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Financing of new technology: The discussion among economists

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Abstract

Purpose: This paper presents some of the disputes that have arisen among political economists concerning the financing of production embodying new technologies.

Methodology: Literature review.

Findings: In classical political economy, Adam Smith established the issue of financial risk as posing dangers to banking and economic activity in general. This gave rise to a view that the state should underwrite new technology, a view represented today by proponents of state industrial policy and green technologies. At the end of the nineteenth century the rise of monopoly finance capital raised questions about the ability of private enterprise to keep investment at the cutting edge of new technologies. The institutional vehicle for private enterprise promotion of new technology is venture capital, whose innovations are subject to the business.

Keywords: new technology, venture capital, innovation, Smith, Bentham, Rae, Schumpeter.

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Introduction

New technology has held a fascination in the financial markets, from well before Saccard and Melmotte stepped out of the pages of Zola's *L'Argent* and Trollope's *The Way We Live* to entertain their readers with financial scandal. New technology invites us to set aside our market or conventional evaluations and expectations in order to seize possible rather than actual opportunities, born of imagination rather than experience. This poses dangers to credit and finance, where transactions deal in future obligations with less assured future returns. This paper opens with an analysis of those dangers that emerged in the work of Adam Smith. Section Two summarises the analysis of costs and benefits of new technology that superseded Adam Smith and how these may be apportioned between the state and entrepreneurs. The rise of long-term financing raises a new set of questions around monopoly and the willingness of large corporations to finance and diffuse new technology, which is the subject of Section 3. The final section deals with issues arising from the use of venture capital as a vehicle for financing new technology.

10.1. Adam Smith on credit and new technology

By and large, Smith shared his contemporaries' disapproving attitude towards the stock market system of corporate finance. In the last quarter of the 18th century, the theft and robberies committed by the East India Company, culminating in the scandalous trial for corruption and cruelty of the first Governor-General of India, Warren Hastings, from 1788 to 1795, could only confirm the unfavourable financial opinion that had arisen in the wake of South Sea Bubble.⁴⁶ However, Smith was particularly concerned about the extent to which new technology could corrupt credit and divert it from its proper function of providing financing to stable, established businesses. At the heart of this corruption was the tendency of businessmen promoting new technologies (whom he called "projectors") to exaggerate the prospects for success of that technology. True to his method of reducing economic explanation to moral sentiment, Smith saw this tendency to view future business outcomes favourably as arising out of natural self-regard affecting all men:

The over-weening conceit which the greater part of men have of their own abilities, is an ancient evil remarked by philosophers and moralists of all ages. Their absurd presumption in their own good fortune has been less taken notice of. It

⁴⁶ References to Adam Smith's condemnation of joint stock finance may be found in (Toporowski, 2000, pp. 19–20, 139, 144–145.

is, however, if possible, still more universal. There is no man living, who, when in tolerable health and spirits, has not some share of it. The chance of gain is by every man more or less over-valued, and the chance of loss is by most men under-valued, and by scarce any man, who is in tolerable health and spirits, valued more than it is worth (...). The establishment of any manufacture, of any new branch of commerce, or of any new practice in agriculture, is always a speculation from which the projector promises himself extraordinary profits. These profits sometimes are very great, and sometimes, more frequently, perhaps, they are quite otherwise. (Smith, 1904, vol. 1, pp. 119–129)

Accordingly, in making business plans, there is a bias towards exaggerating future returns. Actual returns in business, i.e. the productivity of labour, are, according to Smith, determined by the location of the business, its technology, trade and competition in that line of business. Those returns, he argued, were lower in manufacturing countries where there existed free trade and a high degree of competition in the various trades, and higher in industrially backward countries where trade was restricted. Smith believed that credit needed to be assured to competitive businesses in order to maintain economic and banking stability. In contrast to his well-known views in support of free trade and *laissez-faire* in business, Smith advocated the regulation of banks in general and, in particular, limits on the rate of interest that could be charged by banks.

The interest chargeable for loans had been regulated in England since the time of Henry VIII and, prior to his break with the Roman Church, by ecclesiastical Canon Law. By Smith's time the ceiling on interest was fixed at 5% (in Scotland now as well as England). Smith was a firm supporter of the Usury Laws. In the course of justifying such government regulations, Smith outlined what he considered to be the likely consequences of allowing interest rates higher than the rate that is "somewhat above the lowest market price, or the price which is commonly paid for the use of money by those who can give the most undoubted security (Smith, 1904, vol. 2, p. 399).

If the legal rate of interest in Great Britain, for example, was fixed so high as eight or ten per cent, the greater part of the money which was to be lent would be lent to prodigals and projectors, who alone would be willing to give this high interest. Sober people, who will give for the use of money no more than a part of what they are likely to make by use of it, would not venture into the competition. A great part of the capital of the country would thus be kept out of the hands which were most likely to make a profitable and advantageous use of it, and thrown into those which were most likely to waste and destroy it. Where the legal rate of interest, on the contrary, is fixed but a very little above the lowest market rate, sober people are universally preferred, as borrowers, to prodigals and projectors. The person who lends money gets nearly as much interest from

the former as he dares to take from the latter, and his money is much safer in the hands of one set of people than in those of the other. A great part of the capital of the country is thus thrown into the hands in which it is most likely to be employed with advantage. (Smith, 1904, vol. 1, p. 400)

Smith's argument here is clearly over the limit that should be placed by the usury laws on the possible interest charged. However, given that the purpose of the usury laws was to prevent banks charging interest above the legal ceiling, it is an obvious implication that, without such a ceiling, banks would charge higher rates of interest. As Smith pointed out, the composition of business would then change in favour of "prodigals and projectors" who are willing to pay higher interest and would waste finance on their schemes.

Within years of the publication of *The Wealth of Nations*, Jeremy Bentham took issue with Smith over his views on usury. Bentham was an ardent enthusiast of Adam Smith's laissez-faire political economy, which complemented his own liberal political and legislative ideas. He read *The Wealth of Nations* soon after it was published and re-read it. According to the editor of Bentham's economic writings, Werner Stark, "a most thorough study of Smith's illustrious treatise was the mainspring of all Bentham's economic knowledge" (Stark, 1952). Bentham acknowledged that "as far as your track coincides with mine, (...) I owed you everything" (Bentham, 1787/1952, p. 167). Perhaps for this reason he was outraged by Smith's argument for regulating the rate of interest. Travelling in Russia, he heard a rumour that the government in London led by William Pitt the Younger was planning to cut the legal rate of interest down from 5% to 4%. This turned out to be a false rumour, but it proved to be the catalyst for Bentham to bring his thoughts together in a pamphlet entitled *Defence of Usury*. The pamphlet was in the form of a set of rhetorical letters to Adam Smith, making clear that it was Smith rather than Pitt to whom Bentham's reproaches were addressed.

The *Defence of Usury* mounted a serious political case against the Usury Laws. In Bentham's view, banking is like any other business and it was no business of the government to regulate the "hire of money" any more than the hire of horses (Letter IX). The laws, he argued, did not discourage prodigality, since this could usually and equally be financed from savings or the sale of assets (Letter III). The laws were widely evaded, and this tended to discredit the law in general (Letters VII and VIII). Its roots lay in muddled thinking: the Aristotelian notion that money is unproductive, the prejudice of borrowers, as opposed to lenders, and anti-Semitism (Letter X).⁴⁷ Furthermore, limiting interest reduces the "parsimony" which augments the "capital" that is the basis of trade (Letter XIII, p. 198).

But Bentham reserved his most furious economic arguments for a defence of "projectors". Their speculations, he argued, were the foundation of economic prog-

⁴⁷ Bentham shared the Enlightenment view favouring equal citizenship for Jews.

ress, and it was wrong to deny them finance on any terms that they were willing to pay. The Usury Laws themselves did not concentrate finance on good projects, but merely deprived all projects of finance (Letter XIII). A notable omission is the absence of any mention that the level of interest rates may itself discourage “projectors”. Bentham argued as if only government limitations on interest rates can hold back projectors. In this way Bentham established finance as the partner of capitalist enterprise, rather than, according to mercantilist thought, a usurious parasite on that enterprise. This is not really surprising. Bentham himself was the author of a new model prison, the Panopticon, for whose construction he singularly failed to raise money or interest from the government. But it made him identify with “projectors” to a personal degree.

Bentham’s argument in favour of industrial speculation was to attract Keynes’s attention. In the “Notes on Mercantilism etc.” in his *General Theory*, Keynes noted Smith’s preference for “cheap money” and Bentham’s defence of projectors. In a footnote, Keynes wrote:

Having started to quote Bentham in this context, I must remind the reader of his finest passage: “The career of art, the great road which receives the footsteps of projectors, may be considered as a vast, and perhaps unbounded, plain, bestrewed with gulphs, such as Curtius was swallowed up in. Each requires a human victim to fall into it ere it can close, but when it once closes, it closes to open no more, and so much of the path is safe to those who follow. (Keynes, 1936, p. 353)

The quotation clearly recommends itself to Keynes for Bentham’s apparent recognition of the economic problem of uncertainty, whose analysis was to be such a distinctive part of Keynes’s thought. If there was such a recognition on the part of Bentham, its scope was narrower than may appear from Keynes’s citation, in a footnote to and semi-detached from the discussion of the financing of projectors. Bentham in fact continued:

If the want of perfect information of former miscarriages renders the reality of human life less happy than this picture, still the similitude must be acknowledged: and we see at once the only plain and effectual method for bringing that similitude still nearer and nearer to perfection; I mean the framing, the history of the projects of time past, and (what may be executed in much greater perfection were but a finger held up by the hand of government) the making provision for recording, and collecting and publishing as they are brought forth, the race of those with which the womb of futurity is still pregnant. (Bentham, 1787/1952, p. 180)

Bentham therefore has in mind less the uncertainty of the human condition that was the cornerstone of Keynes’s philosophy, and more the uncertainty over the

outcome of industrial innovations. His view here is arguably much closer to that of Hayek's entrepreneur, carefully seeking to avoid the errors of others in his market, and trying to avoid ending up as the exemplar of error to others.⁴⁸

Bentham and Keynes had in common an outstanding ability to throw off brilliant observations on the margins of their discussions. Bentham realised that he had drifted away from his defence of usury, to which he returned with renewed vigour, leaving his philosophical and political economic intuition, like so many of his other insights, dangling inconsequentially in his text.

Bentham's *Defence of Usury* is therefore essentially a plea for commercial freedom to be extended to banking, an argument that the Usury Laws were ineffective and that they constrained saving, and therefore investment, as well as an account of the economic benefits of projectors. He did not deal with the main burden of Adam Smith's argument in support of the Usury Laws, namely that a rise in the rate of interest would cause a decline in the quality of credit, as sound competitive businesses with lower rates of profit are driven out of the market for credit by the high interest rates that "projectors" are willing to pay to secure their imagined high returns from their new technology.

10.2. The costs and risks of new technology

For Adam Smith, the economic progress that arose from technological change came through the division of labour. He considered that returns from improvements in capital equipment, and new machinery for production, were uncertain and subject to the high regard that "projectors" have for their foresight and their calculations. This view was criticised by the Scottish-Canadian John Rae (1796–1872), who was highly regarded by John Stuart Mill and the Austrian School, but little noticed beyond. This neglect is unjustified, in view of Rae's critical appreciation of Smith's work as well as his serious, pioneering contributions to economic methodology and the study of the economics of new technology.

Rae argued that Smith had been wrong in attributing the increase in the wealth of nations to the division of labour. In Rae's view, it was rather technical progress that facilitated the division of labour and increased the wealth of society, which Rae defined much more explicitly as the stock of capital equipment available for production. This stock was then "augmented" by "invention" (Rae, 1834, p. 264).

⁴⁸ Cf. "Competition is essentially a process of the formation of opinion: by spreading information, it creates the unity and coherence of the economic system (...) It creates the views people have about what is best and cheapest, and it is because of it that people know about what is best and cheapest, and it is because of it that people know at least as much about possibilities and opportunities as they in fact do" (Hayek, 1946, p. 106).

The promotion of “invention” therefore enriches society. However, laissez-faire and reliance on the self-interest of individuals, as advocated by Smith, cannot effectively support technological innovation. This is because, in Rae’s view, the time horizon over which the individual calculates his or her advantage is limited to their life-span, or perhaps that of their family. This is relatively short by comparison with the time horizon over which society calculates social benefits. He therefore urged that the state should intervene to support “inventions” broadly defined to include all the arts and the sciences (Rae, 1834, p. 53). Moreover, the process of diffusion through observing new practices and learning to implement them will then expand the productive effect of the new capital (Rae, 1834, p. 363). In this way improvements in the wealth of nations become public goods freely available to all rather than being dependent upon narrow self-interest (see Ahmad, 1996; Mair, 1990).

Rae’s work is not widely known, even among economists. It is curious, therefore, that his idea that the state should take responsibility for new technology, because private enterprise is unlikely to do it consistently and systematically, recurs through political economy to the present day. In the twentieth century the idea may be found in the work of Hobson, who argued that expanding finance for industrial laissez-faire led to monopolies and waste, and therefore the organisation of new technology, and the underlying investments in science and education, should be undertaken collectively by the state: “The character of machine-production (...) is essentially collective. The maladies of present machine-industries are due to the fact that this collective character is inadequately recognised, and machinery, left to individual enterprise and competition, oppresses mankind and causes waste and commercial instability” (Hobson, 1926, p. 428).⁴⁹ In the 21st century, the idea that the state should take the lead in promoting and financing new technology is at the foundation of the movement for public “development banks” (Griffith-Jones, 2022; Griffith-Jones & Ocampo, 2018). The idea is the basis of the work on industrial policy of Mariana Mazzucato (e.g., Mazzucato, 2013).

10.3. Monopoly and technological progress

A part of Hobson’s argument for state intervention arose because he thought that ‘there are certain dangers of monopoly attaching to all private conduct of industry. Collective control deals with these wastes and dangers, adjusting itself to their extent and character’ (Hobson, 1926, p. 410). Even before Hobson wrote these words, the impact of monopoly on technological progress had been taken up by

⁴⁹ Hobson shared with Rae the neglect of academic economists, although Hobson had more of a popular following outside universities.

the Polish economist and social critic Ludwik Krzywicki. In 1890, he published an article showing how the new markets for long-term corporate finance (bonds and stocks) were used to buy up competitors and create monopolies. The monopolies were used to extract higher profits from markets. The elimination of competition meant that the resulting corporate giants were no longer interested in improving production techniques (Krzywicki, 1890).

Krzywicki later visited America and even attended the Chicago World Fair in 1893. The new technology on display changed his mind and convinced him that the new monopolies were still interested in investing in new techniques. He no longer argued that monopolies were holding back technological progress. In fact, his criticism shifted over to the social consequences of monopoly rather than technological backwardness (Krzywicki, 1905a, 1905b, 1905c).⁵⁰ The question was later taken up in the United States by Joseph Schumpeter. He questioned the logic behind the notion that monopolies should hold back from investing in new technologies. The logic rested upon the idea that the costs sunk in installing particular equipment need to be recouped before new investment will be undertaken. There is an argument that having invested in a particular generation of technology, monopolies will buy up rights to newer competing technology in order to protect the position in the market of existing technology. Schumpeter dismissed this sunk cost as a factor in industrial decision-making, arguing against the idea that under socialism, with the abolition of monopoly power, technological change could be accelerated:

Private management [of monopolies – J.T.], if actuated by the profit motive, cannot be interested in maintaining the values of any given building or machine any more than a Socialist management would be. All that private management tries to do is to maximize the present net value of total assets which is equal to the discounted value of expected net returns... it will always adopt a new method of production which it believes will yield a larger stream of future income per unit of the corresponding stream of future outlay, both discounted to the present, then does the method actually in use. The value of past investment, whether or not paralleled by a bonded debt that has to be amortized, does not enter at all except in the sense and to the extent that it would also enter into the calculation underlying the decisions of a Socialist management (...) by-gones are by-gones (...) and any attempt to conserve the value of past investment would conflict as much with the rules following from the profit motive as it would conflict with the rules set for the behavior of the Socialist manager. (Schumpeter, 1943, p. 97)

Schumpeter's argument that monopoly has no effect on the pace of technological change was partly an effort to demonstrate that the Great Depression of the 1930s did not hinder the adoption of the new technologies of the time: the internal com-

⁵⁰ See also (Kowalik, 1959; Toporowski, 2023).

bustion engine, electronics and pharmaceuticals. He had in mind the expansion of these industries balancing the decline of older industries, such as railways and shipbuilding, in the process that he called “creative destruction” in the economy of the United States (Schumpeter, 1943). This argument confused the question of technological diffusion with the more macroeconomic question of the level of investment that is required to secure full employment.

Schumpeter was perhaps too ready to dismiss the effect of an established market position on the willingness of firms to invest in new technology. According to Kalecki, that effect depended not just on having an established position in the market but on the degree of unused productive capacity that the firm possesses. If a firm has machinery standing idle, then it is unlikely to add to that machinery with equipment, however much more productive it may be. For Kalecki, technological change is endogenous to investment: the higher the share of investment in national income is, the greater the proportion of productive equipment that is more recent and therefore embodying the most advanced technology. Additionally, the returns to investment are not themselves “expectations” abstracted from the process of investment. Kalecki’s theory of profits postulated that the higher the rate of investment is, the higher the rate of profit is, on average across the economy as a whole, and this feeds back into expectations of future returns from investment (Kalecki, 1933/1990).

The link between monopoly and the rate of investment in new technology came about not because of the private nature of the interests controlling the monopolies, as Schumpeter supposed, but because, as the literature on imperfect competition argues, monopolies operate with excess capacity. This excess capacity discourages investment (Kalecki, 1932/1990; see also Sylos-Labini, 1962). Furthermore, Kalecki challenged Schumpeter’s view that innovation increased competition, claiming that it rather tended to strengthen oligopoly (Kalecki, 1941/1991).

Kalecki concluded from this that innovations initially tend to stimulate investment, but then depress it as new technology becomes widely diffused. In an industrially diversified economy, the two effects on investment may overall cancel each other out, perhaps creating what Schumpeter called “creative destruction”. However, any imbalance between these two effects would influence the trend of economic activity around which the investment business cycle fluctuates (Kalecki, 1943, p. 89). He was later to conclude that a falling away of industrial invention would result in a decline in investment and a slow-down in economic activity (Kalecki, 1954, pp. 158–159).

When Kalecki was working out his argument about the impact of new technology on investment, in Oxford, during the Second World War, he discussed the question of industrial progress with another emigré economist, Josef Steindl. Steindl was later to write a fundamental study of the link between monopoly and the level of investment to show that the United States had been suffering from low growth, economic stagnation and economic depression from the 1880s up to the Second World War. He attributed this to monopolies and cartelisation creating excess capacity that

discouraged investment. But Steindl also introduced debt as a factor in investment decisions, with firms tending to postpone investments if their borrowing exceeded a certain ceiling (Steindl, 1952).

Steindl narrowed down Kalecki's view that essentially the rate of investment decides the pace at which new technology is diffused. In other words, new equipment embodies new technology. But the discovery of new manufacturing processes, or new products, in itself, will not evoke more investment until existing capacity is either fully utilised or is worn out and needs replacement:

Innovations (...) affect only the *form* which net investment takes. Innovations are applied (...) because business has money available and demand is such as to produce a high level of utilization. The stimulus of these economic factors produces additions to the capital stock, which usually, or very often, embody some innovation, simply because there is usually a stock of innovations and ideas waiting to be applied. Technological innovations accompany the process of investment like a shadow, they do not act on it as a propelling force. (Steindl, 1952, p. 133)

Steindl was later to change his mind, under the influence of Christopher Freeman, whose studies of systems of innovation persuaded Steindl that innovation may itself be a factor in encouraging investment (Steindl, 1976).

10.4. Venture capital

The work of Christopher Freeman left another legacy related to the financing of new technology, in the work of his Venezuelan collaborator, Carlota Perez, in the last years of his life. Perez, like Freeman, based her work on expanding the interpretation of the Kondratiev long-cycles that Schumpeter associated with technological innovations. In Perez' work, these cycles are linked to cycles of the financial development that is necessary, in her analysis, to finance research and development, and subsequently diffusion of new technologies. In each long cycle she argues that there is an initial phase, before a record of actual returns has been obtained, in which financing is highly speculative, that is usually followed by a financial crisis, as financing overreaches the uncertain profitability of the innovation. Subsequently, financing settles into a more assured track of financial support and returns (Perez, 2002).

Like Schumpeter's work, Perez' analysis raises further questions concerning the scope of new technology and its financing. However, it identifies clearly a feature of new technology: its excitement of expectations in order to seize possible rather than established opportunities with a track record, and thus its appeal to "animal spirits" rather than market or conventional evaluations. As a guide to policy and

economic decision-making, it points to the precariousness of the private financing structures supporting new technology, however beneficial that technology may be (see Toporowski, 2004).

In the last half-century, the financing of new technology has been especially associated with “venture capital” funds, providing finance for new technology start-ups, and then their expansion. These funds are best understood as a form of a “holding company” specialising in the initial finance of small businesses (see Steindl, 1952, p. 147). Holding companies play an important part in nearly all economies, where they “internalise” the process of capital allocation and the distribution of liquidity between subsidiaries of the holding company. Venture capital funds do this by investing in start-ups and maintaining the liquidity of the fund through borrowing and the sale of shares in successful (i.e. profitable) companies that they have nurtured (see Toporowski, 2023b).

However, the interest of venture capital in supporting new technology is by no means assured, despite declarations of interest in remunerative innovations. The success rate of start-up companies is small, and predictably fluctuates with the business cycle. Venture capital funds rely on selling their successful companies into the capital market (or to established corporations or holding companies) at a very high premium on the amount of money invested, to cover the shortfall on their much more numerous loss-making investments. Since the liquidity of the capital market also fluctuates with the business cycle, venture capital funds are prone to similarly cyclical cash flow changes. In recessions, lower success rate for their investments, and weaker liquidity in the capital market, are accommodated by shifting the focus of venture capital funds towards more established technologies with good cash flow, for example in retail business. This makes venture capital an inconstant support for new technology, in particular new technology that requires financing that is sustained over a long period of time, such as in clean energy or major infrastructure.

Conclusions

The discussion among economists about the financing of new technology has coalesced around two questions. The first one is the part that government must play in supporting the research and education which industrial innovation requires, as well as in facilitating the diffusion of new techniques.⁵¹ Here there is general consensus that the state should guide and support new technology rather than leaving it to the vagaries of market forces and uncertain finance.

⁵¹ See the recent discussion in Juhász and Steinwender (2023).

The second question raises issues of financial stability. Even before the need for state support was put forward by John Rae, Adam Smith had argued that the sponsors of new technology have the capacity to corrupt the banking system in a way that went beyond mere speculation in new ventures. Whether successful or not, the option of financing undertakings of unknown profitability risks depriving established technologies of the finance necessary for more mundane economic activities. In economies with functioning capital markets, the suspension of focus on the financial track record of technologies with a history, can still lead to speculative excess, notably with the dot-com bubble at the turn of the century. This again highlights the inadequacy of private enterprise and market forces in the promotion and diffusion of new technology.

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