaking an R&D project or are already using a new technology? In short, how efficient are the subsidies in terms of extra social benefits generated per pound spent in subsidy? Some sceptics in recent years have argued that such schemes have low additionality and as a result these schemes are less popular now than they were some 25 years ago.

Practical Policies

- In the UK, the government has experimented with a variety of policies of this sort:
- • R&D tax credits are the biggest single funding mechanism for business R&D provided by the British government.1 R&D tax credits help R&D-active companies to reduce their tax bill or, in the case of small or medium sized companies (SMEs) who are not making profits, and who are therefore paying no tax, by providing a cash sum.
- • Knowledge Transfer Networks offer financial support to organisations that have the capability to establish or enhance networks. This can be seen as a subsidy paid in return for creating positive spillovers.
- • Direct grants for R&D are available to startup companies and SMEs to carry out research and development work on technologically innovative products and processes.
- • Programmes to support specific technologies (electronics, biotechnology).
- • Technology adoption or diffusion subsidies. • Technology training subsidies and consultancy subsidies.

PROPERTY RIGHTS

- Such schemes require the externalities from R&D activity and information gathering to be ‘commoditised’ by use of intellectual property rights. We have already discussed the different approaches to protecting intellectual property in Chapter 7. When these externalities are commoditised in this way, the inventor is in a position to act as a licenser of the spillovers from his/her activities, and thus to internalise some of the externalities that would otherwise be enjoyed free by others.
- The argument for doing this is clear enough. But there is a downside. The cost of a patent system, besides the administrative cost, is that it gives monopoly rights to inventors; as with any form of monopoly, that is inefficient. Moreover, such a scheme acts against technology diffusion by putting a price on something that was originally a free spillover.
- Once again we see the inherent dilemma in technology policy. Incomplete appropriation leads to insufficient provision under the market solution, and the establishment of property rights can help to achieve a higher level of provision. But the establishment of property rights over something that under natural conditions would spill over at zero marginal cost will itself introduce an element of inefficiency.

Practical Policies

Institutions for protecting intellectual property have existed for some time (see Chapter 8). The UK government's main policy in this area has been to commission a wide-ranging review of the intellectual property framework, called the Gowers Review (2006). This review recognised that intellectual property is a critical component of the UK's strategy for success in the global economy, but needed some reform. The key challenge for the IP framework is to create incentives for innovation, without unduly limiting access for consumers and follow-on innovators. The Review recognised three priorities:

- tackling IP crime and ensuring that IP rights are well enforced
- reducing the costs and complexity of the system
- reforming copyright law to allow individuals and institutions to use content in ways consistent with the digital age

Following the Gowers Review, and in recognition of a changing balance between different instruments for protecting IP, the UK Patent Office was given a new name: the UK Intellectual Property Office.

GOVERNMENT'S OWN R&D ACTIVITIES

- In severe cases of market failure, the government can in principle assure that socially valuable (but privately unprofitable) activities take place by direct government expenditure on R&D, or other expenditures on the science and technology infrastructure
- The first obvious difficulty with direct public-sector involvement in R&D is that public agencies lack the commercial information and market incentives which firms in the industry would possess. For this reason, it is generally argued that public involvement in R&D is more appropriate with basic research than with near-market R&D. And moreover, it is often argued that positive externalities and the appropriability problem are more important in basic research than in near-market research.
- The second possible difficulty is that government funded research could crowd out privately funded research. This might happen as a consequence of competing for scarce scientific or technological talent. Or it might simply displace the incentive for privately funded research, by freely offering the results of such research to companies (that would be willing to pay for it on their own). Another way of looking at this is to recognise the possibility that government funding of R&D perpetuates a dependent corporate culture in which research is, 'something the government pays for'.

Practical Policies

In the UK, the government has a wide variety of policies of this third sort. Indeed, as the number of subsidy schemes has declined because of concerns about additionality (see above) this number of schemes of this third sort has grown. All of these policies can be seen as an attempt to add to and strengthen the group of scientific and technology institutions that make up the national system of innovation in the UK. We can group these policies into three sorts, as shown in this final list:

- Infrastructure
  - Government research laboratories
  - Standards institutions and measurement laboratories
  - Promoting clusters
  - Technology transfer institutions
- Education and training
  - Direct sponsorship of university research
  - Sponsorship for collaboration between universities and industry
  - Engineering and technology programmes
  - The ‘Micros in Schools’ programme
- Vision and foresight
  - Foresight programmes
  - The ‘Technology Strategy Board’

INNOVATION POLICY IN THE FUTURE

- I finish this lesson, and indeed the course, with a conjecture. In the future, government policy towards innovation will be different from policy towards innovation in the past and present.
- Why do I say this? There are two main reasons. First, much policy is still governed by a relatively simplistic model of how innovation happens and how innovation helps to create wealth. A common argument is that invention and creativity don't really count until they turn into innovation, and innovation doesn't really count until it impacts on company productivity and/or profitability. Chapter 19 would suggest that this perspective is far too narrow. When we take account of the multiple channels through which creativity, invention and innovation can create wealth, then a more subtle approach to policy is required.
- Second, most past policy seems to be governed by the assumption that more innovation is always good. As one policy maker said to me, the message has been, in essence: 'go forth and innovate!' It is only a slight over- statement to say that the main object of policy is to increase the amount of innovation – more or less uncritically. But again, we have seen in Chapters 19 and 21 that more innovation is not always a good thing.
- What will this new approach to policy look like? The simple answer is that we don't know yet. But it will be more subtle than the approaches described above.
- In conclusion, let us remind ourselves of the remark by Ernst Schumacher (1974, p. 26) noted in Chapter 2: 'man is far too clever to be able to survive without wisdom'. We have the power to come up with all kinds of clever innovations and many of them may enhance the competitiveness and performance of the companies that implement them. But the full implications of these innovations for sustainability and welfare may be a great deal more complicated than the immediately obvious effects, and some apparently benign innovations can have unexpected and damaging side-effects. The policy objective must move away from how to achieve more and more innovation, of whatever kind, to how to achieve more of the right sort of innovation.