# In Search of New Atlantis: What can HET on innovation reveal about the path out of the 2009 Great Recession?

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## Abstract

The 2009 "Great Recession" has created a severe collapse of business expectations to coincide with severe financial overexposure. In this economic climate there is the tendency for the private sector to withdraw from investing in the future and for the public sector to seek to protect the major institutions of capitalism. Both lead to the exclusion of innovation and the concomitant deterioration of the accumulation process. In this context, there have been calls by some prescient economists and politicians to recognise this severe downturn as the opportunity for the generation and implementation of new knowledge. Innovation needs to be generated - particularly eco-innovation into sustainable development - and supported with a large public and private accumulation programme.

In about 1623, Francis Bacon wrote a fable about a secret undiscovered island, Bensalem, in which scientific progress through innovation (Bacon's "instauration") created an idyllic economy where humanity was in concert with nature. This Bacon juxtaposed with another island, Atlantis, which gained wealth and prominence through its domination over nature, until nature took its revenge. From Adam Smith onwards writings on economics have recognised the power of innovation to drive an economy. Using Bensalem as the ideal, this paper appraises visions of innovation and accumulation from various HET schools (especially Neoclassical, Austrian, Schumpeterian, Post-Keynesian, Ecological) to assess what these schools can contribute to development of an ecologically sustainable economic trajectory out of the 2009 Great Recession.



*Key Words*: innovation, Francis Bacon, recovery, sustainable development, schools of thought

> Human ingenuity and technological innovation can do the job for us, but only if there is genuine global commitment to change. As with addressing climate change, both developed and developing countries have to modify the trajectory of their impact on the natural environment. (Tanner, 2009)

### 1.1 Where is New Atlantis?

In about 1623, Francis Bacon (2003) wrote a fable about a secret undiscovered island, Bensalem, in which scientific progress through innovation (Bacon's "instauration") created an idyllic economy where humanity was in concert with nature. This Bacon juxtaposed with another much more famous island, Atlantis, which gained wealth and prominence due to its domination over nature, until finally nature took its revenge. The mythological island continent of Atlantis, as Plato (1977) tells it, "…was larger than Libya and Asia together…[which] was swallowed up by the sea and vanished…in a single day and night of misfortune". Bacon's fable was an ingenious approach to politics. The aim was to convince the power elite at the time to use the inductive scientific method he had formulated, for the benefit of humanity. Bacon sought to promote a new version of Atlantis for Europe (i.e. "Western society") to create; one that was closer to the truths that were uncovered by Bacon's lost European ship crew when they found themselves rescued by the good citizens of Bensalem.

New Atlantis would function along Bensalemian lines. It would have a state sponsored scientific institution (like Solomon's House in Bensalem) in which scientific experiments are conducted in the inductive method proposed by Bacon for "…finding out the true nature of all things" (Bacon, p. 20), but with "...reverence and obedience they give to the order of nature" (Bacon, p. 22). So it is the "…special knowledge of the workings of nature, which Solomon's House used as the foundation of its remarkable work" (McKnight, 2005). For Bacon, the spiritual discipline attained by the members of Solomon's House overcomes corruption and materialistic preoccupation,[1] and in this way New Atlantis would have science in concert with, and not conquering, nature.[2] Science would work with nature and not attempting to dominate it as happened in the Atlantis of Plato's world.

The lost crew from Western civilisation are told by the Governor of Bensalem that the success of science is based on the great instauration that comes out of Solomon's House. In this Bacon uses the accepted word of the time for spiritual renewal, "instauration", but gives it a new twist by naming Solomon's House scientific

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[1] In the fable, Bensalem's Governor claims the island possesses a copy of Solomon's *Natural History*, and the ongoing scientific work of Solomon's House advances the knowledge contained within the book. In identifying this, McKnight (2005) notes the literary link between "Solomon's House" and the biblical "Solomon's Temple".

[2] McKnight (2005) rejects the traditional view that for Bacon, growth of human knowledge through science was required in order to have "power over nature" (Broad, 1963, p. 174). To quote in full the McKnight argument:

> It is well known that Bacon repeatedly links the knowledge of nature with the ability to bring relief to man's estate. Most often this linking is associated with knowledge as power. What is often overlooked is Bacon's emphasis on charity as the motive for using the knowledge of nature for the benefit of humankind - and, more specifically, the allusion to the biblical Solomon's reward for his "large heart" and his request for knowledge that can help meet the needs of his people. It is wrong, therefore, to link Bacon to a Faustian exercise of egomaniacal power. The understanding of nature enables humanity to enjoy the blessings that God provided, not simply to conquer the natural world with impiety.

programme as "The Great Instauration".[3] This programme is the act that revives and revitalises society by starting over again to rebuild and enhance knowledge in the "…productive union of the mind with nature" (McKnight, 2005). New Atlantis is the place where this occurs. In modern terms, this programme provides opportunity for human ingenuity to blossom through the creative work of science and the productive work of innovation, and by this action to turn away from the self-indulgence of Western society. Bacon sees the great instauration occurring by means of the advancement of learning and not by means of religion and its ecclesiastical corruption. Practical aspects of new insights and research are what Bacon views as the outcome of innovation which benefits the whole nation. To the crew and the reader, Bacon shows that the path of renewal is innovation via the most learned and incorruptible inhabitants of Bensalem, the members of Solomon's House, who carry out their science and innovation in obscurity. This is in contrast to Atlantis which flagrantly exhibited its wealth and avarice that it gained by corrupt and inhumane means.

### 1.2 The Path to New Atlantis

Fast forward to 2009, and the 2008 Global Financial Crisis (GFC) has created what the International Monetary Fund has christened "The Great Recession"[4]. This recession has created an extremely severe collapse of business expectations to coincide with severe financial overexposure. As with the sea that "swallowed up" Atlantis, the GFC "swallowed up" Western advanced economies and their flagrant exhibition of wealth and avarice gained by unethical self-regulation, cheap credit and underpriced resources of nature (Das, 2009). In this recessionary climate there is the tendency for the private sector to withdraw from investing in the future and for the public sector to seek to protect the major institutions of capitalism. Both lead to the exclusion of innovation and the concomitant deterioration of the accumulation process. In this context, there have been entreats by some prescient economists and politicians to recognise this severe downturn as the opportunity for the generation and implementation of new knowledge. Innovation needs to be generated - particularly eco-innovation into sustainable development - and supported with a large public and private accumulation programme.

An example of such entreats comes from Lindsay Tanner, Federal Minister of Finance and Deregulation in the Rudd Labor Government, in the opening quotation. This can be seen in the context of Bacon's own entreat above, as the path to New Atlantis which will arise out of the devastation wreaked by the GFC.[5] Tanner wants human ingenuity and technological innovation to develop a new trajectory away from the tsunami of materialistic preoccupation and corruption into which Western society

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[3] In this fable, Bacon uses religious language to advocate the radical idea of innovation:

> We have certain hymns and services, which we say daily, of laud and thanks to God for his marvellous works: and forms of prayers, imploring his aid and blessing for the illumination of our labors, and the turning of them into good and holy uses. (Bacon, 2003, p. 41)

[4] Dominique Strauss-Kahn, IMF Managing Director, speaking at the African Finance Ministerial meeting in Dar es Salaam, 10 March, 2009. This "Great Recession" had its financial roots in Ponzi financing using sub-prime mortgages and collateralised debt obligations in the USA (see Kregel, 2008).

[5] First to use the term "GFC" in the context of "market fundamentalism" was George Sorros (1998, p. 135 - title of Ch 7), then Stiglitz (2000) "GFCs: Lessons from Recent Events" (Bisignano et al., 2000).

became enmeshed. The programme required needs to come from the wise and disciplined members of the scientific and innovation community residing in advanced economies within what recent literature has identified as the National Innovation System.

A stronger, and broader, evocation of New Atlantis comes from Robert Shiller, Professor of Economics at Yale University in an interview with Rik Kirkland of McKinsey on 14 April 2009, when he said:

> I think the government has to take an attitude that it is the sponsor of innovation, both of scientific innovation and of financial innovation. The government learned that years ago, just after World War II, when they created the National Science Foundation - and the government aggressively supports scientific innovation. We have to have the same attitude toward financial innovation. (Kirkland, 2009)

Aggressive support for scientific innovation is exactly the Baconian agenda. Shiller adds an interesting addendum. It is not strong regulation and shackling of the financial system, because this would be anathema to any form of innovation, as evidenced during the immediate post-World War II period when financial institutions were a strong restraint on innovation (Kingston, 1984). Instead, Shiller is advocating sponsorship of financial innovation. This means the public would need to have an input into the path of financial innovation, through the political process as USA did with its scientific goal of placing man on the moon.

From Adam Smith onwards, writings on economics have recognised the power of innovation to drive an economy. Therefore, there must be much in the history of economic thought on the role of innovation in the macroeconomy. This chapter provides an investigation into these writings to find what they articulate about the path of innovation. Innovation is not a static concept that can be placed within the standard neoclassical equilibrium paradigm, thus the path of innovation occurs over time (whether logical or historical) and is a dynamic concept. Some writers suggest a dynamic path to New Atlantis and how to get there, others merely analyse what has occurred in the process of travelling on (or off) the innovation path, and still others prognosticate on the future of innovation - be it a path of destruction to old Atlantis, or a hopeful rise finally to the New Atlantis that Bacon exhorted (and is still exhorting us) to reach.

This investigation will use Bensalem as the ideal - or template. Visions and analyses of innovation and accumulation from various economics writers representing major schools of thought in the past will be assessed against the New Atlantis template set up by Bacon. From this investigation will emerge what these authors can contribute to development of a path to the New Atlantis advocated by Tanner above; i.e. an ecologically sustainable economic trajectory out of the 2009 Great Recession.

### 1.3 The Template for New Atlantis

The central players in this investigation are the major authors in history of economic thought who developed theory in order to make sense of innovation and explain the dynamic economic growth path arising from it. Yet, as Kingston (1984, p. 11) notes: "Theory, however, is always behind reality, and the men (sic) of action who make the real world do so largely unaided (and un-encumbered) by theory." Thus, to begin this template it is important to acknowledge that the authors wrote in the context of the innovation (or lack thereof) that was occurring immediately prior to their writing, attempting to analyse the economic predicaments of their own juncture in time.

Initially what these writers reveal is a short period path of innovation that has occurred in the immediate past, say over the last ten years of one cycle. They analyse capitalists who made innovation decisions in the 'heat of battle' of the market competition process. These capitalists can be ascribed with the title "entrepreneur". Sometimes, writers who come later and have the advantage of some long run data on the innovation process, endeavour to provide a long-term (50 year plus) perspective on how innovation has unfolded. However, this is only in the retrospective analysis of a researcher who is looking to find long-term (or secular) patterns. The entrepreneurs made their decisions in the short period. This is the Kaleckian approach to time, in which the long-term economic growth path is a slowly changing component of a chain of short period situations (Kalecki, 1971, p. 165). This approach to decision-making time is endorsed by Adolph Lowe who cited Kalecki as "valuable support" to the notion that:

> To the extent to which the technical structure is unalterable in the short period, the prevailing degree of factor specificity determines each stage of the growth path. Therefore, what in retrospect appears as a secular process is, in fact, an abstraction derived from a sequence of short-term movements, the latter being the only 'real' processes. (Lowe, 1976, p. 10)

For this reason, the investigation needs the short period real economic context within which explanation of innovation is being discussed by the relevant author. Also, the authors investigated are writers of the time who advocate an innovation path, not the mass of economists who have looked retrospectively to interpret past innovation within a prism of their own economic perspective.

With the Baconian template, "The Great Instauration" programme needs to be clearly identified. In modern language, this means providing ontology for innovation. Courvisanos (2007) provides such ontology, suffice to summarise this position by noting that: "Innovation can be defined as the creative application of knowledge in a new form to increase the set of techniques and products commercially available in the economy." (Courvisanos, 2007) As Bacon would argue, the future of New Atlantis depends on, "...innovations in the broadest sense [including opening up of new sources of raw materials] as the most important promoter of development" (Kalecki, 1954, p. 161). Thus, Kalecki regards short period innovation promotion as crucial, arguing that the "...influence of this factor is analogous to that of an increase in aggregate profits which in the course of a given period makes investment projects generally more attractive than they were at the beginning of this period." (Kalecki, 1954, p. 158) Through this process of innovation, together with the innovation-induced profits (or any other financial instrument), a dynamic secular growth path will be generated.

From the above definition, innovation has a technological driver component that leads to investment and creates accumulation that leads to a secular economic growth path (Verspagen, 1993). Technological innovation is the commercial implementation of new technical knowledge. This knowledge is derived from scientific or engineering developments in specific research and development (R&D) activities or in the course of day-to-day production and marketing activity (Sahal, 1981, p. 42). This ranges from epoch-making major new technological innovations (like the microcomputer chip) to minor marketing-based product innovations (like modifying a car model by adding fins to its rear). All technological innovation requires substantial investment in new means of production which establishes the economy's accumulation path.

Kalecki also recognises another form of innovative behaviour which "...is largely concentrated on a 'scientific organisation' of the assembly process which does not

involve heavy investment" (Kalecki, 1954, p. 159). This non-technological innovation component is based on creative application of human resources management and marketing knowledge. Both do not involve modifying the technological process or product, and require a relatively minor amount of capital expenditure. However, these "human capital" components are crucial complements to technological innovation, but would not exist without technological change itself.[6] Bacon clearly correlates Solomon's House - "the lantern of this kingdom" (Bacon, 2003, p. 19) - with the biblical Hebrew King, Solomon, under whom the Hebrews (like Bensalem) enjoyed unprecedented prosperity and freedom from religious or political interference by neighboring powers. This came from the human capital factors in "The Great Instauration"; chiefly the leadership of Solomon in making "his kingdom and people happy" (Bacon, 2003, p. 17) by "…providing enlightenment and prosperity; enlightenment encompasses religious knowledge as well as philosophical knowledge of the workings of nature that can be applied for the benefit of humanity." (McKnight, 2005)

In Bensalem, the administrative officer for Solomon's House called Joabin, emphasises to the European crew of the sterile milieu in which the state exists when "men" become obsessed with their intellectual creations. Joabin identifies this with the divorce of mind from nature.[7] In the context of the analysis in this chapter, industrialisation that arose from the Industrial Revolution of the late 18th Century in Great Britain is always referred to in the retrospective innovation literature as the launching pad for the massive technological innovation that has transformed Western society into "advanced" economies (Freeman and Perez, 1988; von Tunzelmann, 1995). Since that launch, Western society has been marked by the greatest technological progress in human history and with it the twin feats of escalating standards of living and augmenting destruction of nature (Boulding, 1966). Western society has become so obsessed by the mind of intellectual creations via industrialisation that nature has become further and further detached from it. Thus the dilemma arises that any expansion out of deep recession requires major innovation processes, which from the experience of the last 240 years, the growth from this technological innovation exacerbates environmental destruction.[8]

Thus, the New Atlantis template has two central elements. One is the role of science and technology in providing the technical wherewithal to power an innovation-based paradigm shift away from the excesses that led to the downfall of the longest and strongest boom in Western economic history. The other is the role of human capital

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[6] Some innovation studies see human capital factors as inducing technological innovation (e.g. Prajogo and Ahmed, 2006), while others see these human factors as working in tandem with technological innovation (e.g. Jiménez-Jiménez and Sanz-Valle, 2008).

[7] Bacon (2003) repeatedly uses the "marriage" image in reference to mind and nature because he wants to emphasise the moral and religious base that is required in any society to maintain order.

[8] Two broad interpretations of this dilemma exist in the economic growth literature. One interpretation is evidenced by Lipsey et al. (2005, pp. 426-31) who expresses optimism that technological change will be able to continue to solve "the problems caused by externalities of growth", but faces the dilemma of whether "human assessment of the costs and benefits of doing" so is appreciated and correctly priced. The other interpretation is evidenced by Davies (2004, pp. 225-31) who argues that what has emerged since the Industrial Revolution is "...the accumulation of material wealth with little regard for the quality of our lives", focussing instead on economic growth in "quantitative terms".

factors that complement technological change in a way that supports, rather than destroys, the ecosystem (or nature). The aim now is to embark on a search for New Atlantis using these two central elements. Major writers in the classical, neoclassical, Marxist, Austrian, Evolutionary, Post-Keynesian and Ecological traditions are examined to detect aspects in the innovation story of economic growth which are relevant and applicable to charting an accumulation path out of this current major recession.

### 1.4 Classical Economics

Adam Smith is chronologically the next major writer to look at innovation since Bacon. Whereas Bacon writes in the form of a fable to provide a path for innovation, Smith gives an account of rising innovation around him at the beginning of the Industrial Revolution. Smith (1976), at the very start of his book with the illustration of the pin factory in the new industrialised England, attributes innovation to organisation of the assembly process in the form of the division of labour through specialisation.

Smith identifies three improvements out of specialisation (a major form of process innovation) that results in dramatic increases in productivity: worker dexterity, time saving and mechanised machine invention. Von Tunzelmann (1995, p. 36) assesses the first two as merely "one-off" improvements that expire quickly due to limits of boredom and being an initial structural shift, respectively. The third factor provides the basis for long term growth through the accumulation process as new machines bestow the ability for labour to continually specialise. Further, as von Tunzlemann notes in this context, Babbage (1963, p. 21) extends the Smithian innovation exposition to the need for systemic co-ordination through the "mental division of labour".[9] This latter factor is not "once-off", but the type of management of human resources that notoriously produced Fordist hierarchical "scientific management" (Taylor, 1967) through mass production, but continues today in a more considerate form under the HRM business discipline. Together, the last two factors (one technological, the other human) create the path of economic growth via increasing scale of production.

Examining the Smith-Babbage innovation insights through the Bacon template provides two important elements to any path of renewal. On the technological front, insight on the role of accumulation is not limited to the demand stimulus of investment during the construction phase, but also to the ongoing learning that emerges. Von Tunzelmann (1995, p. 38) identifies this from Smith's (1976, p. 21) discussion of "improvements in machinery" that result in three forms of learning: learning-by-using, learning-by-doing, and scientific learning. All three arise from mental division of labour, by opening up possibilities of further innovation through cumulative causation in the form of both process and product innovation. In an intriguing twist, Smith sees this mental contribution coming, not from any deductive reasoning (the dominant scientific approach of the time), but Bacon's inductive

[9] This is the same Charles Babbage who is famous as the inventor of the mechanical computer and less known as the father of complexity-based mathematics. "Babbage was much more knowledgeable than most of these [classical economists] about manufacturing" (von Tunzelmann, 1995, p. 115), yet as Colander (2000, p.7) notes he "has received almost no attention either in economics literature or the teaching of the history of economic thought." A similar outcome has occurred to Bacon.

"serendipitous process making new connections and combinations" (von Tunzelmann, 1995, p.38). For Smith, science via induction, as with Bacon, has a very positive cumulative role for innovation and the development of society. This is at odds with writers on economics, both past and contemporary of Smith, who regard science as merely information for enterprises to use, but with no cumulative spillover effects (see Say, 1821, pp. 52-3).[10]

On the human factor front, this is closely interrelated to the technological factor. The only way that the mental stimulus of learning can occur is if humans are allowed to use their inductive reasoning. This requires the type of human resource management that Bacon endorsed through Solomon's House of enlightenment from which emerges an understanding of the workings of nature. Unfortunately, economic history tells a story of very limited "enlightenment" in the British Industrial Revolution, with learning and innovation coming from well-to-do middle class owners and small groups of highly skilled workers, while the aristocracy became a threatened species and the rest of society was mired in poverty and exploitation. Thus, there was no scientific institutional force behind Britain's industrialisation, as the science of The Royal Society (established a century earlier) was deductive in approach, its knowledge was not exploited by the British industrialists and its science was further advanced in other countries (see von Tunzelmann, 1995, pp. 101-37).

What can be discerned from the Smith-Babbage analysis is that paradigm shift comes from investment demand by entrepreneurs with available capital funds, a commitment to inductive learning and the ability to reinvest with cumulative knowledge. The investment is in productive capital that results in quality niche innovation, leading to a relative few set of customers willing to pay for higher quality and, thus, cumulatively building up scale of production. Bacon's two elements emerge out of science and technology with a "lantern" of learning leading the way. Yet, many aspects of Bacon's template are missing from the Smith-Babbage insights. Notably two aspects are worth noting. First aspect is the lack of any explicit significant public policy or scientific institutions driving the innovation process. Second aspect is the lack of understanding of how innovation links mind to nature, with only the rudimentary insight that it is through mental division of labour that learning and reinvestment take place.

No other classical writers are involved in this story. As the Industrial Revolution became entrenched in Britain and then spread to Europe and America, the attention of the classical economists shifted away from understanding the innovation path, and focussed on the resulting problems that emerged from this paradigm shift in economic structure. They tried to explain these problems by analysing the distribution of products (consumer market) and income (resources market) in a comparative static approach. To them innovation was adequately analysed by Smith, even though not fully understood by writers like Say. This obsession with static distribution issues

[10] Interesting to note that J.-B. Say "…later expressed doubts that the Law would hold good in circumstances of innovation." (von Tunzelmann, 1995, p. 41). Given that in the real world, economic development can not occur without innovation, the implication is that Say's Law only applies in static states of equilibrium, and that (from critical realism perspective) the 'unreal' world of comparative static pseudo-dynamics is the only way to analyse economic development.

gained its full luminosity in neoclassical economics (NCE) with the rise of the Marginalist Revolution in the mid-19th Century.

### 1.5 Neoclassical Economics

Famously Rosenberg (1982) attributed economists to possessing a "black box" into which resources go in, and products come out. Inside the box is where the process of innovation occurs. This stems from the NCE obsession with resource allocation through optimising price-guided distribution issues, rather than through entrepreneurial-guided production issues. This is a strange "black box", given that pricing decisions have to be made inside the firm, as do non-price competition issues that NCE also analyses. Further, there is also the crucial exogenous element of science and technology which flows into the box but is considered as inappropriate for economists to analyse (Robbins, 1932, pp. 32-8), and thus left undetermined in NCE. The production function encapsulates the best-practice technology fix between resources with two ways to advance this technology. One is the 'unresearched' parametric shifts in the function, and the other is the unexplained induced innovation from a rise in one factor price.

The NCE view of innovation has one association to Bacon's template. To NCE, science and technology are the antecedents of innovation while ignoring the role of human management in innovation (Sanidas, 2005, p. 70). Thus, any broad national or global problem resulting from economic growth (particularly greenhouse gas emissions) is resolved by higher prices (e.g. energy) and the exogenous advances of science. This is the standard NCE perspective on the power of human scientific knowledge and its applications to overcome the constraints of nature. The traditional view of Bacon is that this same knowledge from science will overcome the "ignorance of nature", so that the human mind has the power to conquer nature (Broad, 1963, p. 174). However, the recent McKnight reinterpretation of the union of "mind with nature" outlined at the beginning of this chapter implies that the traditional view of Bacon (as with NCE) is a reflection of the technological optimism created by the massive advances in science since the Industrial Revolution. Instead, a careful reading of Bacon (2003) reveals this attitude to be the path to Old Atlantis and its avarice ways. The path to New Atlantis must be found elsewhere, by cooperating and adapting to nature. "If they [men (sic) of science] cannot succeed in this difficult enterprise, man will destroy himself by his half-way cleverness." (Russell, 1963, p. 180)

Empirical studies on the sources of economic growth using an aggregate production function framework, from Abramovitz (1956) study of the USA onwards, find that the major factor to a large extent is the 'residual' factor (referring to technical change - or process innovation - in a broad sense).[11] Yet, all the basic internal static NCE growth model factors that are explicitly price responsive make up a relatively small amount (e.g. Denison, 1962). Without abandoning the NCE model, mainstream economists have tried to "adjust" the empirical evidence by various clever methods, e.g. include capital services in the capital input (Jorgenson and Griliches, 1967), disaggregate the

[11] Some other empirical studies that have identified the significant role for technical change and innovation are Denison (1962), Denison and Poullier (1967), Landes (1969), Kuznets (1973), Mensch (1979), Maddison (1982), von Hippel (1988), Vivarelli (1991), von Tunzelmann (1995), Courvisanos and Verspagen (2002), Lipsey et al. (2005).

residual (Dension, 1962), dissect growth into stages (Rostow, 1960). No consensual empirical approach has emerged from these *ad hoc* efforts to incorporate innovation, leaving the residual without any general pattern that could be accounted for through the manipulation of marginal input values in the market place.

Theoretically, NCE has attempted more recently to "peer" into the black box like a "peeping Tom", attempting to explain innovation without distorting the legitimacy of NCE.[12] Nobel Laureate Kenneth Arrow in 1962 developed two key NCE concepts on innovation that have been continually cited since then. Borrowing from psychology, Arrow (1962a) identified learning-by-doing that occurs when new capital resources are introduced into the firm, but ignoring Adam Smith's other two "learning" concepts because they are product specific and do not fit into the NCE resource allocation framework. Then, accepting the other forms of learning as exogenous "production of knowledge", Arrow (1962b) absorbs them into an algorithm for the incentive to innovate as a function of market competition and deduces that competitive firms have a higher incentive to innovate vis-à-vis monopolists. Thus, the price/profit guide to resource allocation remains sacrosanct in the pseudo-dynamic NCE world of innovation. Demstez (1969) is critical of Arrow (1962b) because it compared monopolists with large output against much smaller outputs in perfect competitive conditions. As Kingston (1984, p. 10) notes, it is the imperfections creating market power that provide the above-equilibrium average return on investment which stimulate innovation. This critique of Arrow began a large heterodox strand of thought in which the dynamic path-dependence of firms impacts on incentive to innovate as much as the price-guided allocative system.[13]

New neoclassical growth theory is the most recent strand of NCE to tackle innovation within its limited resource allocative system. This strand takes the work of Kamien and Schwartz (1968) on induced innovation by firms and then endogenises technical change within growth models. Technical change, from R&D expenditure and human capital accumulation, is modelled as a stock variable with positive externalities. This creates a divergence between optimal and equilibrium growth. Various environmental factors have been modelled in an effort to identify the form of the growth-environment dilemma. A major achievement of these models is to reject the neutrality of money (Aghion and Howitt, 1998, p. 269), thereby opening the door for government intervention to improve economic welfare. However, Stanfield (1995) raises two concerns; inability to, first measure size of intervention and then, fix the existing configuration of institutional specifications. Without such measures and fixes, optimality through intervention is impossible (Verspagen, 1992, p. 652).

[12] Just like a 'peeping Tom' attempts to see what is going on inside without becoming involved, since that would then distort the activity being surreptitiously viewed.

[13] Christensen et al. (2009), through their study of USA pharmaceutical companies, show clearly that large firms with strong market power have large integrated systems which provide "the scope to create within themselves a new disruptive value network". On the incentive to innovate issue, Christensen et al. (2009) recognise the much more complex factor that large firms tend to resist disruptive innovation in favour of incremental innovation despite significant market signals, which indicates a lock-in path of innovation towards failure (e.g. General Motors and new model petrol-driven cars, pharmaceutical companies and new drugs, Microsoft and 2007 Vega software system).

From the discussion in this section, it is clear that the path to New Atlantis can not be found in the NCE paradigm. Benhaïm and Schembri (1996, p. 131) explain that neoclassical optimality prevents NCE growth models from providing any guidance for public or private investment strategies despite acknowledging market failures.[14] The equilibrium-optimality constructions cannot perceive sustainable development "other than a state to reach" within very restrictive settings. NCE has no path to ecological sustainability that provides a productive union of mind and nature. Evolution of the system through technical change in historical time is not possible under optimality conditions. This neoclassical optimality approach assumes that today's economy is merely a scaled-up version of yesterday's economy. This does not provide a path for economic renewal out of recession. A negative, but useful, conclusion arises in seeking this path to New Atlantis: NCE neglects the evolution of institutions that occur with different technological trajectories and associated investment dynamics that effectively alter the path of economic development (Courvisanos, 2009b). These are the elements that need to be taken account of in the search for New Atlantis among the following heterodox economics schools of thought discussed below.

### 1.6 Marxist Economics

Economics took an alternative heterodox fork in the road from classical economics via Karl Marx, and away from mainstream NCE. This road leads to acknowledging that innovation, through Marx' theory of technological change is a social process (or Bacon's human factor). Starting from the same point as Smith, Marx sees the social organisation of work under specialisation in the early years of the Industrial Revolution as reacting to the initial mercantilist interest in expanding profit-making opportunities. This is the primary stage of the innovation process. Marx calls this "simple reproduction", and it is the organisation of work into divisions of labour with machines that allow increase scale of production.

The science of machines, or what Usher (1954) calls "mechanical inventions" adds the technological factor of Bacon's template. As the Industrial Revolution powered on into the 19th Century, Marx observed the limits to scale of specialisation which induced a capital-goods producing sector with inter-industry relations coming into operation. When such machines are validated by capital accumulation, the result is technological innovation.[15] Marx identifies this second stage of the innovation process as "extended reproduction" that allows capitalism to continually grow. This growth is imperilled by the social relations of production, manifested by the conflict over the distribution of income between capitalist and workers. This conflict undermines profitability of firms and creates instability in capitalism that materialises as business cycles (Marx, 1959). This Marxist cyclical contradiction of the business cycle in the context of 20th Century monopoly capital is explicated in great detail by Michał Kalecki (see Section 1.9 below).

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[14] As Metcalfe (1995, p. 26) clearly puts it: "In quite a fundamental sense, innovations and information asymmetries are one and the same phenomenon. Indeed, such asymmetries can scarcely be termed market imperfections when they are necessary conditions for any technical change to occur in a market economy."

[15] From this historical path of technology, it is clear that Marx is not a technological determinist. For a full explication of this argument, see Rosenberg (1982, pp. 39-43).

Two parts of the Bacon fable emerge out of the Marxist account of innovation. One is the role of human ingenuity that Marx sees as the crucial creative driver prior to the reality of reproduction. Thus, it is the "architect" through her/his "imagination", and not the "bee" through its hard work, that undertakes innovation (Marx, 1954, p. 174). The other is the way Marx explained how innovation results in "nature" becoming "one of the organs of his activity", but which would then change her/his own nature, leading to destructive exploitation (Marx, 1954, p. 175). This harks back to Bacon's own concerns about innovation leading to Old Atlantis and its destructive avaricious conquest over nature.

The path of renewal away from Old and towards New Atlantis is something Marx focuses on in two ways. The first is on renewal within capitalism after recession. Marx was the first writer to provide a comprehensive and systematic endogenous account of business cycles, with major expansion occurring through innovation-induced structural change. However, he notes that each new expansion sows the seeds for its own future downturn, exacerbating the contradictions of capitalism further. These contradictions continue to widen the gap in social classes, until the second permanent renewal occurs via a socialist revolution. Since our focus in this chapter is the innovation path out of recession, the political path to a socialist utopia is left aside.

Marx's account of expansion out of recession is clearly linked to process innovation and its impact on labour-process (Marx, 1954, pp. 173-92). Having explained the "reserve army of the unemployed" as a result of technological unemployment caused by the displacement of workers by new more labour-saving capital technology, the story is set for an expansion. As a result of lower demand and excess capacity in the consumer goods industries during the downturn, profits are squeezed and investment continues to decline.[16] Postponing investment intensifies the downturn and puts innovation on hold (even if invention is still going on at a strong rate). For Marx, cycle trough and resulting turning point comes from a similar process to neoclassical economics. This is the process of adjustment in supply downwards to meet lower demand. With output falling faster than wages, competitive pressures force some expansion through a rise in investment, and with it accompanying incremental innovation (see Marx, 1959). This is an "automatic" account of expansion, but with no effective renewal path to New Atlantis. This road, for Marx, has to wait until the socialist revolution arising from the proletariat and a vanguard leadership in advanced economies.

In contrast, there is a very sharp analytical focus on the microeconomics of innovation in the path to cyclical recovery by Marx. He was the first to identify what business management theorists call "first mover advantage" by which innovative start-up firms introduce an innovation. However, these start-ups will find it very hard to maintain their advantage since they would have "far greater cost of operating an establishment based on a new invention as compared to later establishments arising *ex suis ossibus*. This is so very true that the trail-blazers generally go bankrupt, and only those later buy the buildings, machinery, etc. at a cheaper price make money out of it" (Marx, 1959). Although the focus is on process innovation, compared to the modern product

[16] Howard and King (1985, p.218) regard Marx "at his best" when discussing the downturn. For more explicit Marxist accounts of profit squeeze, see Glyn and Sutcliffe (1972) and Boddy and Crotty (1975).

innovation story, the account is a very cautionary account of the limits to first-mover advantage. Further it supports empirical evidence that suggests the first entrepreneurs that take the start-up risk under the high uncertainty of a deep recession have severe susceptibility to failure (Sundbo, 1998). This accounts both for the number of start-up failures on the path to recovery, and the many "false starts" that occur during troughs. Thus, the more innovative the firm is, with significant shifts in technological and organisational structure involved, the greater the susceptibility to failure.

Given that a leading researcher on innovation, Nathan Rosenberg (1982, p. 34) clearly described Marx as a "careful student of technology", it is interesting to note the paucity of Marxist writing on technology and innovation. There is a body of Marxist literature on technological transfer to less developed economies, with a split between "dependency" theorists who see poor transfer (e.g. Frank, 1967) and more traditional Marxists who stress peripheral development (e.g. Warren, 1980). There are also studies on the implications of such technological change, leading to the falling rate of profit (e.g. Shaikh, 1982), which are outside the remit of this chapter. Mandel's (1975) theoretical work on long waves of growth relate to the empirical work of Kondratieff (1984), and provide a technological determinist account of "techno-economic paradigm" shifts approximately every 50 years. Long waves have been developed in far more detail (and less deterministic) by the evolutionary economics school which is discussed below in Section 1.8.

Taken in its entirety, Marxist economics with its roots in the classical specialisation production process provides a fruitful basis to the search for New Atlantis. The recovery out of a recession has its foundation in the system of reproduction in which capital investment validates innovation, and the path is one that is uncertain, unstable and prone to false starts. The subsequent exploitation of workers by this process raises further concerns about the path ahead. The next section adds another dynamic process to the search for a path, one that comes from a completely opposite ideological perspective.

### 1.7 Austrian Economics

Agency is fundamentally lacking in the Classical-Marxist perspective and only implied under a resource allocation algorithm in neoclassical perspective. Austrian economics sees the agency of the entrepreneur as central to the determination of innovation. This agent is seen as alert to opportunities for taking advantage of discrepancies and gaps in the market system.[17] In this sense, the Austrian entrepreneur is an arbitrager; a persona embodying foresight, knowledge and willingness to act in situations of widespread ignorance of the disequilibria that exist in the market that comes out of the criticism that the neoclassical position lacks any subjective human element to agency (Canterbery, 1995, p. 262). Exploiting opportunities in process innovation is the way Austrians see entrepreneurs adding value to the final product through the techniques that are 'put to use'. The more capital-intensive the processes of production, the more capital goods are put to use with increasingly complex techniques and with a higher market price that the product can command. Value is thus added by the "degree of roundaboutness", leading to capital deepening in the economy (Kirzner, 1973). The appropriation of monopoly power in the market is

[17] Neoclassical economists call such discrepancies and gaps 'disequilibria in the market'. See Kirzner (1973) for a modern-day exposition of Austrian entrepreneurship

evidence of creative and successful entrepreneurship. Such monopoly power is not seen as permanent by Austrians unless such power is underwritten, subsidised and otherwise supported by governments and their regulatory agencies.

Promoting the innovation provides the competitive advantage. As an arbitrager, the Austrian entrepreneur identifies and reveals the ends latently demanded in the economy. Marketing is merely the process of informing market participants of the opportunities created by entrepreneurs. Any monopoly power that is established from marketing will be slowly undermined in the marketplace rather than the quick response assumed by the neoclassical perfect competitive process. Thus, from the Bacon template, the Austrian entrepreneur is driven by the non-technological element of innovation that can constitute a competitive advantage for a time. Any technical change is a subsequent outcome of arbitrage, with technological innovation emerging from the entrepreneurial activity of the firm. There is no formal role for public and private institutions to lead science and technology like Solomon's House. The Austrian perspective lacks an institutional focus, but provides strong agency motivation which is a crucial element in any path to recovery.

Like Marxists, Austrians have a strong accumulation link from innovation to investment, but in this case it is driven by the entrepreneur's need to produce the final marketable product. Effective demand is latent and always waiting for the entrepreneur to exploit. The investment process continually alters the structure of capital, where this capital is the only factor of production and embodies anything that the entrepreneur invests in (human, physical, natural or social) to produce the final product (Kirzner, 1976). Contextual relevance to this entrepreneurial process centres on Schumpeter (1934) and the role of small innovative firms developing the creative niche in capitalism that is the bulwark of technological innovation, which reflects the capitalism of the 19th Century. The laws of motion are governed by the actions of the entrepreneur, with cycles being the subjective reflections as well as signals of these actions.[18] These signals, Hayek (1931) explains, are distorted by governments with inflationary monetary policies. Thus, surveillance of market created rules under the principles of private property is the one acceptable role of government in the process of innovation and economic development. *Laissez-faire* is rationally necessary for entrepreneurship to flourish, with judicial outcomes protecting private property rights being the centrepiece of public policy (Kingston, 1984).

For the Austrians, innovation is only limited endogenously by the imagination and creativity of entrepreneurs and exogenously by the heavy hand of government restraining opportunities through regulation. Both limitations are subjectively bounded by the operation of individual creativity and by the negative reaction of entrepreneurs to regulation. There is much research in the business management discipline on the most effective ways of unlocking the creative potential for business (e.g. Amabile, 1997) but this does not provide a model of creativity that can be used to understand economic development of the innovation process. This means that the specific institutional role for innovation that Bacon espouses can not be found in the

[18] Hayek (1984) notes that overinvestment leads to the downturn. The problem for Hayek is that capitalists misread the signals and continue to produce at levels that lead to significant excess capacity. Government planners, on the other hand, insist on ensuring all excess capacity is employed and thus thwarting any entrepreneurial process innovation.

Austrian approach. There is also no guidance for public policy for innovation, since subjective individualism drives innovation.[19] Uncertainty underlies finding opportunities and delivering outcomes. This is the crucial dynamic element that drives the entrepreneur, but it is not analysed in a way that would facilitate the better handling of uncertainty for potential entrepreneurs. Thus, it is not clear whether entrepreneurial actions will deliver the desired outcomes. Examples of actions by entrepreneurs in the corporate collapses of the early 2000s ("tech wreak", Enron, WorldCom, Martha Stewart) indicate that optimum social outcomes may not always result (see Clarke et al., 2003).

Bacon's most learned and incorruptible inhabitants that lead the innovation process are missing in this Austrian perspective. Also there is no link to nature in order that innovation can be subject to humanity's strictures. The concern is that this approach can be a rationalisation for capitalist excesses in a globalised economy where the rule of national law is becoming much more tenuous. Further, as a path to recovery, cyclical expansion occurs merely from signals, rather than any significant policy intervention. There is no policy strategy for renewal, but instead a clear indication that society must have social and communication systems that allow entrepreneurs to be very cognisant of information and signals in the community (for example, in relation to climate change) that engenders innovative solutions from the creative classic entrepreneur. The problem is that although the classic entrepreneur still exists, empirical evidence suggests (as Marx's noted) "…that only a minority of new companies survive, and that these are often not particularly innovative." (Sundbo, 1998, p. 157)[20] The innovation process has become institutionalised since Thomas Edison introduced the R&D department into his innovation of a longer-lasting light globe. Technological and organisational innovation have to a large extent become organised, 'managed' and taught as strategies in MBA programmes. They need to be harnessed in any search for New Atlantis, but from the Austrian perspective it is largely subjective and can not be planned.

### 1.8 Institutional and Evolutionary Economics

The two related schools of economic thought, institutional and evolutionary, have the largest research agendas related to innovation of any school of thought outlined in this chapter. The strength of this research has led to one monograph proclaiming in the title: *A New Economic Paradigm? Innovation-based Evolutionary Systems* (Bryant and Wells, 1998). Borrowing the concept of strong agency motivation from his Austrian school teachers, Schumpeter's entrepreneur evolves into a major economic force with institutional specificity. For Schumpeter (1939), the entrepreneur responds to waves of optimism and pessimism to create clusters of inventions, which then are diffused through the bunching of investment: the 'clust-bun' effect (Courvisanos and Verspagen, 1992). This leads to investment cycle patterns and the development of a trigger mechanism to significantly increase the rate of investment in endogenous

[19] Hayek (1948) explains how little we know from the objective basis of human activity.

[20] Sundbo (1998, p. 160) goes on the argue that "..the number and significance of the entrepreneurs compared with the large, complex companies have been weakened." Although job creating by small firms can be a path to recovery in the short term, generally such ventures do not survive and do not involve technological innovation, as identified in empirical studies quoted by Sundbo (1998, p. 157). Thus, the path to renewal can be easily stymied before it reaches significant economy-wide aggregate scale of production.

(incremental) innovation on the basis of a specific exogenous basic (or radical) innovation already created by the established large corporation. Thus, the long wave again appears in full view, this time spurred on by the diffusion of techno-economic paradigm shifts in major innovation engines like steam and electric power and more recently information technology (that have more recently become known as general purpose technologies, GPT). This creates what Mensch (1979) describes as S-curves of industrial complexes, with long periods of growth through the S-curve are interrupted by relatively short periods of deep recession and "turbulence" at the end of each GPT-driven S-curve.

The upturn is specified by Schumpeter (1939). At the bottom of the investment cycle an innovative trigger to initiate a 'virtuous cycle' effect occurs with investment rising to diffuse basic innovation. This increases the amplitude of the expansion phase of the investment cycle, raising innovation intensity and shifting the trend path of economic growth upward.[21] Here for the first time in the history of economic thought there is a specific explanation of the path to recovery, but is it the path to New Atlantis? Unfortunately, Schumpeter (1942) sees this path as an exorable path to stagnant socialism, as large corporations become huge bureaucracies that no longer have the entrepreneurial spark of innovation. These dominant firms are so significant to national economies that governments need to support them, resulting in a state-supported mendicant capitalism. Schumpeter's apocalyptic vision is becoming a reality in the wash-up of the GFC[22], and can not provide any clear innovation path of renewal out of the GFC.

Galbraith (1967) provides an alternative, but sanguine, vision of state-supported capitalism. For Galbraith, the role of government in technological innovation is to support the corporate "technostructure" through the educational and scientific estate made up of teachers and researchers in schools, universities and non-profit research centres. Their intellectual work and social organisation "…are woven into the work of big corporations, which provide research funds, endowed chairs, and lucrative consultancies in exchange for these valuable new technologies and techniques." (Parker, 2005, p. 440-1) This estate generally does not challenge the order of the corporate planning system and is bound to it by mutual love of what Galbraith called "technological virtuosity" and the social prestige it engenders. Such mutual love has been challenged by the GFC, with governments around the world confronting large global financial and industrial firms like General Motors with their lack of corporate responsibility and demanding innovative responses.

Galbraith (1967)'s institutional perspective is strongly based on a public sector interventionist position. Out of the large corporate collapses following the GFC, this Galbraithian vision has become the *ad hoc* fashion of the times. Galbraith argues that

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[21] See Toivanen et al. (1999) for empirical support on this virtuous cycle effect. Also, an opposing 'vicious cycle' effect works to reduce innovation intensity, thus sending the investment cycle into a significant contractionary phase.

[22] Most notably, there is the bankruptcy in June 2009 of General Motors, the largest corporation in the 1960s which at that time GM controlled more than 50 per cent of the global light-vehicle market and represented ten per cent of the USA economy. Come June 2009 and the USA government is attempting to ensure survival of a drastically downsized GM and some semblance of an American indigenous automobile industry by taking up 70 per cent of its equity. GM's "murder" of the electric car ten years ago has turned out be a suicide action by the company. (Neil, 2009)

the political power imbalance needs to be addressed by reformist public policies which aim to provide more balanced development; especially for regions, industries, unions, communities and independent innovators that do not have the support of the technostructure. Galbraith (1973) spells out such a program of balanced development from a macroeconomic perspective; however the specific role of innovation and technological change is not developed. This specific innovation policy perceptive has been developed in by recent Neo-Schumpeterian school, which combines the evolutionary agency of Schumpeter with the institutional specificity of Galbraith.

Bryant and Wells (1998) edited monograph provides a clear outline of the Neo-Schumpeterian innovation policy approach. For an overview of the theory that provides its foundations, see Nelson (1987). From this perspective, innovation policies need to be both active and positive in the direction of encouraging variety, fostering experimental behaviour, supporting new developments, focusing on system building, enhancing diffusion, promoting learning organisations and their skills training, as well as assisting to influence expectations (through broad-based grants, tax concessions, mentoring, and supporting small business services). The major contribution from this perspective is the holistic approach to analysis and policy, recognising interdependencies with dynamic evolutionary forces. This requires complex economic dynamics that can identify systemic (rather than market) failure and interventionist policies to overcome such failures. Many examples of success in this innovation approach can be noted: war-based economies, reconstruction from major devastation (e.g. the Marshall Plan), national sports-based academies, regional clustering around universities, and technology parks. These elements are the closest economics writing to the Bacon template, at both the technological and human factor levels. It is a detailed sentient account of an innovation path in line with Bacon's "The Great Instauration" programme.[23]

Galbraith is seen as supporting the technocratic role of the professional manager, separating ownership from management and developing an internal organisational structure based around strategic planning (Sundbo, 1998, p. 141). Galbraith uses this internal corporate structure to focus on the politico-economic role of large corporations on the external society, while Penrose (1959) and the resources-based view (RBV) focuses on how corporations organise their internal resources. Penrose also provides a clear growth process for independent start-ups towards multinational status, something Galbraith does not entertain, but which is crucial in any path to renewal. Out of today's very many start-ups, a few will emerge as the future Galbraithian goliaths and their own technostructures. Despite identifying "creative destruction" at the product/process level, Schumpeter never entertained the idea of creative destruction occurring at the firm level, with the General Motors bureaucratic dinosaurs of today being replaced by the "General Solars" of tomorrow.

Yet, the ideal firm size of innovation champions is not clear. RBV follows Penrose in identifying the precise circumstances and actions of the firms that determines innovation champions. Scherer (1980, p. 418) warned 25 years ago that "…[t]he search for a firm size uniquely and unambiguously optimal for invention and innovation is misguided". There is strong theory and evidence to support both small

[23] See Courvisanos (2006) for a detailed critique of this programme.

and large firm innovation propensity. In fact, medium-sized firms tend to be the most disadvantaged, since they lack the dynamism of small entrepreneurship and the wherewithal of large firms to conduct R&D. However, "…[u]equivocal evidence is found that [market] concentration exerts a negative influence on the number of innovations being made in an industry." (Acs and Audretsch, 1991, p. 14) This means that innovations can emerge as much from small firms as from large firms, thus industrial and regulatory policies cannot be based on simple rules about firm size but more related to market power through high concentration in particular industries. In general, the role of government from the RBV perspective is the need to be active supportive (e.g. removing monopoly rents), and not passive supportive of established large corporations (e.g. extending the life of intellectual property rights).

For all the potency of the institutional-evolutionary innovation path identified above, there is strong supply-side element to the innovation drivers. Market demand fails to register, leading to the problem of effective demand and how this limits any innovation path. From this emerges the most critical factor, which Galbraith himself identified; the lack of market power as a crucial element in the innovation process, despite the occasional reference to market concentration strength as a negative influence on innovation. It is to this that the next school of thought addresses its research interest.

### 1.9 Post-Keynesian (Keynes and Kalecki) Economics

A macroeconomic perspective on the technological innovation process is lacking in all the previous perspectives. Their emphasis is on the industrial organisation of innovation. Galbraith's own Keynesian predilections gave him a strong effective demand macroeconomic view, but this has never been wedded to his technostructure and the political economy of technological innovation. Keynes own work on a monetary theory of production harks back to Marx's monetary circulation, but more clearly identifies the autonomous components of aggregate demand affecting the real economy which may not be in synchronicity with supply generated due to the ability of actors in the economy to hold liquidity in an non-ergodic world (Davidson, 2003). Investment, for Keynes, was the chief driver of reproduction of the system (à la Marx), but was also the most unstable component of demand due to firm susceptibility tensions (Courvisanos, 1996). Thus, lack of synchronicity results in instability for the economy. For Keynes, innovation is - in Steindl's (1952) words - a "shadow of investment", as technical progress[24] is embodied in capital accumulation. This assumes that all growth-based innovation is technological (ignoring the important role of organisational innovation identified by Bacon) and also remains inside Rosenberg's black box of industrial organisation.

Keynes's focus on investment, however, opened the door for a Post-Keynesian analysis of innovation that links this crucial Bacon-driver to the instability of capitalism via effective demand, and not the Say's Law world of supply. Kaldor recognises the "technological forces" that can keep the capital-output ratio from rising, notably human capital formation, R&D and technological spillovers from trade (Thirlwall, 2003, p. 224). Stuck within his own 20th Century, Kaldor (1966) saw

[24] Post-Keynesian literature generally assumes that any technological innovation is "technical progress" (e.g. Thirlwall, 2003). "Progress" has a strong positive connotation. There is no appreciation that technological innovation may also be a constraint to progress (as will be discussed in Section 1.10).

technological innovation driving manufacturing industry to increasing returns and inducing growth in the rest of the economy, as it did for the industrialising South-East Asian economies in the 1970s and 1980s. Paradigm shift of innovation to a knowledge economy can not be appreciated from this Kaldorian analysis.

A small group of economists working in the Kalecki-Steindl tradition have made a significant contribution to the macroeconomic demand-oriented aspects of technological innovation that helps to appreciate the economic development and volatility of modern neo-liberal capitalism. This provides an effective demand oriented path to renewal that no other perspective is able to achieve. The agency that is central to the determination of technological innovation in the Post-Keynesian literature is called "the capitalist". The capitalist links innovation to investment decision-making so that the elements of effective demand and cyclical volatility at the broad base are related to the cumulative processes in all forms of innovation at the firm/industry level. This perspective derives from Keynes (1936) and his clear view that investment is the essential, but 'undependable' drive wheel for the economy. Co-progenitor of the Post-Keynesian perspective, Michał Kalecki, identifies the historically determined profit levels as generating the ability to invest in capital goods and in innovation knowledge enhancement. Profits (or surpluses in non-profit organisations and public authorities) not only provide the wherewithal to invest, but also through their extension of the capital funds owned by the organisation ("entrepreneurial capital"), it also allows for access to loans and share issues ("rentier capital"), which can further extend capital and knowledge-based investment (Kalecki, 1954, p. 92).

Capital accumulation is embedded in the endogenous (or induced) innovation generated from within the organisations (*via* R&D expenditure, and knowledge spillovers). Such innovation is of secondary importance from the scientific standpoint, coming as it does from: (i) slight adaptations on previous capital equipment; (ii) cosmetic improvement in old products; and (iii) extension of previous raw material sources. Kalecki (1954, p. 161) calls the "innovation effect" a "development factor" which creates the following dynamic process:

> …innovations prevent the system from settling to a static position and engender a long-run upward trend. The accumulation of capital, which results from the fact that long-run investment is above the depreciation level, in turn increases the scope of the influence of the development factors and thus contributes to the maintenance of the long-run trend.

Kalecki, then, sees "exogenous" innovation as representing the intensity of innovation with given capital investment levels. This means that any change in the intensity of the innovation effect originates in the scientific invention or basic business opportunity identified as the source of the innovation. So that a:

> …reduction in the intensity of innovations…will also initially cause a disturbance in the cyclical fluctuation and, by means of a slump more pronounced than the boom, will make for a lower long-run level of investment. (Kalecki, 1954, p. 148)

This would lower the long-run trend, where an increase in innovation intensity would raise the long-run trend in economic growth.

Freeman and Perez (1988) were the first to integrate the Post-Keynesian and Evolutionary perspectives into a model of paradigm shift and accumulation. Perez (2002) has made refinements to this analysis using historically related periods called

"installation" and "deployment". This model begins with invention and the early attempts at installing the new innovation with the support of financial entrepreneurs. R&D amounts in aggregate to a large body of investigation going on continuously at different rates of intensity, and at different scale of activity (from small start-ups to large R&D corporate divisions). This large R&D spending and related innovation effects are bound to lead to some major new 'discovery' or 'invention' which is related to the total aggregate R&D (and other invention activities). Discovery is linked to possible small developments in various laboratories and informal networks between firms and industries, eventually coming to fruition in some way divorced of any specific competitive behaviour. New technological paradigms come out of such installation and are the basis of structural change to a new long wave of boom and prosperity; but not yet!

Deployment of technological systems and paradigm shift arise only after all the minor improvements (endogenous innovation) are squeezed out of the old systems and paradigms by 'monopoly capital' entrepreneurs who want to protect existing capital stock and delay the new paradigm taking over. There is also '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 capital stock, cannot justify the entire shake-up of industries, since not enough interrelated clusters have been formed. In some way (via collapse of speculative bubbles or insufficient effective demand), recessions send the old capitalists to the Marxian 'dustbin' of history. New capitalists' reactions against uncertainty of profits come from competitive pressures and growing inefficiencies of old capital stock. This induces adaptation, deployment and diffusion of innovation, creating a technological trajectory that is totally new, establishing a new strong investment upturn. At the same time this upturn re-establishes the conditions for a new phase of steady development. A paradigm shift occurs when the new adapted technological systems pervade the whole economy. This is a very sophisticated path to renewal, but it lacks a political economy perspective.

The Keynesian-Evolutionary model can be integrated with political economy through a Marxist-Keynesian framework. This is done by linking the above analysis with 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 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 powerful institutional framework based around monopoly capital. It was Steindl, back in 1952, who recognised this secular decline as the incentive to reduce surplus capacity and invest in established monopoly capital sectors. In his 1976 introduction to the 1952 book reprint, 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).

Courvisanos (1996, pp. 225-30) outlines three policy paths for renewal: (i) demand management to regularise investment cycles at the macroeconomic level (e.g. "cash splash" handouts); (ii) encouraging innovation into new technological systems at the

microeconomic level (e.g. emissions trading scheme); (iii) 'socialisation of investment' through perspective planning at the mesoeconomic level as countervailing power to the planning system of monopoly capital (e.g. public infrastructure). More integration needs to be done. The policy paths described need to take account of the role of competition (Austrian) and collaboration (Institutional) in the innovation process. Despite the appropriate investment demand conditions and public support, without these two market dynamic elements of firm innovation, the innovation process could be heavily stymied as it was during the command economy period of Eastern European economies (see Marangos, 2004). Further, the path to renewal identified so far lacks the other Bacon element - the constraints of nature. There is a serious neglect of this aspect of the Bacon template in all the major 20$^{Th}$ Century economics perspectives as the world economic booms were being continually powered by GPT that have been slowly but surely chocking life as we know it.

### 1.10 Ecological Economics

Bacon's 'humanity in concert with nature' has become an enormous ecologically systemic concern since the 1970s scientific and social literature on limits to economic growth (physical – Club of Rome; social – Fred Hirsch; technological – Schumacher; consumerist – Vance Packard; entropic - Georgescu-Roegen). Then in 1987 emerged the first scientific report of the Greenhouse Effect which made the front page of Australian newspapers for one day and then disappeared until the Bruntland Report *On Our Common Future* in 1989.[25] Only two strands of economics have directly attempted to address these concerns in the context of the economic system and both are critically evaluated for their major limitations by Courvisanos (2009b). NCE, through the sub-field of environmental economics, has a static optimality tool kit consisting of market failure and cost-benefit analysis to derive sustainable development policies. Courvisanos (2009b) argues that this very same tool kit which is applied to every aspect of life through an economic algorithm (right 'down' to the 'economics of tooth brushing' to work out the optimal time needed to brush our teeth in the morning) prevents any coherent incorporation of the ecosystem into the economic system.

Ecological economics is the alternative systems-based approach to the environment which is in concert with Bacon's "productive union of mind and nature". This alternative optimal approach to sustainable development is based on the seminal work by Herman Daly (1977). Daly argues that sustainable development can only be achieved through an optimal ecological scale of resource use that is derived from the "biophysical equilibrium". This equilibrium determines that the optimal scale of production is where there is a balance of material-energy throughputs into the economy that maintains the flows from the ecosystem at a constant sustainable level. This is the optimal steady-state economy (SSE).[26] Daly (1977, p. 17) considers

[25] I am here ignoring the climate change sceptics that have come out of the woodwork recently, funded by significant interest groups from the extreme political right (e.g. Heartland Institute) and the extreme political left (e.g. Citizens Electoral Council of Australia). Also, the ecological concerns of this planet are much broader than just climate change.

[26] Towards the end of a more recent book, Daly (1996, p. 223) clearly recognises the optimality of his SSE version of sustainable development: "The optimal scale, following our basic ethic, would be the one that maximizes lives ever lived over time at a sufficient level of per capita resource use for a good life".

innovation as essential in this type of economy to improve the quality of society without adding to the stock of human artefacts that would distort the biophysical equilibrium. Market-based instruments of the type supported by neoclassical economists are the public policy tools used to achieve steady-state. In the restatement of his case, Daly (1996, p. 31) explains that in a "SSE the aggregate throughput is constant, though its allocation among competing uses is free to vary in response to the market." This incorporates private incentives in optimal allocation to achieve collective control at the optimal scale of production. Daly's path-breaking analysis continues to dominate ecological economics as can be observed from the "frontier issues" book by Lawn (2007), in which it is argued that transition to SSE is necessary to achieve sustainable development.

Georgescu-Roegen's application of the entropy law on material-energy flow to economic growth is the basis of Daly's SSE optimal rule and is the crucial unifying concept for ecological economics (Faber et al., 1996). In all versions of sustainable development that come out of this flow analysis, the aim is to set up a use pattern with constant environmental and resource stocks over time. This can be achieved by keeping all natural stock in their original state (strong sustainability) or only maintaining a constant aggregate sum of all stocks (weak sustainability).[27] There are two constraints needed to implement such optimal rules, one is the carrying capacity of the environment and the other is the ability to close the economic-ecological system within which the strategy is being developed (van den Bergh, 1996, pp. 36-49). Both raise serious concerns of how the market economy can determine the biophysical equilibrium path. Sustainable development in ecological economics is, thus, not an assumed future equilibrium state as in neoclassical economics, but instead identified as the future macro-optimal equilibrium SSE that environmental policy must be assessed against to determine their appropriateness (Söderbaum, 2007).

SSE is constrained market environmentalism in which the investment process operates the same way as with neoclassical economics but with the crucial pre-analytic setting of an optimal scale of production. Size of the investment projects is predetermined, yet there exists market-based encouragement to develop ecologically sustainable technology. Thus, a highly (favourably) cited article in *Ecological Economics* by Pearce and Atkinson (1993) begins discussion with: "To do this we adopt a neoclassical stance and *assume* the possibility of substitution between 'natural' and 'man-made' capital" (p. 104, original emphasis). This analytical devise is very much locked into the neoclassical paradigm, with overriding macro-SSE optimality. This approach in *Ecological Economics* reaches its nadir with Sim (2006) where the neoclassical IS-LM model is extended to include an EE environmental equilibrium constraint that represents all interest rate-output combinations such that the economy's use of environmental services is exactly equal to the ability of the natural environment to supply them. Sim's admits that "the model imposes a strong assumption that policymaker has perfect knowledge of what the environment constraint is", but more puzzling is the implication that standard macroeconomic policy can induce supply of the natural environment. The ecosystem is responsible for the latter, not the economy!

[27] For details on issues related to policy implementation of such optimal rules, see for example, Costanza (1994), van den Bergh (1996, pp. 53-79), and Parts Two and Three of Faucheux et al. (1998).

Vercelli (1998) argues cogently from first principles that the uncertainty problems identified by Post-Keynesians make any optimisation algorithm based on substantive rationality impossible to be expressed in anyway that would have operational significance. The elements of irreversibility and complexity that arise over historical time imply that an adaptive procedural (or bounded) rationality is required. This means that the objective of sustainable development can only be achieved in a cumulative process of learning-by-doing and acquiring knowledge through implementation of acceptable adaptive (non-optimal) conventions and rules. Thus, even when some attempt is made by ecological economists to incorporate an evolutionary view of technical change, it falls into neoclassical traps. For example, Carrillo-Hermosilla (2006, p. 731-2) has an agent-based model that considers the problem of technology lock-in as only "potentially significant" and then goes on to explore a precautionary approach that is "complementary to conventional equilibrium oriented environmental polices".

### 1.11 Charting a Path to New Atlantis

The discussion above provides a journey through the economic thought of innovation using as a guidepost Bacon's template. What emerges is not a coherent path to New Atlantis, but economic 'straws in the wind' that need to be integrated into a systematic path that can be charted to New Atlantis. Many of these 'straws' are 'negative' straws that clearly indicate any policy actions using these concepts will lead us back to Old, and not New, Atlantis. This is particularly the case with neoclassical economics, but as shown above, all schools of economic thought are guilty to some extent of diverting away from the innovation path to New Atlantis. The avarice economic growth of Old Atlantis is often much too strong for any economic school to deny.

The following emerge as the main innovation economics elements from HET:

1. The chart must be drawn up with a short-period scale to indicate the time reference to which investment decisions are conducted. This is chain of short period (5-10 year) accumulation path within which firms make investment decisions. The long period (50 years plus) is merely the addition of short-period outcomes.
2. The Smith-Babbage paradigm shift derives out investment demand by the entrepreneurs with available capital funds and a commitment to inductive learning, as well as the ability to reinvest with cumulative knowledge.
3. Neoclassical economics shows that market power creates incentive for human scientific knowledge and its applications which aim to overcome constraints of nature; in particular, the constraints of animal and human power that limit both time and mobility.
4. Marxist system of reproduction through capital investment validates innovation, with a path that is uncertain, unstable and prone to false starts; which are 'tempered' by the exploitation and alienation of the masses.
5. Austrian entrepreneurial agency promotes innovation by providing the competitive advantage which can be arbitraged for private gain, to the 'natural' benefit of society.
6. Evolutionary economics recognises the impact of innovation on the dynamics of competition through encouraging variety, experimentation, diffusion and learning. In the process this builds social institutions and knowledge systems that assist in addressing expectations.
7. Post-Keynesians develop an effective demand oriented path to renewal that supports the deployment of scale in innovation through reproduction; leaving new

arrivals in innovation to struggle in a world of niche markets until paradigm shifts occur.
8. Ecological economics sees constrained markets as innovating towards macro-optimal steady-state equilibrium, which ensures biophysical human sustainable long-term existence.

Together the eight points above provide the critical elements for the path to New Atlantis. These elements are not possible to implement during a time of strong economic expansion. All the literature indicates that paradigm shift innovation occurs at disjunctions in history. The 2008 Global Financial Crisis is such a disjunction. Governments, businesses and communities face the option of attempting to hold on to the Old Atlantis which is going under (e.g. bailouts of failed banks and auto companies), or grasp the nettle through the eight elements above and chart a course to New Atlantis. This latter course is what Lindsay Tanner is imploring. Is it a realistic path? Clearly there is more 'room to move' for governments, capitalists and the community to take this path.[28] The path requires economic development through learning-by-doing in a path-dependent way that produces increasing returns to ecologically sustainable innovation. Such scale comes from capital accumulation and reproduction by means of entrepreneurial agency that is guided by evolutionary channels of knowledge. The task is to develop open, but guided, complex systems - logically very far removed from equilibrium - with short-term innovation and investment decisions that link simultaneously to long-term ecological and economic sustainability. This is the ship that can take the voyage on this charted course to New Atlantis.[29]

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[28] Who would have thought one year earlier, in May 2008, mainstream economists would in May 2009 seriously entertain economic policies like fiscal stimulus, nationalisation of banks, re-regulation of self-serving capitalists, community-based action on local and global environmental issues. In the past these issues were the prerogative purely of the 'loony left'.

[29] I have charted a specific course along these lines in Courvisanos (2009a).

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