

# John Rae on the Causes of Invention

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## The role of invention in the *New Principles*

John Rae's *Statement of Some New Principles on the Subject of Political Economy* (1834; cited below as *NP*) was intended to refute Adam Smith's analysis of the causes of the wealth of nations and the laissez-faire conclusions generally drawn from it. 'Invention' plays a central role in Rae's argument. He accused Smith of attributing economic growth exclusively to the accumulation of capital and of attributing accumulation in turn to individual savings decisions.<sup>2</sup> Rae argued that although an individual certainly becomes rich by saving,<sup>3</sup> things are different for a society as a whole. An individual who saves can acquire assets from others, but a society can only use saving productively by creating new capital assets. If all, or the 'greater number' of individuals try to save, they may succeed for a time, but as 'every branch of business within the society' becomes filled up, the desire to save will be diminished (*NP*, p. 22).

Individuals can invest in doing more of the same, but societies can only continue to accumulate for any length of time by adopting new methods of production, which themselves have to be invented. Rae supported this rather weak argument by appealing to the facts. The national capital of Great Britain, he claimed, had expanded tenfold in a few centuries, as a result of 'the wonders and achievements of art, ... fire and water transformed into our obedient drudges, ... carrying us over the land with the speed of the wind, bearing us through the ocean against tide and storm', and so on (*NP*, p. 14). He concluded:

Invention is the only power on earth that can be said to create. ... [I]ndustry and parsimony increase the capitals of individuals; national wealth ... cannot be increased but by the aid also of the inventive faculty. (*NP*, p. 15)

This makes Rae the first economist to see technical change as the main source of continuing

economic growth and, since he saw no limit to the scope for invention, the first to foresee an unlimited potential for future growth.<sup>4</sup>

He was careful not to overstate the extent of his disagreement with Smith. He agreed that ‘the causes of the wealth of nations ... are to be found in the improvement of the productive powers of human labor’ (*NP*, p. 12), and that capital accumulation is an indispensable component of that improvement. Having defined an ‘instrument’ as any (useful) produced good, lumping consumer goods, intermediate goods and capital goods together, he devoted much of the *New Principles* to discussing the ‘amount’ of instruments formed, thus effectively identifying growth of output with growth of the capital stock. Syed Ahmad (1996) suggests that the difference between Rae and Smith might be discussed by looking for the necessary and sufficient causes of growth in their work, but it is clear that accumulation is both a necessary and (in a sense) a sufficient condition for growth for both of them, provided at least that extraneous variables such as the geographical and social environment are held constant.

What is at stake here is not the importance of capital accumulation, but its causes. Both thought that savings were automatically invested, but Smith attributed saving to the ‘uniform, constant, and uninterrupted effort of every man to better his condition’, which is thus ‘the principle from which public and national, as well as private opulence is originally derived’ (Smith, 1776, p. 343). According to Rae, Smith’s case for laissez-faire follows. Since total saving is the sum of individual saving, and since individuals can be trusted to save (in general, if not in every case – there are some ‘prodigals’) any state intervention will reduce saving and hence economic growth (e.g. *NP*, pp. 16–17, 63–5).<sup>5</sup> This argument, however, only holds if the determinants of private saving can be treated as exogenous. Rae’s case is that they are not, and that Smith treated ‘what is merely a necessary concomitant for a cause’ (*NP*, p. 28). In Rae’s story, saving, like population, is endogenous, with invention as the exogenously determined cause of growth. ‘It is invention, which showing how profitable returns can be got from the one [capital], and subsistence procured from the other [population] that may most fitly be esteemed the cause of both’ (*NP*, p. 31).

Rae’s case, then, is that (1) invention is needed to maintain the incentive to save and (2) invention

has causes independent of individual savings decisions, causes which are open to influence by the 'legislator' where individual savings decisions are not. Rae's treatment of (2) is the main topic of this paper. (1) requires a little further discussion, though it will not be pursued at length here. Rae's case for the role of invention in permitting continued saving and investment has three components. (1.1) Savings/investment is responsive to changes in the anticipated rate of return on instruments. (1.2) Invention increases the rate of return, thus inducing savings and investment. (1.3) Without invention, the rate of return would be forced down, and accumulation would soon stop. Of these, (1.1) is the subject of Rae's capital theory and his account of intertemporal choice. Individuals balance the return on different instruments against a number of factors such as the uncertainty of surviving long enough to enjoy the benefits, altruistic feelings towards their descendants (who will benefit if the saver does not survive), and so on. (1.2) can be taken as axiomatic – only inventions which raise returns are of interest. Finally, (1.3) is partly a consequence of Rae's theory of intertemporal choice – accumulation stops at a (positive and perhaps substantial) rate of return reflecting the 'effective desire of accumulation' of the community – but it is also an empirical question – how close is the community to the minimum acceptable rate of return thus determined, and how rapidly would returns be driven down if invention did not restore them? Rae implicitly assumed that established communities are close to equilibrium, so growth would soon stop if invention were to stop. There would be no further movement to slower yielding instruments because those already in use fully reflect the effective desire of accumulation of the community.

Something should be said here, if very briefly, about the role of the division of labour. Rae did not deny its importance, but (again) questioned Smith's view of the underlying causality. Smith attributed the division of labour primarily to the accumulation of capital (e.g. 1776, p. 277). The 'extent of the market', often cited as Smith's main explanation for the extent of the division of labour, can itself be traced back to the general level of economic activity in the locality, a result of the accumulation of capital, along with other factors such as favourable location which can be taken as constant over time. Smith did mention inventions as a factor affecting the productivity of labour, but claimed that 'the invention of all those machines by which labour is so much facilitated and abridged, seems to have been originally owing to the division of labour' (1776, p. 20). The primacy of

capital accumulation and hence of individual savings decisions as the central cause of growth is maintained.

Rae reversed the causality – the division of labour is the result of invention, not the other way round. Simple technology gives few opportunities for division of labour. The invention of more specialized and complex instruments creates potential gains from specialization. Where Smith argued that specialization made labour more productive, through increased ‘dexterity’ and the like, Rae stressed the more efficient use of instruments, which a specialist uses full time. An unspecialized producer would either not use specialized equipment at all, or would have to leave it idle much of the time (*NP*, bk 2, ch 8; see also Ahmad, 1996). Two comments are appropriate here. First, what is at stake, again, is causality – Smith treated the invention of machines as a result, not a cause, of the division of labour, while Rae reversed the causality. Second, the difference between them may reflect real changes in the world they saw around them. In Smith’s time manual skills really were of primary importance, but by the time Rae wrote, more than half a century later, technology was already beginning to be embodied in the design of the machine rather than in the skills of the person who used it.<sup>6</sup>

In sum, Rae’s analysis is centred on the role of invention as the primary, independent, causal factor behind economic growth. At any date, the wealth of the nation depends on (1) the state of knowledge, which is the result of past invention, (2) the effective desire of accumulation, which determines how far that knowledge is employed, and (3) the available materials, that is, the natural environment (*NP*, p. 109).<sup>7</sup> If (2) and (3) are treated as constant over time, the wealth of the nation can only grow as a result of new invention.

### **Invention and its causes**

Despite its central role in his system, Rae did not define ‘invention’ clearly and explicitly. His examples and passing comments in the early part of the book suggest a fairly broad but reasonably familiar definition. Invention is described as ‘improving agriculture and the other old arts, or ... discovering new ones’ (*NP*, pp. 14, 20, 23). Examples include steam power, the threshing machine,

and so on. A summary listing of some of the things which a 'legislator' might do to 'direct part of the energies of the community towards the furtherance of this power of invention' gives further clues; the legislator should support the progress of science, art (that is, technology), the discovery of new arts and of improvements in the arts already practised, and 'the discovery of methods of adapting arts already practised in other countries' to local circumstances. All of these are said to require 'the aid of the inventive faculty' (*NP*, pp. 15–16).

The opening paragraph of the chapter on the causes of invention suggests a wider definition, one which goes far beyond mundane economic issues and provides some backing for the apparently wild claim in book one chapter one of the *New Principles* that 'invention is the only power on earth ... that can be said to create' (p. 15).

Invention ... is the great immediate maker of all that is the subject of our thoughts, or ministers to our enjoyments, or necessities, nor is there any portion of our existence, which is not indebted to its antecedent formative power. ... It is always a maker, and, in a double sense, a maker. From the depths of the infinity lying within and without us, it brings visibly before us forms previously hidden. These are its first works. But neither does it intend to stop, nor does it, in fact, stop here. The forms which its eye thus catches, and its skill 'bodies forth' into material shape, pass not away; they remain. Things of power, true workers, drawing to themselves, and fashioning to their semblance, the changeable and fleeting crowd ... they are, in truth, the only permanent dwellers in the world, and rulers of it. In this, the double power of his works, the mathematician is as much a maker as the poet, and the poet as the mathematician, and genius in all its manifestations, may ... be considered as the same power, and as excited to action by similar causes. (*NP*, p. 208)

The idea that invention is a maker 'in a double sense', of the 'double power' of the works of invention may seem puzzling at first sight. It makes sense if it is taken with the distinction that Rae drew, much earlier in the book, between the poem of Childe Harold and the paper on which it was printed (*NP*, p. 14). He can be read as saying that the inventor or creator produces something physical and time bound – a manuscript, a prototype, or something else that can serve as an example

– but that this physical embodiment of something new can be distinguished from its lasting content, which is perpetuated by subsequent copying or by serving as the basis for further development.

He admitted that his subject, political economy, 'leads us to attend to invention merely as it concerns itself with the physical world', but this is only one form of the work of 'real discoverers, in any of the regions over which the power of this principle extends' (*NP* pp. 208–9). 'Invention' it seems, is anything that adds to the stock of knowledge, defined broadly enough to encompass a poem or a work of art.

Rae went to extreme lengths in the opening pages of the chapter on the causes of invention both to emphasise the gap between the mass of mankind and the 'man of genius',<sup>8</sup> the inventor or creator, and to dramatize the tribulations he faces. The context is his claim that 'man is essentially imitative' (*NP*, p. 209). The inventor is one who does not imitate. 'Among the men with whom he lives, he lives as not of them' (p. 219). Novelty is misunderstood and resented. 'The personal history of most men, who, in modern times, have brought into being those arts by which human power has been so largely advanced, is little else but a narration of misfortunes, and ingratitude' (*NP*, p. 217). (Rae must surely have had his own rather unhappy life in mind.)

He clearly set himself a problem with this extreme formulation. How is invention to be explained? If novelty and creativity are not rewarded, what motivates invention? His first shot at an answer is heartfelt but unconvincing.

We in vain search for any sufficient motive exciting to [invention], unless the good arising from communicating good, and the consequent desire to be a benefactor in the most extended possible manner. ... When strongly felt, it irresistibly impels those who are conscious of capacities equal to the attempt, spite of every obstacle to be overcome or pain to be endured, to task themselves to the performance of works of permanent and diffusive utility. (*NP*, pp. 210–11)

Invention is a moral choice, and its rewards are not of this world. Since Rae included poetry and mathematics among the works of invention and emphasized the gulf between the man of genius and

the common herd, one might expect him to argue that the poet, at least, is driven by an inner need to write poetry for its own sake, regardless of others. Not so – Rae consistently presented invention as the result of a calculated choice. The inventor balances benefits against costs but his calculation of the benefits is shaped by altruistic feelings towards humanity at large.

He had earlier argued that saving and thus capital accumulation depend on a willingness to wait for rewards. If people were rational and immortal, there would be no problem, but they are neither. A saver cannot be sure of living to benefit from the full fruits of investment. The 'effective desire of accumulation' thus depends on altruism, on a concern for the welfare of one's descendants. Willingness to devote oneself to invention demands an even wider form of altruism, a concern for the welfare of the whole community over an indefinite future. Intelligence too is required for the future benefits of both investment and invention to be appreciated and valued. A high effective desire of accumulation and a willingness to invest thus tend to go together. If the community as a whole feels a duty towards the future, then inventors may be rewarded, or at least admired. The resentment of novelty which he had earlier stressed may be reversed and a desire for fame, if not fortune, can drive invention. Economic success is, it seems, an index of (and a reward for) the moral and intellectual standards of the community.

In Rae's discussion of more directly economic cases, a rather different picture emerges. Take, for example, the discussion of advances in the use of steam power in Britain (pp. 245–7).

As the progress of order, civilization, and art, covered the island of Great Britain with a numerous population, the stores of fuel ... were by degrees exhausted. ... Necessity thus taught its inhabitants the use of coal. (*NP*, p. 245)

As coal mines were driven deeper, drainage became a problem, but the use of steam power to drain mines came to the rescue. Rae set out the factors which brought about the first use of steam power, 'an agent ... far greater than any which has hitherto been placed within the hands of man' (p. 246). The need was urgent, the materials were available, previous improvements in machinery had paved the way, and the funds were available. The previous progress of science, in particular the concept of latent heat, may have played a role. Rae admitted that practical inventors could have progressed

without the theory of latent heat, but if (pure) science had only helped to bring forward the progress of steam power by a few years, that was valuable enough (*NP*, pp. 247–8). The inventor in the broader sense of the opening pages of the chapter thus plays some role, albeit a small one.

The progress of steam as power source ‘may be said to have been inevitable’ (*NP*, p. 247). Steam navigation emerged on the inland waterways of America, because the circumstances there were particularly favourable (*NP*, p. 248). The creation of steam powered railways, again, is explained in terms of the context – horse-drawn railways were already in use and steam power had come into use in mines. What was needed to bring the two together was a lighter and more compact steam engine to pull a train.

The undertaking was commenced with full assurance that it would accomplish the desired improvement, though the manner how was not known. ... Had not Great Britain existed, metal railways and steam carriage might have been still in only the category of possibilities. (*NP*, p. 249)

The tortured genius of earlier parts of the chapter has vanished, to be replaced by a story in which invention proceeds logically and smoothly, with ‘full assurance’ of success. This version of Rae’s story could even be forced into a Smithian mould –capital accumulation, it could be said, by pressing on resource constraints, creates both needs and opportunities. The division of labour ensures the existence of specialists to respond to them, and technical advance follows. Rae would, of course, have rejected this reading, since he always insisted that invention was primary and capital accumulation and the division of labour were secondary, but it does seem at the least that one could describe growth in terms of a sequence of inventions following each other in a predictable fashion, without drama and without any need for need for state intervention.

### **Import substitution**

What seems to be the main line of Rae’s story, already sketched in earlier parts of the book, emerges towards the end of the chapter on the sources of invention. In this the emphasis is on the transfer of

technology from one industry to another (the account of the development of steam power could be read in this context), but above all on the transfer of technology from one place to another, with consequent adaptation and change.

I believe it will be found that there is no art in existence which we may not find means to trace ... to the rudest and most simple principles, and which may not be shown to have attained perfection by continual changes from place to place, and material to material, and by encountering consequently alternating difficulties and facilities, the former developing its powers, the latter extending their field of action, and both, by helping to introduce general principles, weakening the restraining power of the tendency to servile imitation, and advancing the progress of science. *This successive passage of the same arts from country to country*

*seems to be the great exciting cause of the progress of them all.* (NP, p. 253, emphasis added)

Circumstances are different in different places, so importing techniques from elsewhere is never a matter of simply copying. In any case, the procedures which are to be copied are those of somewhere far off. In a new location the normal desire to stick to what is familiar is ruled out, opening the way for improvement and adaptation. Setting up an industry in a new location both requires and stimulates invention.

Rae emphasised the potential gains from setting up an industry in a new location, but he also stressed the difficulties involved. The individual who takes the lead must have special qualities, even if they are not quite those of the 'man of genius' who 'lives apart', as in the earlier part of the chapter. 'Very few individuals have a thorough knowledge of every different part of any complicated manufacture'. The 'director' has to 'preserve the economy of the whole, and to search out the individuals best fitted for carrying on every part' (p. 47). In a new country, this means finding and bringing in people with the necessary skills, and either importing machinery or having the equipment constructed locally, where it is, of course, new and unfamiliar. The costs and risks are correspondingly high.

Rae stressed that it is not simply a matter of copying what is done elsewhere – adaptation is

needed to set up production in a new location where circumstances are different. The new industry can and (according to Rae) often does surpass established centres, given time. The 'director' himself presumably cannot do the adapting, since we are told that no individual knows all parts of a complicated manufacture, but he plays the key initiating and organizing role. The relation between specialists and director is reminiscent of Schumpeter's distinction between inventor and innovator, discussed below.

Import substitution provides the main context for Rae's case for action by the 'legislator', that is, for state intervention. Throughout the *New Principles* he pointed to what we would now call the public-good character of invention, thus laying the basis for a wholly coherent case for state intervention. It is, however, rather difficult to see quite what the state can do to promote genuine novelties which must, by their nature, be difficult or impossible to foresee. Rae's pessimistic attitude to the reception of genuine novelties makes the problem worse. If the community as a whole is mistrustful or actively hostile to real invention, as Rae claimed, how can the 'legislator', the representative of the community, be expected to promote invention? Rae recognized the problem but dealt with it rather limply, saying that only a community which values intelligence and scores high on altruism towards future generations is likely to be willing to support invention (*NP*, p. 378). It is clear that he did not see such communities as the norm. In the case of import substitution, however, the opportunities and incentives for the legislator to act are much clearer. The aim is to establish a domestic industry to produce a familiar (imported) product with an established market, while those who have most to lose, the existing suppliers, are foreigners.

Rae argued the case for state intervention to support infant industries strongly, but qualified it carefully – he was not against markets or trade in any general way. He urged the legislator to be cautious, to assess the potential benefits carefully, and to support only industries that were likely to succeed. Support for new industries could take several forms: premiums for those individuals who first establish a new domestic manufacture, bounties (subsidies) for home products, or duties on imports. Rae suggested premiums first, to test the water, then bounties or duties to build up a full-scale industry (*NP*, p. 367–8).

Import substitution, then, plays an essential role in Rae's story. His first version of the sources of invention seems too pessimistic – if novelty is always rejected and despised, how can development ever happen? The second version, implicit in the story of the development of steam power, on the other hand, makes the process of development appear more automatic than Rae wanted, and seems to leave no role for state intervention. His focus on import substitution as the main motor of development neatly avoids both Scylla and Charybdis.

### **Rae, Schumpeter, and the incentive to innovate**

There are obvious parallels between Rae's ideas and those put forward much later by Joseph Schumpeter. Both emphasised the importance of habit and routine in everyday life, but argued that real economic development was the result of the efforts of those few who could break out of customary patterns of thought and introduce real novelties. Thus Schumpeter argued that 'everyone will cling as tightly as possible to habitual economic methods', and that 'carrying out a new plan and acting according to a customary one are things as different as making a road and walking along it', while development 'is defined by the carrying out of new combinations' (1961, pp. 8, 85, 66). No other significant figures in the history of economic thought shared this very specific view of economic development. Schumpeter must have been influenced by Rae, but the difference in context and in the state of development of the subject is such that the influence is at the level of what Schumpeter called 'vision' rather than analysis. Whatever Schumpeter took from Rae he remade completely in his own analytical framework. I shall not pursue the question of influence – I bring Schumpeter in here simply because the comparison between the two throws a useful light on some of the distinctive features of Rae's viewpoint.

Schumpeter drew a sharp distinction between invention and innovation.

As long as they are not carried into practice, inventions are economically irrelevant. And to carry any improvements into effect is a task entirely different from the inventing of it. ... besides, the innovations which it is the function of entrepreneurs to carry out need not necessarily be any inventions at all. It is therefore not advisable, and it may be downright

misleading, to stress the element of invention as much as some writers do. (1961, pp. 88–9)

Innovation, in Schumpeter's terms, means the introduction of something that is economically, rather than conceptually or technically, new. The entrepreneur, the central character in Schumpeter's story, is an innovator but not necessarily an inventor.

Rae's concept of invention, stretching as it does from music and poetry to import substitution, is much broader than Schumpeter's concept of innovation. It is not even clear that Schumpeter's 'innovation', in its pure form, would count as 'invention' in Rae's terms at all. Suppose one individual thinks up a new technique but, for some reason, never puts it to use, while a second individual, a Schumpeterian innovator, takes it up and introduces it on a practical scale. Is the second an 'inventor'? It is not clear from Rae's text, though the 'director' of a project to start local production of something produced abroad (see above) seems very close to a Schumpeterian entrepreneur. Rae evaded the issue by arguing that some 'invention' was always needed to adapt production to local circumstances. If Rae had made some distinctions on the lines of Schumpeter's it might have clarified his very confusing account of the causes of invention.

In Schumpeter's story, innovation is followed by copying, but the innovator has a temporary lead over imitators and can gain a corresponding temporary profit before competition is restored and the gains from innovation spread among the generality of consumers. This provides the incentive for innovation. Whether this incentive is sufficient to ensure an optimal level of innovation – a matter of great concern to Rae – is a question that Schumpeter did not address directly. The returns to innovation do not constitute a 'supply price' of entrepreneurship, he argued, since such a thing does not exist (1961, p. 154). They may be much greater than is required to call forth the amount of entrepreneurship actually observed (which, of course, says nothing about whether the observed level of innovation is optimal), even though the possibility of success acts as a 'stronger incentive than is rationally justified by its magnitude multiplied by the coefficient of probability' (1961, p. 155). Entrepreneurial profit is the main source of upward social mobility in a capitalist society; the 'rich' are the successful entrepreneurs and their heirs (1961, pp. 155–6). One might add that the ability to innovate successfully was, in Schumpeter's view, rare, but even in a business cycle downturn it takes

only 'one or a few' of these rare individuals to turn the tide and pave the way for more (1961, p. 228). Given this perspective, a lack of incentives to innovate does not seem a matter of concern.

Rae's view was quite the opposite. He stressed the extra costs incurred by the first to do something new, especially (as noted above) the costs involved in starting local production of previously imported goods. These costs he saw as virtually prohibitive for the individual, even where the potential long-run gain to the community as a whole would amply justify the costs. This makes perfect sense in his framework. The gains from invention last for ever (though they are, presumably, eventually incorporated into later developments) and accrue to the whole community. More specifically, those who copy can appropriate the benefits without incurring the special costs faced by the innovator. One can readily translate this argument into the language of modern economics – innovation has the character of a public good and the free rider problem inhibits individual provision or, to make the same point from a different point of view, there are positive externalities attached to innovation, so social benefits exceed private benefits. In some cases, he argued, the potential benefits may eventually rise so high that the return to the individual 'projector' is enough to justify investment, but in this case the potential social benefits must have been positive much earlier, so even where private initiative does do the job, it does it too late (*NP*, p. 54).

What can be said about these conflicting views? It is clear that the total social benefit accruing from an innovation is only partly captured by the innovator. That much seems to be common ground – one might see the difference between Rae and Schumpeter as the difference between saying a glass is half full or half empty. Schumpeter's approach would be appropriate for the case in which an innovation depends on an almost costless, albeit rare, act of creative insight.<sup>9</sup> Provided the return is enough to induce the potential entrepreneur to act, and enough to enable him to raise the money to prove the idea in practice, that is enough. There is no need for the whole of the social gains (which might be very large) to accrue to the lucky individual who had the original idea. Rae's argument, on the other hand, would fit cases in which the outcome is reasonably predictable, but in which there are substantial initial costs. Modern, organized, research and development programmes often fit this pattern, but were almost unknown in Rae's time. That is presumably why he concentrated on the case of import substitution, where observation of the foreign industry and of the

local market for imports gives a fairly clear idea of the potential private and public gains. His argument also requires a particular structure to the costs of transmission of information – it must be costly to gain detailed knowledge of the processes used elsewhere and/or costly to adapt that knowledge to local conditions, (making life hard for the trail-blazer) but cheap to transfer the knowledge from firm to firm within a particular area or country (making copying easy for those who follow). When Rae was writing, his implicit assumptions about the costs of information transfer made sense, since long distance transport was slow and expensive while the relevant technical knowledge was often embodied in the craft skills of workers, who were reluctant to move far afield but easily tempted to change employers within a single locality.

Rae faced a problem. In order to support his main argument – against Adam Smith and in favour of government support for infant industries – he wanted to emphasize the difficulty of establishing something new, but he made the point so strongly that it seemed almost impossible for anything new to get started at all. He then had to explain how progress had in fact happened. The altruistic genius of the opening pages of the chapter on the causes of invention provided an answer of sorts, but offered no real basis for the desired policy conclusions. His solution was to point to special circumstances in which normal channels of trade were disrupted, for example by war, or in which political upheavals forced skilled workers and other specialists to emigrate, taking their skills with them. Disturbances of this sort are bad for accumulation, since insecurity discourages investment, but good for invention, since the normal bias towards imitation loses its force when the normal sequence of events is broken (*NP*, p. 222). When normal sources of supply fail, people have to make for themselves what they can no longer get from others and they have to find new materials to replace those that have become unavailable. Economic growth proceeds irregularly, with periods when accumulation is interrupted but invention stimulated, followed by peaceful interludes in which accumulation exploits the fruits of (previous) invention.

Government policy, on the other hand, can stimulate invention without the costs which disruption imposes. Rae hoped that the world might become a more peaceful place, so intervention would become the only means of stimulating invention. This is an ingenious solution to the problem, but it is still rather hard to square with some of Rae's examples, such as his account of the essentially

smooth development of steam power (discussed above). One might, perhaps, argue that disruption of normal patterns of trade (or government assistance) is needed in the specific but (Rae thought) particularly important case of import substitution, because in this case the nascent local industry faces competition from established foreign competitors, while steam power was a real novelty, not just a transfer from elsewhere, and did not need special support.

It is worth noting that Rae's account of the immediate consequences of innovation differs from Schumpeter's. In Schumpeter's story the focus is on a single industry or market. The first with a cost reducing innovation can sell at the old price to begin with, making a large profit, while an innovator who creates a new market can sell at a monopoly price. Once others copy, the price is bid down. This story goes back to Ricardo and was echoed by Marx, though Marx, in a Rae-like touch, commented on the extra costs facing the innovator, so that 'the trail-blazers generally go bankrupt', leaving those who follow on, 'the most worthless and miserable sort of money-capitalists', to reap the gains (Marx, 1962, p. 103).

Rae, by contrast, was very vague about the course of prices and the nature of the gains accruing to the first-comers. He argued that an invention in one industry raises returns generally, though the basis for this claim is very unclear. It must presumably imply a price reduction in the industry concerned, else how would other industries benefit? Take his example of an innovation which cheapens the making of bread (*NP*, p. 259). He claimed that the bakers would have 'a small additional profit', the whole society would have cheaper bread, and returns on investment would be raised throughout society. Here the innovator's profits have clearly been eliminated, as the benefits are 'very shortly' diffused throughout society. He did not present any detailed discussion of pricing or profits in the intermediate stage in which the innovation has not been generally adopted, though it is hard to see how one can draw useful conclusions about the incentive to innovate without tackling these issues. More generally, Rae had rather little to say about the workings of markets, and was rather clumsy in what he did say. His main discussions of capital and returns are cast in terms of the physical returns, evaluated subjectively by the individual, with the market introduced only later in the argument. His analysis is the weaker for it.

## Conclusion

The structure of Rae's argument in the *New Principles* depends crucially on his claim (1) that invention has causes distinct from (and prior to) the current level of saving, (2) that laissez-faire will generate a sub-optimal level of invention, and (3) that state intervention can and should redress the balance. His attempt to demonstrate these points is somewhat confused, because he did not make clear distinctions between different types of inventive activity, and because he described the motivation of the inventor and the rewards of invention in a variety of different ways. It is, of course, reasonable to think that there may be real differences between the relevant factors in different cases, but the fact that Rae did not distinguish clearly between the different cases he considered makes him appear simply inconsistent. Taking a very broad view of invention and focussing on scientific and artistic creativity led him to an over-pessimistic view in which it is hard to see how invention can progress at all. Consideration of British development led to the opposite conclusion – invention seemed to proceed smoothly without outside help. Import substitution turns out to be the one case which fits (or can be made to fit) his argument perfectly. It requires and stimulates 'invention', but whoever initiates production in a new locality faces exceptional costs, and cannot normally be expected to do so without some form of state support. The potential benefits are visible and readily comprehensible, so the legislator can reasonably be expected to understand them and to act accordingly – given, of course, an acceptance of Rae's account of the determinants of economic growth in place of Smith's.

## Notes

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<sup>2</sup> Whether Rae's interpretation of Smith is correct is a secondary issue in this context, since Rae, not Smith is under discussion. For a fuller discussion of Rae's critique of Smith, see Brewer (1991).

<sup>3</sup> This can clearly be made true by definition: define wealth as value of assets, define saving as income minus expenditure, and define income so as to include all capital gains and windfalls.

<sup>4</sup> Adam Ferguson (1767) or even David Hume (1955; c.f. Brewer, 1996) might be cited as possible precursors of the view that growth is driven by technical change, but neither developed any substantial economic analysis to back up this insight. Turgot (1973) and others perhaps saw unlimited scope for human advance, but in terms of the advance of knowledge rather than in a specifically economic context.

<sup>5</sup> Neither Smith nor Rae seems to have considered the possibility that the state could directly affect the aggregate rate of saving, say by saving itself out of tax revenues, or by somehow compelling individuals to save.

<sup>6</sup> Though I will argue later that Rae's discussion of import substitution implicitly assumes that setting up a new industry required far more than just importing the necessary machines.

<sup>7</sup> Population and labour supply are treated as endogenous, as in Smith. The socially determined subsistence wage affects the return on investment and hence the equilibrium stock of instruments, but Rae said little about the determinants of wages.

<sup>8</sup> The masculine ('man' of genius) is Rae's. I shall generally use the masculine to avoid artificiality.

<sup>9</sup> Take the example (cited by neither author) of the wheelbarrow. This very useful device

depended only on the prior invention of the wheel but was unknown in classical antiquity, despite the existence of large building projects where it would have been very valuable. Once the idea came to some anonymous person in the Middle Ages, the use of the wheelbarrow spread rapidly throughout Europe.

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