Innovation

As the research field of economics deepened over more than two centuries since the Industrial Revolution, the linkage between innovation, growth and economic development - which early classical writers emphasised - has become more tenuous. Only economists examining the economy as a vast interconnected 'open systems' canvas continued to maintain this link, notably Karl Marx, Rosa Luxemburg, Michał Kalecki and Joseph Schumpeter. In the 1990s this situation dramatically altered, with an enormous expansion of research into innovation from many perspectives. Post Keynesian economics, after some early efforts in this area, has tended to neglect this issue as its emphasis on short-term economic outcomes places innovation into the autonomous forces of long-term growth (Bellais, 2004).

Innovation can be defined as the application of knowledge by the enterprise in a new form to increase the set of techniques (or processes) and products commercially available in the economy. This knowledge application can be technological or organisational (human resource) based within the enterprise, operating in a cooperative mode (Shapiro, 1991). The forms innovation can take are (i) continuous incremental (or '*Kaizen*'); (ii) radical discontinuous based on research and development (R&D); (iii) technological systems change based on a cluster of innovations; and (iv) techno-economic paradigm shift due to major structural change (e.g. the steam engine, information technology). Forms of innovation can dovetail into higher order innovation, thus becoming increasingly more important to society.

Contemporary innovation research has taken two approaches. One is broad-based evolutionary change in the long-term structure of capitalism, focusing on the impact of innovation on the economy. The other is narrow-based entrepreneurship

studies at the firm and industry levels, focusing on the individual entrepreneur or firm in managing innovation. Although both approaches acknowledge that innovation is deeply rooted in the uncertainty of the future world that brings change, their theoretical models acquit the issue through appeals to historical patterns or market adeptness, respectively. Post Keynesian analysis, identifying the sole source of uncertainty as the unexpected variations in aggregate demand arising from business cycles, provides the basis for analysing innovation as the precondition to investment decision-making. Innovation in the form of knowledge and creativity is embodied as technology through investment in new capital stock. Thus effective demand variation and accompanying cyclical volatility, signalled through profits as the reaction coefficient to the investment function, sets up successful innovation. This entry focuses on analysis of innovation that is based on this Post Keynesian perspective and incorporates research from both broad and narrow approaches.

Attempts in economics generally to incorporate investment into the theoretical analysis of innovation have been limited. Two major exceptions to this are Salter (1960) from the neoclassical perspective, and Freeman and Perez (1988) from the evolutionary perspective. Both innovation studies set up economic ‘snapshots’, which provide case study patterns to show the plausibility of the theoretical relations they derive with respect to investment. Due to their primacy of investment, Post Keynesian writers have used these two works to begin fleshing out their innovation framework.

Salter examines technical change arising from process innovation only and its implications for means of production increments at the margin in different industry sectors. In an exceptionally insightful manner, Salter recognises the gap between available process innovation and its application via investment. He uses market signals to indicate possible postponements in the use of introduction of more innovative means

of production and consequent delays in scrapping old means of production, thus the capital stock becomes 'fossilised' (Salter, 1960, p. 154). This exposes technical change to different rates of productivity growth between industries. The leading Post Keynesian, Geoffrey Harcourt, used this Salter approach to technical change in a number of significant articles in the decade 1965-75, culminating in Harcourt and Kenyon (1976) with an analysis of the impact on pricing behaviour of investment decisions incorporating technical change.

Freeman and Perez (1988) take a dynamic structural adjustment view of the economy with respect to innovation as a whole, and note the mismatch of current investment to new available technology. Rather than market signals, this study examines the variations in the climate of confidence related to the type of innovation and the life-cycle of the industries which account for this mismatch, leading to intensified investment instability. Courvisanos (1996) has extended this work by incorporating the life-cycle of innovation, from embryonic R&D to sustainable incremental change, into the investment instability of business cycles.

The classic proposition of an investment model with innovation comes from Joseph Schumpeter, who recognised that the investment function responds to waves of optimism and pessimism that create clusters of innovation and thus, 'bunching' of investment. Courvisanos (1996) shows how this leads to susceptibility to unstable investment cycles and the development of a trigger mechanism to initiate fundamentally new innovation systems with trend 'long wave' implications. In his final attempt at modelling investment, Kalecki (1968) identifies this cycle-trend pattern that innovation has on the investment function is due to higher profitability of more advanced means of production based on new innovation systems. Thus the intensity of innovation, in terms of the extent to which high profits from investment can be generated impacts on the

amplitude of investment cycles and shifting the trend path – or trajectory – of investment growth. Virtuous circle effects occur as innovation intensity rises, increasing the amplitude of the upper turning point of the investment cycle and shifting the trend path upwards. Vicious circle effects increase the amplitude of the lower turning point and shift the trend downwards. The pace of innovation is a shift parameter in the Kaleckian investment function. Courvisanos and Verspagen (2003) provide empirical evidence of this cycle-trend pattern.

Gomulka et al. (1990, p. 535) attempt to provide ergodic closure to the Kalecki trend and cycle theory. This study argues that Kalecki's central role of innovations in preventing the trend rate of unemployment from increasing is unsupportable, as '…the balanced growth rate which Kalecki took to be stable is, in fact, unstable, rendering it unsuitable to serve as the trend growth rate.' Lavoie (1994, pp. 297-327) examines Kalecki's innovation and investment analysis at the theoretical level and rejects the ergodic closure assumption which ties this theory back to the neoclassical mainstream. Kalecki clearly assumes that the rate of capacity utilisation may diverge from its full-capacity rate even in the long run, with the 'reserve army of the unemployed' as the typical feature of capitalism for a considerable part of the cycle. This asserts instability, as the dynamic non-ergodic business cycle has innovation-creating conditions that move the trend growth away from any analytical 'stability' and into the world of uncertainty.

The cause of clustering of innovation and subsequent bunching of investment ('clust-bun') is in debate. The prerequisite for clustering is deep depressions or breakthroughs in technology; both reflect reactions by private and public sectors to deep problems in the downswing of the previous business cycle. Then, the bunching requires effective demand stimulus through widespread diffusion of the cluster effect which can only be done through the availability of a surplus for investment (private profits and

public deficit spending). Impediments to this 'clust-bun' effect reside in the institutional frameworks of nations, particularly the ones that have still-dominant mature industries with older technologies (Freeman and Perez, 1988, pp. 58-65). Increased uncertainty arising from large investment in the new technology systems also adds a further impediment through increased macroeconomic volatility, slowing down the diffusion process.

The causality sequencing of innovation and investment is reversed by work done by Nicholas Kaldor and Joseph Schmookler, with the rate of investment determining the rate of innovation. Kalecki also recognises this sequence, despite having identified the innovation-driven process. Kalecki places this investment-driven process clearly into an appropriate context by viewing this innovation process as '...part and parcel of "ordinary" investment' (Kalecki, 1954, p. 158), or endogenous innovation.

Instead of unidirectional causality, the discussion above clearly leads to a circular flow where one innovation process feeds into the other. Kaldor's principle of cumulative causation is the 'self-reinforcing dynamic' in the circular process of investment demand leading to innovation that then stimulates further investment. The distinction between endogenous and exogenous innovation specifies how innovation enters this cumulative causation process. In this context, R&D expenditure is central to the endogenous innovation process, where large firms with strong profit results have the ability to activate large R&D spending, with patents reflecting the clustering of innovations, while exogenous innovation relates to techno-economic paradigm shift.

In Kalecki's view of innovation, endogenous innovation is of secondary importance from the scientific standpoint, coming as it does from: (i) slight adaptations on previous capital equipment (process innovation); (ii) cosmetic improvement in old products (product innovation); and (iii) extension of previous raw material sources. Such

continuous incremental innovation is called endogenous because it is the cycle itself that induces the innovation and, with it, higher levels of investment orders. With endogenous innovation occurring in a Kaleckian macroeconomy, the analysis can focus on how such innovation affects the firm/industry level, leading to an increased degree of oligopoly and higher market concentration (Shapiro, 1991) which has also been supported by evolutionary economics studies.

The firm's R&D expenditure is a form of intangible investment to be incorporated in the long-term business investment plan. This enables the firm to hold a stock of innovations that are ready to be applied when susceptibility to investment risk is relatively low. In this way endogenous innovation can be generated and directed by a process of investment. Assume a firm decides to increase investment at relatively low susceptibility, i.e. with low vulnerability to unstable investment cycles due to restricted past investment commitments in quantity (of 'dollars') and in quality (of innovation intensity). Then under competitive pressures and higher costs of postponement, the R&D investment in the past makes these innovations abundantly ready to implement. R&D investment effectively increases the strategic productive capacity of the firm. In an industry where innovation is a regular competitive strategy, R&D expenditure would be large and would vary under the same susceptibility pressures as capital expenditure. In an industry where innovation is only occasionally implemented, R&D expenditure would be small and constant over the investment cycle. Geroski (1994) provides evidence from the UK in the 1970s that radical innovation out of such R&D reduces market concentration.

The endogenous creation of innovations out of low susceptibility makes some means of production obsolete and thus not part of excess capacity calculation. Also, oligopoly firms (and industries) lobby for the assistance of governments in reducing

private costs of production (through subsidies, tax concessions or protection) when these firms attempt to expand their market by innovations in order to utilise new, and decommission old, idle productive capacity. Such innovation and under-writing of the related risks reduces the rate of increase in susceptibility and encourages an investment recovery.

R&D amounts in aggregate to a large body of investigation going on continuously (at different rates of intensity). This large R&D spending and related individual entrepreneurial activity are bound to lead to some major new 'discovery' or 'invention' which is related to the total aggregate R&D and innovation support funding, rather than any particular one R&D project. This discovery is linked to possible small developments in various laboratories and informal networks between individuals, firms and industries, eventually coming to fruition in some way divorced from any specific competitive behaviour. New technological paradigms come out of such aggregate developments and are the basis of structural change to a new long wave of boom and prosperity (Freeman and Perez, 1988, pp. 47-58). Changes in technological systems and paradigms arise only after all the minor improvements (endogenous innovation) are squeezed out of the old systems and paradigms by 'monopoly capital' protecting existing means of production and delaying the new paradigm from taking over. There is also a 'log jam' in endogenous innovations based on the new paradigm, which compounds the latter's slow initial adoption. This occurs when established powerful capitalists, with much old means of production, cannot justify the entire shake-up of industries, since not enough interrelated clusters have been formed.

Technological paradigm shift leads to exogenous innovation input, affecting the investment cycle. The introduction of a new paradigm produces a large exogenous boost to industry investment at low susceptibility points. This investment boom relates to

paradigm changes in large, important industry sectors that adopt new technology systems (e.g. petro-chemical innovations), or in the whole economy (e.g. steam engine innovations). Either way, the investment boom is strong and resilient over a series of future cycles in susceptibility.

As the institutional framework slowly adapts to the new technological system, entrepreneurs' reactions against uncertainty of profits come from competitive pressures and growing inefficiencies of old means of production. This induces adaptation (by industries) and imitation (within industries) to technological trajectories that are totally new, establishing, at very low susceptibility, the new investment upturn. It is creating a new investment boom and at the same time re-establishing the conditions for a new phase of steady development. A paradigm shift occurs when the new adapted technological systems pervade the whole economy. Many from the evolutionary school of economics identify such a shift with the beginning a new long wave in the economy's development

This analysis links together the two types of innovations described by Baran and Sweezy (1966) namely 'normal' (or endogenous) and 'epoch-making' (or exogenous). A period of secular decline in economic development can now be associated with the limitations of scale production in oligopolistic competition, as the old technology systems are running out of possible new adaptations. Diffusion of the old systems through endogenous innovation slows down, and imitators become considerably fewer. The large powerful corporations, with support from the state, attempt to protect existing capital values and ignore the new technological systems being developed on the fringe of the corporate world. This tends to exacerbate the mismatch between new technologies and the powerful private and public institutions based around monopoly capital, which Courvisanos (2009) named 'political aspects of innovation' after Kalecki (1943). Steindl,

using a Kaleckian model back in 1952, recognised this secular decline as the incentive to reduce surplus capacity and invest in established monopoly capital sectors. In his 1976 introduction to the second edition of his 1952 book, Steindl stated that he was '...ready to admit a possibility which I denied in my book: that it might be the result of exhaustion of a long technological wave' (1976, p. xv). In this way, the conclusions of the Kaleckian and evolutionary traditions can be integrated.

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See also:

Business Cycles; Growth Theory; Institutionalism; Investment; Kaldorian Economics; Kaleckian Economics, Technology and Innovation.

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