Political Economy of Innovation and Sustainable Development: A Kaleckian-Schumpeterian Synthesis in the Context of Cycles and Crises

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Abstract

Central to this paper is a critical realist political economy approach based on the works of Michał Kalecki and Joseph Schumpeter, both of whom identified cycles, crises and innovation as the three dynamic forces driving economic development. The paper outlines initially how capitalism, through investment, enshrines innovation in profit and power which determines the course of cycles and crises. Using Kalecki's own analysis, Courvisanos in "The Political Aspects of Innovation" (*Research Policy*, 2009) identifies the economic, technical and political power that resides within the decision-making elite. This power ensures continued operation within the current profit-making paradigm despite economic and ecological crises. This systemic failure enshrines economic, political and innovation systems within all nations. It is the reason why there have been massive bailouts of corporations that failed; huge financial support for nations with no means of repayment; and large industry and political support for minimal climate change processes and no addressing of food security issues.

The methodology of this paper is critical realism based on the work of Bhaskar (*A Realist Philosophy of Science*; 1978). From critical realism, objects are seen as possessing inherent structures and causal powers (or generative mechanisms). The exercise of these powers causes events to occur at a given manner. This paper, through an outline of the political economy of innovation inspired by Schumpeter, identifies the various causal mechanisms on innovation that underlie the unsustainable economic development that brought the world to these crises, and systemic failure barriers that limit current innovation responses towards sustainable development.

The analysis in this paper is a prelude to a sustainable development framework with guided strategic intervention by transformative eco-innovation as a public policy path. The prelude sets up for a framework based on the theory of instrumental analysis (Adolph Lowe), integrated with the more recent work from complexity theory dealing with uncertainty (led by Brian Arthur and the Santa Fe Institute).

> Human knowledge and human power meet in one; for where the cause is not known the effect cannot be produced. Nature to be commanded must be obeyed; and that which in contemplation is as the cause is in operation as the rule. (Bacon [1620] 2000, p. 47)

Introduction

Cycles, crises and innovation are the major economic forces that shape capitalist economies. These forces need to be harnessed for the daunting task of shifting the juggernaut of industrial and economic development away from the technological and organizational systems that have created an ecologically unsustainable world. Innovation for transforming the world's industrial system into an ecologically sustainable society is the clarion call in this paper. Creative destruction is required on an enormous scale to open the market space for eco-innovation.

The aim of this paper is to sketch out briefly how innovation is created, implemented and diffused through the globally dominant capitalist economic system. Based on these revelations, the framework is set out for public and private innovation strategies that form a transformational path towards sustainable development. Full argumentation and details are presented in Courvisanos (2012). This paper primarily outlines a eco-sustainable framework for this transformational paradigm shift.

Using critical realism methodology, the nature of innovation is revealed in the context of how it operates to support unsustainable economic development. From this critique, the framework for a strategic shift becomes evident. As a starting point which is a given and not argued, is that the ecologically-based sustainable development literature provides the rationale for paradigm shift. The framework is based on the work of two giant figures of the 20th Century in the field of political economy, Michał Kalecki and Joseph Schumpeter. Kalecki is recognised as developing the same 'effective demand' approach to economics (initially in Polish and French) that John Maynard Keynes developed under 'Keynesianism' in the English speaking world, but unlike Keynes, Kalecki had a clear non-neoclassical epistemology. Schumpeter is known for recognising the creative destruction aspect to innovation. Both Kalecki and Schumpeter identify cycles, crises and innovation as the three dynamic forces plotting the path of economic development. Kalecki with his class-based Marxian economics roots and Schumpeter with his agency-based Austrian economics roots seem strange bedfellows. Nevertheless, the starting point for both is to view innovation as being the implementation of new ideas that address specific problems and/or identifiable opportunities that occur on the basis of the economic boom and bust of cycles. Where Schumpeter is known for opening up the evolutionary approach to innovation and economic development, it is Kalecki's "adaptation mechanism" through investment in innovation which forms the central element in the eco-sustainable framework set out below.

From the standpoint of the early 21st Century, the depiction of cycles, crises and innovation needs to be revisited and reconstructed in the context of immense developments that had not been identified by Schumpeter, Keynes or Kalecki. These developments include the rise of the hi-tech service economy on the back of the information and communication technology revolution; the intensification of globalisation as a commercial reality; the increasing rate of destruction of Earth's ecosystems through economic growth in both developed and developing economies; and deep over-accumulation and financial instability that lead to economic recession with accompanying unemployment and regional inequalities.

A political economy approach to these global problems is required; one that focuses on the centrality of power and the generation of patterns which show both correspondence and

contradictions in the way that market processes relate to the real world. This alternative approach has a critical realist perspective, examining the real social world as it negotiates an open system of social structures and agents. How does Kaleckian and Schumpeterian analysis coherently interact in this behavioural space?

The Kaleckian behavioural and accumulation perspectives, in terms of entrepreneurial investment, are the basis of profits and reproduction. What underlies this investment process is the Schumpeterian innovation perspective that sees clustering of basic or radical innovations as the wellspring for the upturn in the trough of a business cycle. Then, the Kaleckian adaptation mechanism enables this clustering to become investment bunching, which is the innovation impulse for a cyclical expansion. The shift to incremental innovation and consequent limitations of reproduction create the conditions that are susceptible to cyclical contraction. Then, there is the inevitability of crisis that waits for a trigger to cause the downturn. This is the dynamic macroeconomic setting within which the framework operates.

This paper goes on to provide the critical realist critique that exposes the role of investment which is the basis of profit and power that is unsustainable. Then the political aspects of innovation set in place barriers to a paradigm shift towards sustainable development. This analysis is the prelude to the development of a framework for sustainable development that provides a path to paradigm shift for capitalism.

Critical Realism: Knowledge and Power

Critical realism contends that event regularity does not explain anything. Instead, critical realism looks at the nature of being (or ontology) as socially constructed with underlying causal mechanisms that produce observable events. From critical realism, objects are seen as possessing inherent structures and causal powers (or generative mechanisms). The focus is on innovation in this analysis, so the generative mechanisms here relate to the innovation process. Suffice to define innovation as the creative application of *knowledge* in a new form to increase the set of techniques and products commercially available. The former is commonly called process innovation, while the latter is product innovation. It is the exercise of the causal powers to do with innovation that leads to specific changes (or events) to occur.[1] Thus, knowledge and power provide the basis of the political economy of innovation, as has been identified as far back as Francis Bacon (see opening quotation) in *New Atlantis* (Bacon [1620] 2000) which is the first tract on politics and innovation.

Causal mechanisms can be observed by a reading of the vast array of literature on explanations of how innovation impacts on economy and society. This critical realist approach identifies innovation and its implementation through three forms of investment. The first is by firms in capital accumulation, referred to as tangible investment. The second is codified and tacit knowledge within firms, referred to as intangible investment; e.g. research and development (R&D), design, in-house training, experimental time, organisational architecture and networks.[2] The third is public investment in knowledge-based infrastructure and support for building innovation capacity; e.g. education and training, internet access, technology parks and incubators, protection and incentives.[3] Let's briefly examine each.

[1] For an introduction to critical realism, see Sayer (2000) and for a more sophisticated treatment specifically addressing the economics discipline see Lawson (1997; 2003a).
[2] See Webster and Jensen (2006) for this breakdown of investment from an enterprise perspective.
[3] See Freeman (1995) for all such public investment in the context of national innovation systems.

Innovation has a technological driver component that leads to tangible investment which creates capital accumulation. This leads to a secular economic growth path identified from a Schumpeterian perspective (Verspagen, 1993).Technological innovation is the commercial implementation through tangible investment of new technical knowledge. This knowledge is derived from intangible investment in scientific or engineering developments on specific R&D activities or in the course of day-to-day production and marketing activity (Sahal, 1981,p. 42). The chain of innovative activities 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). For Kalecki, technological innovation requires substantial tangible investment in new means of production which establishes the economy's accumulation path.

Kalecki also recognises intangible investment as the other driver of innovative behaviour which "...is largely concentrated on a 'scientific organisation' of the assembly process which does not involve heavy investment" (Kalecki [1954] 1991,p. 335). This non-technological innovation component is based on creative application through intangible investment of human resources management and marketing knowledge. Intangible investment does not involve modifying technological processes or products, and requires relatively less expenditure. Together the two drivers form a technological-human capital duality that is crucial to the success of implementation of new ideas.

The third driver is generally ignored in mainstream (pro-market) analysis because it relates to the enabling public sector. Public investment is in many forms. The largest funding is direct support for private R&D *via* subsidies, tax incentives, infrastructure (scientific/technical research in universities and specifically designated research institutes) and intellectual property regulation (e.g. patents, copyright, trademarks). There is also selective public investment in research infrastructure (e.g. synchrotrons, technology parks, co-operative university-business research centres), subsidies in specific areas of concern (environment, social groups, non-urban regions), and public sector procurement of R&D (as in defence industry, see White, 2005). All the above provide direction to innovation as part of public policy support. Except for the neoclassical school, all schools of economics support such active policies, with the particular direction of knowledge accumulation up for political debate involving various permutations from centralised planning to democratic grassroots decision-making. The proponents of such active policies argue on the basis that these are emerging areas of economic activity that need support to overcome systemic failures in the market system (Vallas et al., 2010).

As with the sea that 'swallowed up' the lost city of Atlantis (see Bacon [1620] 2000), the Global Financial Crisis (GFC) – that began with the Northern Rock bank collapse (UK) in September 2007 – 'swallowed up' Western advanced economies and their flagrant exhibition of wealth, avarice and power gained by unethical self-regulation, cheap credit and under-priced resources of nature (Das, 2009). In such a recessionary climate with severe deleveraging, the private sector withdraws from investing in the future. Also at these times, conservatives appeal for the public sector to avoid raising the public debt and interfering with market capitalism. Both private sector deleveraging and public sector austerity create barriers to the promulgation of innovation and, with it, the concomitant deterioration of the accumulation process. In this context, some prescient economists and politicians recognise a severe downturn as the opportunity to generate and implement new knowledge. In the face of debt and austerity barriers, governments need to assert and champion a large public

policyprogram that supports the generation and commercialisation of important new creative ideas, in the same way as argued by Bacon in New Atlantis.

An example of such entreaties following the onset of the GFC came 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. (Kirkland, 2009)

Shiller's quotation can be seen in the context of Bacon's own entreaty, as the path to *New Atlantis* arises out of the devastation wreaked by the GFC.[4] Aggressive support for scientific innovation is exactly the Baconian agenda. Shiller adds an interesting addendum. It is not to strong market re-regulation that shackles the financial system that Shiller argues for, because this would be anathema to any form of innovation, as evidenced during the immediate post-World War II (WWII) period when financial institutions were a strong restraint on innovation (Kingston, 1984). Instead, Shiller is advocating the same aggressive public support for financial innovation that has historically been provided to physical innovation. This requires, what Anderson (1999) calls, "social re-regulation" based on democratically-defined objectives towards a path of financial innovation that the public understands and endorses. It is to such practical policy solutions regarding innovation that Bacon argues for.

The late 18th Century industrialisation of Great Britain (known as The Industrial Revolution) is often described in innovation literature as the launching pad for the enormous technological progress in human history, transforming Western societies into 'advanced' economies (Freeman and Perez, 1988; von Tunzelmann, 1995). However, this transformation was marked not only by rising standards of living, but also by the burgeoning destruction of nature (Boulding, 1966). Western society has become so fixated by the mind of intellectual creations *via* industrialisation, that nature has become further and further detached from it. This causes the dilemma that major investment in innovation is required to drive any expansion out of deep recession. However, the capitalist experience of the last two and a half centuries demonstrates that this is inevitably accompanied by mindless environmental destruction.[5] Innovation on a path to sustainable development (or eco-innovation) is what the analysis in this paper is heading towards.

[4]First to use the term Global Financial Crisis in the context of "market fundamentalism" was George Soros (1998 p. 135 - title of Chapter 7), then Stiglitz (2000) used it as the title for his book chapter called: "Lessons from the Global Financial Crisis"; note that all the rest of the authors in the same edited book of readings referred to the more general term used in the title of the book: "Global Financial Crises".

[5]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 express 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". There is an alternative moral economy based on a communitarian approach to innovation that attempts to co-operatively overcome greed, avarice, and ecological destruction (see Owen 2008).

Role of Investment in Innovation

The critical realist perspective calls for an examination of the core political and social institutions that impact on innovation. To do this a conceptual framework of analysis specifying causal mechanisms on innovation is required as the starting point for this inquiry (Lawson 2003b, p. 165). This framework is a pure capitalist economy with no public sector, with addition of the State in the next section. In this section, a political economy framework of entrepreneurship and innovation is laid out that focuses on the centrality of power and the contradictions that arise thereof. Kalecki's class-based approach places "the entrepreneur" in a setting of imperfect competition with reliance on retained earnings out of profits for physical investment to commercialise innovation. The framework sets up a dynamic approach (in historical time) to innovation by endogenising the entrepreneurship process *via* investment in the means of production so that innovation can be commercialised within specific institutional structures (e.g. financial system, trade unions, schooling, university links, and government support). The role of uncertainty and time delays impact on the circular flow of the framework constructed.

Rothbarth (1942) rejects a strict procedural linkage between innovation and investment, but appreciates that uncertainty created by the innovation process leads to strong dependence on current profits for physical investment (whether equity funds or leverage with debt funds). For Rothbarth, this argument provides the starting point for examining the role of innovation using Kalecki's analysis. Rothbarth (1942, p. 227) argues that the profit link to investment, so crucial in all of Kalecki's work, is the "adaptation mechanism" that enables the bunching of investment (in Juglar Cycles) behind some long-run innovation "impulse".[6] This turns Schumpeter's (1939) long-run supply-side process, from start-up or corporate venturing, into one that is centred on effective demand. Thus, the influence of effective demand is based on the speed and strength of the diffusion of innovation as determined by the ability of firms to invest in innovation out of profits (own profits, or borrowing other firms' profits).

Rothbarth's assessment of Kalecki's analysis is based on the complete re-investment of profits in Version I of Kalecki's business cycle model dating from the 1930s. This was only the beginning of a major lifelong investigation by Kalecki into cycles and growth. In this first version, a dampened cycle results, with growth coming from exogenous shocks. Kalecki's cycle Version II in the 1940s introduced semi-autonomous development factors, notably innovation, to "…engender a long-run upward trend" (Kalecki [1954] 1991, p. 327). Finally, two years before his death, cycle Version III (Kalecki [1968] 1991) makes innovation specifically endogenous to the investment process, thus integrating the cyclical short period with the long-run growth trend. In this way, the trend and cycle are not considered separately. In this final version, inventions that are commercialised through investment "…add to profit expectations over and above those generated by the movement of demand in the course of the cycle" (White, 1999, p. 347), leading to a cumulative process of cyclical growth.[7] White

[6]Juglar cycles show oscillations of investment into fixed capital (means of production). Originally identified by Clement Juglar ([1889] 2010).

[7]Goodwin (1967) independently proposed a similar model of cyclical growth and developed it further along Kaleckian lines in Goodwin (1990, p. 99), with the search for ever-renewed profit through technical change as the innovation impetus at the investment cycle trough. Goodwin (1987, p. 106) explains that "…growth generates cycles and…cycles interrupt growth. Such was the view of Marx, a view that was absorbed and elaborated by Schumpeter, but has remained peripheral to mainstream economics". The innovation-instigated cyclical growth process is based on Marx's law of capitalist accumulation (Marx [1867] 1954, p. 574), which "…provided inspiration to contemporary writers, in particular Kalecki and Goodwin" (Medio, 1987, p. 667).

(1999) identifies two reasons in Kalecki ([1968] 1991) to account for this. One is increased productivity in the form of process innovation that incorporates technical progress in new capital equipment, making the previous capital stock technologically obsolete[8] and enabling market demand to be met more effectively. The other is product innovation coming from the stimulus to investment arising from entrepreneurs wanting to be the "…first to avail themselves of the technical novelties" and thus adding a new level of demand (Kalecki [1968] 1991, p. 442).[9]

At this point of the analysis when effective demand has been clearly incorporated in the innovation process, Kalecki's approach can be linked back to Schumpeter. White (1999, p. 350) recognises that clustering of innovations occurs from "…the stream of inventions underlying the process of innovation [which] could be sufficiently erratic to provide the irregularity in economic behaviour necessary to produce deviations in demand and output from those anticipated by producers." With the cluster of innovations leading to diffusion of successful innovations, Courvisanos (1996, pp. 114-39) shows that these deviations can be seen as triggers for cyclical investment turnarounds in periods when commitment of orders to investment is highly vulnerable to sharp change, either as too high (over-commitment at expansion peak) or too low (under-commitment at the contraction trough). There can be reinforcement of this process by the inventory mechanism, in that any small upswing of an inventory cycle at the trough of a business (or Juglar) cycle provides a favourable climate for the spread of investment embodying innovation. This is particularly helpful for explaining the most difficult aspect of any cycle, the rise out of a contraction. In this respect, bunching of investment occurs as per Kalecki, with the stimulus from clusters of 'basic' innovations as per Schumpeter.[10]

Once a trigger for expansion occurs, the investment dynamics become the crucial aspect of the diffusion of innovation. Kalecki identified three dynamics. Time lags in investment are seen as critical by Kalecki in the innovation process, an aspect that Schumpeter rejects. There are two time lags. One is the *ex ante* decision (orders) lag, which identifies the time taken to make the decision to order the means of production (plant and/or equipment). This is due to the need to work out the actual design of the capital stock required and find sources for supplying this capital stock. The other is the *ex post* implementation, which identifies the gestation period for the expenditure; or how long it takes for the capital-supplying industries to produce and deliver the capital stock, and the time taken for the innovating firm to learn how to operate with the plant and equipment in an efficient manner.

The second dynamic relates to the two-sided feedback loop between profits and investment, which also was famously expounded by Joan Robinson in her "banana diagram" (Harcourt

[8]Salter (1966) developed this aspect of process innovation that has been the basis of much research work in the area of obsolescence (see Bloch et al., 2011).

[9]White (1999, p. 350) identifies a third reason from a Sraffian perspective. This is the stimulus to investment "…arising from changes in relative profit rates as a result of changes in technology."

[10]Empirical work by Courvisanos and Verspagen (2002) using long-run patent data supports the bunching effect of investment (*á la* Kalecki) while identifying the clustering of innovation (*á la* Schumpeter). This is in contradistinction to Silverberg and Verspagen (2003) who find no clustering of basic innovations. The proposition is that one basic innovation leads to a cluster of incremental innovations in support of the one basic technology system (Perez 2002, p. 27). All this cluster cycle research is distinctly different from the neoclassical real business cycle research agenda in which clusters occur only due to expectational errors as deviations from the natural (equilibrium) rate, and which Zarnowitz (1985) surveyed as empirically inadequate in explaining business cycles.

1995). Retained earnings out of profits provide the wherewithal to invest, and also allow the firm to borrow for investment on the basis of the profits achieved. Of course, the original investment is made in the expectation of future profits out of the innovation that underscores the investment decision. This seems a very tight two-sided relationship that has strength in that one loop supports the other. Here, Kalecki identifies the third dynamic which undermines the strength of this two-sided loop. This is the inherent instability of capitalism as firms' innovation and investment decisions are exposed to increasing risk and fundamental uncertainty.

By raising external funds from loans or equity for investment, Kalecki ([1954] 1991, pp. 277-81) argues that firms suffer from "increasing risk". This is a concept he originally set out in a few short pages (Kalecki [1937] 1990) and is the marginal risk which increases with the amount of funds obtained externally. External funding is a major issue when commercialising innovation as a start-up venture with no prior profit reserves from the enterprise, thus often requiring venture capital equity funding. Also, for existing firms, radical innovation in corporate venturing would require large commitment to new means of production, thus needing external funding on top of any retained earnings funding available.

From this financial perspective, Kalecki identifies three forms of increasing risk. One is share issue risk, when a large issue of new shares creates the risk of reducing the proportion of the controlling group's shareholding thus diluting its voting power in relation to existing and potential shareholders. Another form of increasing risk is borrower's risk. Increasing levels of borrowed funds involve higher future interest payment commitments, which are negotiated on the basis of regular payment irrespective of cyclical events and their effects on gross profits. The larger the amount a firm borrows, the greater the increasing cash-flow problem that could arise. The final form is lenders' risk which increases (in terms of higher interest rate) as lenders extend more funds to the one firm and leads to the increasing possibility of the lender suffering bad debts from the borrowing firm's cash-flow problems which may even lead to bankruptcy.

The role of uncertainty in Kalecki is an institutional factor that creates instability. Incomplete knowledge about future outcomes is significant for innovations other than for merely new product developments or 'necessity entrepreneurship'. Such lack of knowledge leads to setting levels of desired excess capacity well above normal engineering-based excess capacity requirements, and to accepting increased transaction costs as the level of financing rises. In this way uncertainty is accounted for and managed in a pragmatic way. It is for this reason that Kalecki rarely mentions uncertainty.[11] As increasing risk originates from incomplete knowledge of the future outcomes of investment, then uncertainty becomes institutionalised as an instability factor when such risk is locked into rising transaction costs, or alternatively, to what is known in the finance literature as 'informational asymmetries'. Such efforts can mitigate risk, but not uncertainty.

Figure 1 summarises the Kaleckian investment dynamics in the context of the macroeconomic environment in which virtuous and vicious circles occur. These dynamics can be viewed through the prism of a circular flow mechanism within which the firms and their entrepreneurial agents conduct innovation and investment decisions in real time. In such a critical realist framework, for example, uncertainty will tend to reduce the financial flows in

[11]In the first two volumes of Kalecki's*Collected Works*, which analyse capitalism, there is no reference to uncertainty in either detailed 'Index of Subjects' (see Osiatyński 1990; 1991).

the mechanism or delay them until other elements of the institutions in the system provide some indicators of confidence that the financial flows can be increased.

The Schumpeterian element of the framework is the outside perimeter of Figure 1. This is the National Innovation System (NIS), which carries the institutional and cultural characteristics of an economy that provides the climate for the adaptation mechanism. The NIS is a collection of institutions and organisations which are "...constituted by elements and relationships which interact in the production, diffusion and use of new, and economically useful, knowledge". (Lundvall 2010, p. 2)[12] It is a permeable perimeter, with influences impacting on the NIS from the rest of the world. The more impacts from globalisation on the nation, especially in finance and investment, the more permeable the NIS perimeter. Inside this perimeter, all innovation occurs endogenously, and investment cycles operationalise innovation. Freeman (1995) provides the historical context for such NIS to exist, and explains how such systems condition the way new and old technological paradigms interact within the national boundaries. This perimeter framework also can be adopted at international regional levels (e.g. EU, NAFTA, ASEAN) and at sub-national regional levels, provided the specifics of each perimeter are established.

The NIS forms a *milieu* around the Kaleckian profit-based reproduction system of innovation and investment which incorporates capitalist power in the centre workings of the framework. The mutable crises-prone role of the State operates (like Marx's superstructure) from the NIS boundary towards the inside workings of the capital accumulation process where innovation is commercialised and diffused. The role of the State is not specifically engaged in Figure 1, with its influence (e.g. neo-liberal State stance) merely appearing from the NIS perimeter. The circular flow itself has no government sector and no impact through public expenditures and revenues (taxes, etc.). This government element is specified in standard Keynesian income-expenditure circular flow frameworks (e.g. Arestis et al., 1985-86), and will be formally incorporated in the next section.

Figure 1 is a macroeconomic circular flow through historical time. The explanation of the circular flow diagram within the NIS can begin at any point without any loss of explanatory power. The circular flow directional arrow from investment expenditure (I) to aggregate total demand (AD) follows a standard Keynesian macroeconomic route. I is recognised as the most volatile component even though it generally accounts for around 20 per cent of total AD (Courvisanos, 1996). Then, AD directly affects economic activity (Y) *via* total sales and measured as Gross Domestic Product (GDP) or total output. GDP flows into the general macroeconomy represented by the arrow into the NIS boundary. Being a demand-driven model, through successful commercialisation, AD also directly impacts on the distribution of profits (π) which consists of a given stable level of distributed earnings, while the rest comprises retained earnings for investment (Asimakopulos, 1975). The I-to-π link, *via* sales, is based on the celebrated Kalecki's Dictum which states that "capitalists earn what they spend, and workers spend what they earn" (Sawyer, 1985, p. 73). The causal flow from I to π is based on capitalists deciding on their investment spending, while the 'market' through AD decrees how much profit is realised. This link has been confirmed by a series of empirical studies covering the US (Asimakopulos, 1983), UK (Arestis et al., 1985/1986), and Italy (Del Monte

[12]Many studies refer to NSI, or National Systems of Innovation instead. NSI and NIS are identical concepts. Lundvall (1985, p.55) first developed this modern version of an innovation system, and the concept was subsequently given much institutional respectability by an initial OECD (1997) study.Since then, all major international organisations have established study groups that are examining NIS from their own perspectives (Muñoz, 2004, p. 8).

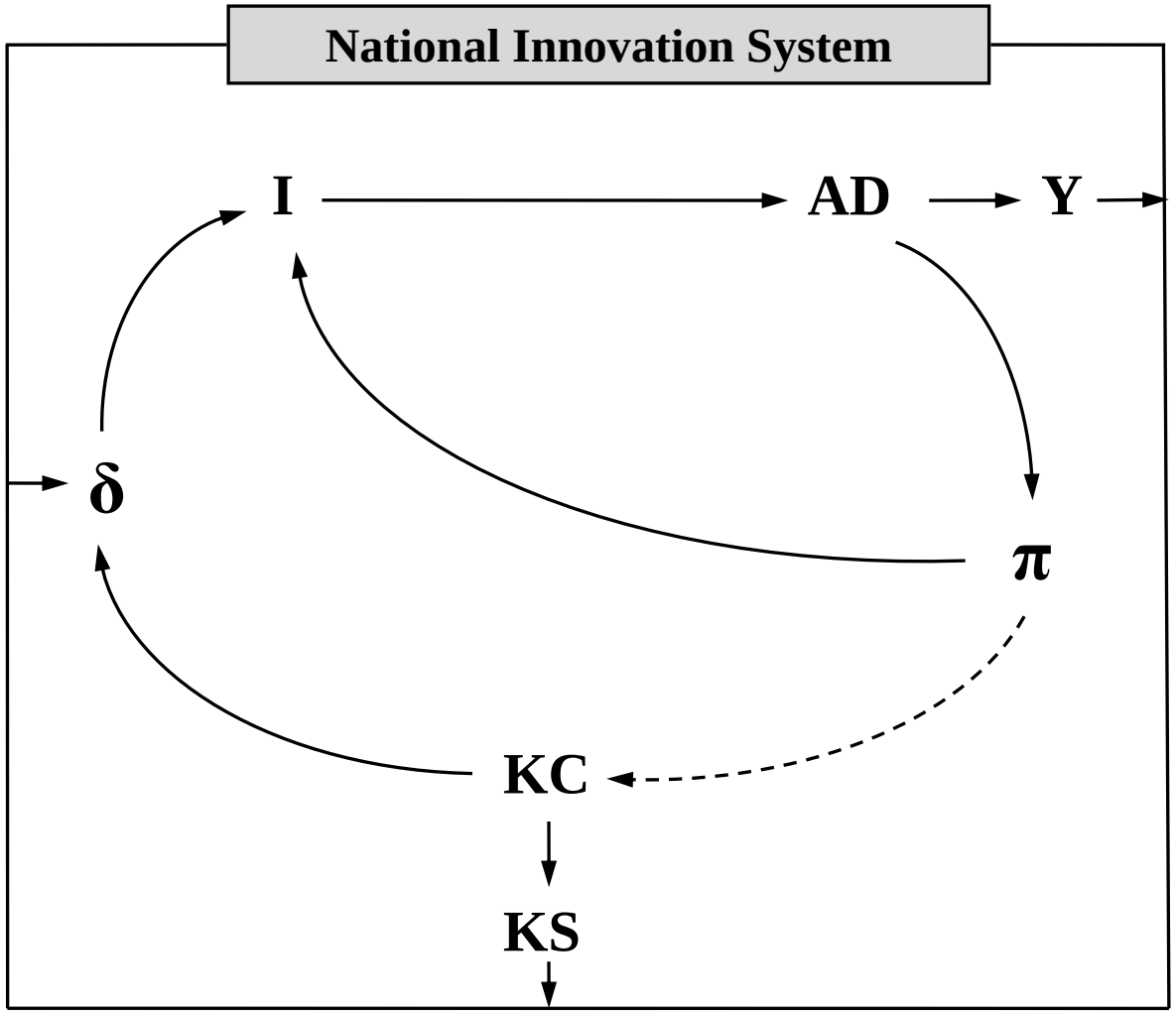
1981, SylosLabini 1967). To close the inner circular flow, retained earnings from profits generally account for around 75 per cent of total business fixed investment in capitalist economies. It is this aggregate retained earnings element which represents the profit flow of funds back directly into investment (I).[13]

Figure 1 macroeconomic framework provides a visual representation of the aggregate economy in which the profits (π) are an aggregate average of all profits earned in a particular economy. The problem with aggregation and averaging is that they cancel out variation due to uneven economic development that is so critical to Schumpeter. With creative destruction, there are new innovative firms and industries that arise, with success generating strong profits. At the same time, there are old mature firms and industries that are struggling to survive with low, and even negative, profits. This wide profit range is masked under the aggregate profit level variable, π. What a strong and rising π would show is that the 'net' between old and new is resolving itself into higher overall economic activity. However, the structural change that would be occurring in these circumstances results in a very uneven economic development. Labour displaced as older sections of the economy are declining would have a difficult time gaining employment in the new sections where the technology and knowledge-based skills required would be significantly different. This diversity within the aggregate profit level can be analysed using Figure 1 as a representative of the reproduction and innovation system in specific sectors or regions.

Examining the outer circular flow in Figure 1, Gomulka (1990, pp. 45-7) in his review of the innovation literature identifies the important influence of profitability on the level of R&D spending in the aggregate, despite larger firms tending to spend a lesser proportion of profits on R&D than smaller firms. In more general terms, Kalecki ([1962] 1991) supports this same position but notes the long and complex time-lag involved for profits to influence "the stream of inventions". More recent studies also identify the crucial role of enterprises in investing their profits in persons working in the organization to build human resource capacity to innovate (Smith et al., 2011). Profits provide the wherewithal for investment in accumulating the stock of knowledge, both internally through the enterprises' own knowledge creation systems and through public science and technology research institutes that are funded in capitalist economies by the profits of the private sector. New successful innovative firms with strong profits are particularly able to invest in such knowledge. Thus 'knowledge capital' (KC) is defined as the stock of accumulated knowledge in terms of public science, intellectual property, processes, routines and networks which are continuously enriched within organisations and others linked to them. This KC is a dynamic concept of continual renewing of knowledge in forms that can be exploited for innovation. Novelty created for production and profit is the reason that this 'knowledge' is considered as 'capital' (Laperche, 2007). The dotted arrow from π to KC represents this investment flow. Unsuccessful attempts at exploiting (or commercialising) innovation are failures that provide further knowledge when next another similar innovation is attempted. These failures are knowledge spillovers (KS) that feed back into the NIS and are depicted as a flow from KC.

[13]On the theoretical details of the 'double-sided relation between profits and investments', see Asimakopulos (1977). See also the empirical results of Laramie et al. (2004, 2007) of the contributions to investment orders in UK and US of changes in profits, capacity utilisation and gearing ratios.

Figure 1:Kaleckian-Schumpeterian Innovation-Investment Circular Flow Framework



Key**: δ** : innovation **I** : investment **AD**: aggregate demand **Y** : economic activity (GDP)
π : aggregate profit level **KC** : knowledge capital **KS** : knowledge spillover

From the discussion above of the two investment flows in Figure 1, it is clear that the π-to-KC flow is more variable than the π-to-I flow and, importantly, also the former occurs over a longer time horizon. This is represented by a dotted arrow, indicating that the π-to-KC flow is not in the same time dimension as all the other flows. Unbroken lines tend to be more direct and faster in their impact on the variables they flow on to. Also, the more successful firms and industries will have stronger flows of profit to both I and KC than old mature firms and industries.

In Figure 1, the two arrows pointing to the δ variable represent Equation 1. Following Ricottilli (1996), the link from KC to innovation (δ) is specified using two knowledge enhancing variables, RD and L. These two variables are a decomposition of KC, and identify the investment in innovation that occurs in aggregate and is shown by the KC-to-δ flow. For the broad framework of Figure 1, a knowledge spillover (or externality) variable, KS, helps feed the NIS-to-δ flow, and thus also is included in Equation 1 as specified:

$$\delta = f_1 (RD, L, KS) \qquad (1)$$

where δ is the change in technology or product (or simply innovation) and is dependent on the three variables described below.

The first variable is RD, which refers to the extent of investment in discovering (R) and adapting (D) new technical knowledge. 'R&D' expenditure is the largest component of this variable. The other is 'non-R&D' creative activities conducted in-house based on developing new uses of existing knowledge, software development and informal *ad hoc* 'on-the-job' changes in areas such as engineering or design work (Huang et al., 2010). In general, non-R&D activities are efforts in discovering and adapting technical knowledge that are not formally recorded as R&D spending (see Jankowski, 1998).

The second variable is L, which represents the current cognitive learning capacity and institutional knowledge capacity in efficiency units of labour employed. Such learning/knowledge capacity requires staff working in the enterprise to have the training and skill to unlock the potential of technical knowledge created by the RD variable, and any spillovers from the KS variable, then appropriating and commercialising the knowledge for innovation. The RD and L terms condition the given state of the NIS, including networks of social relations and technological capacity imported from overseas through licensing, joint ventures and foreign direct investment (see Woolgar, 1998). From the organisations that invest in RD and L, their total KC is a direct arrow flow to innovation (δ). If all innovation emanates from direct input of enterprises' KC, then there would be no other arrow flowing into δ. In fact, in this interlinked and globalised world, such a proposition is unsupportable.

Innovation also comes *via* the NIS due to investment in building innovation and the third variable, knowledge spillovers (KS). Feldman (2010, p. 125) explains that: "Knowledge has characteristics such as being non-rival and non-excludable, which classify it as a public good." Intellectual property rights (IPRs) and other forms of regulation (e.g. tariffs and quotas) aim to limit spillovers and provide monopoly power to the creators of the knowledge as an incentive to innovate. However, knowledge – especially tacit knowledge – tends to leak out, either legally or illegally, due to zero marginal costs that make it difficult to exclude actors from taking advantage and also there is no impeding of such knowledge from being used when it is a public good prior to any establishment of IPRs like patents and trademarks. What is required is creative ability to apply such knowledge and building capacity to learn from preceding application efforts. Based on this, Acs et al. (2009) construct a knowledge spillover theory based on these knowledge spillover characteristics to show that it is successful entrepreneurial activity, especially from start-up ventures, that arise from accessing and using KS. Audretsch (2007, p. 68) however recognises that institutional factors lead to "uncertainty, asymmetries, and high transactions costs" which form barriers to KS; of which more in the next section.

From Figure 1 it is evident that KC has two flow impacts. One is the already identified monetary flow into the innovation (δ) variable, *via* RD and L. The other is the KS spillover variable flowing directly into the NIS. Both impact on the state of a country's NIS. Larger KC has a positive impact on the knowledge and learning capacity of any given NIS. The impact on NIS is cumulative over a long historical process. Within the dominant technological paradigm, the effect is for endogenous innovation to flow through the L term and also through the KS term back into the circular flow and to the δ variable. At the same time, a 'constellation' of technical and economic factors forms around emerging potential technological paradigms, with an accompanying 'log jam' of innovations surrounding these emerging paradigms. Eventually, some of these paradigms do emerge towards a structural break where a new paradigm takes over, transforming the given NIS. When the break occurs, the transformative innovation becomes the new dominant technological paradigm, with the L term becoming crucial in the process of paradigm shift (along with KS spillovers) that lead directly to a strong expansion of the investment cycle, and with this, a rising trend of the business cycle.

The circular flow description is closed by the two flows into investment, i.e. the π-to-I flow and the δ-to-I flow. Equation 2 states this Rothbarth "adaptation mechanism" from innovation to investment as:

$$I = f_2 (\pi, \delta) \qquad (2)$$

where I is investment in means of production, and it is dependent on the profit level (π) and innovation (δ). Profits represent the share of gross earnings for investment and taxes. Taxes are partly used by the government to invest in infrastructure, which in turn supports private investment. The variable δ represents an endogenous flow of innovation incorporated into investment. Underlying these two variables are the decision-making elements that relate to levels of investment expenditure. The π level in a Kaleckian framework also indicates the ability of firms to obtain external funds through the principle of increasing risk, which explicitly identifies stronger profit levels as the increasing ability of firms to attract riskier external sources of funds. Higher π overall gives entrepreneurs stronger positive expectations for implementing their investment decisions on the basis of Equation 2. The next section will explicate the role of the public sector in supporting and/or inhibiting these innovation-to-investment decisions by the private sector.

Dynamics of this circular flow can be exhibited by the exposition of the virtuous and vicious circles. The virtuous circle can be seen in aggregate when an increase in KC leads to a rise in δ, which encourages expansion of I (Nickell and Nicolitsas, 1996). This has a direct positive impact on AD, GDP and consequently on π, which then creates an 'accelerationist' effect on I flowing through greater economic activity and the expansion phase of the investment cycle. An endogenous innovation-based reinforcement of this circle is the increased innovation intensity *via* the dotted flow-line from π-to-KC adding another rise in δ to push the expansion phase further into a strong boom. This dynamic circle exhibits innovation intensity deriving from the growth industries of the endogenous innovation effects of a powerful transformative technological paradigm. The virtuous circle has all the elements associated with an increase in KC which leads to significant rolling out of the dominant technological paradigm. This results in strong economic development of successfully innovative firms/industries/sectors/regions, and provides the bulwark for cyclically rising GDP.

The vicious circle appears in the contraction phase of the investment cycle, when there is a relatively low level of build-up in KC, related to the replication of the dominant technology with the emerging technologies at too early a life-cycle stage for them to be contenders for structural change. The uneven development here is skewed on the negative side. This leads to a decrease in δ, which discourages I as well. This has a negative impact on AD, GDP and consequently on π, which then creates a negative 'accelerationist' effect on I flowing through lower economic activity and the contraction phase of the investment cycle. An endogenous innovation-based reinforcement of this circle is the decreased innovation intensity *via* the dotted flow-line from π-to-KC adding another fall in δ to push the contraction phase further into a strong recession. This vicious circle exhibits innovation intensity that is very weak, deriving from the mature industries of the long established innovation effects of a monopoly controlled 'old' technological paradigm and preventing the expansion of new innovative firms and industries.

The extent of the upswing in the next expansion phase depends on how much it is dependent on the older more mature industries attempting to maintain their market power, compared to the ability of the new technology-based industries to take advantage of any new opportunities that have arisen during the downturn and trough. As KC continues its endogenous innovation push, there is tension with the development of greater economic uncertainty for investment in

'new' products and processes, as identified by Driver and Moreton (1992). This is Schumpeter's "creative destruction", where new innovations take over from older established industries which have had strong market (or monopoly) control, creating uneven structural change as some industries shift technologically while others remain old and mature. Depending on the NIS framework, this problematic tension to the next virtuous circle will appear as a negative influence at different intensities of the endogenous innovation-based expansion phase in the investment cycle. The extent of this negative influence affects the strength (or lack thereof) of the new expansion phase and the trajectory of the long wave.[14]

The virtuous/vicious circles cyclical pattern can be related to the earlier identified clustering of innovation and bunching of investment. However, the translation of this bunching of investment to the business cycle is in debate (see Freeman 1994, pp. 86-9). The debate can be bypassed by adopting Shackle's (1972, p. 433) "kaleidic mechanism". This mechanism is an ephemeral pseudo-equilibrium based on accepted practices which are often subject to sudden re-adjustment leading to a new precarious pseudo-equilibrium based on "delicately stacked" conjectures which give way to these "sudden landslides of re-adjustment". The Kaleckian feature of expanded reproduction allows linkage of the two circular flow processes *via* effective demand to produce kaleidic patterns. Looking first at the Π-to-KC flow, the prerequisite for a strong flow that provides the 'raw material' for innovation (or δ) is deep depressions or breakthroughs in technology. Both reflect reactions by private sector and public sector to profound problems in the downswing of the business cycle coming into the depression. In this state of the economy, bunching of investment from Π-to-I requires effective demand stimulus through widespread diffusion of the innovation process that can only be achieved through the availability of a surplus for investment (private profits and public deficit spending). Roadblocks to this dual circular flow reside in the institutional frameworks of nations; particularly the ones with 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 roadblock through increased macroeconomic volatility, which Toivanen et al. (1999) empirically identify as slowing down the diffusion process.

Depicting the kaleidic mechanism in a formal setting, the aggregate investment Equation 2 can be linked to the interplay between investment in innovation capacity (π-to-KC) and investment in implementing innovation (π-to-I). This results in investment cycles orders with innovation as represented by Equation 3. This equation shows the two flows from KC (made up of RD and L)-to-I <u>via</u>δ, and π-to-I. There is also the knowledge spillover (KS) externality flow out of KC into the public domain of the NIS which adds to total public knowledge as the basis for creativity and then into δ. Thus, KC flows in the circular flow as RD and L, as well as KS. Then, Equation 3 encapsulates the circular flow processes described by Equations 1 and 2, stated as:

$$I_{t+1} = c(\pi_t^{\alpha} RD_t^{\beta} L_t^{\lambda})^{\kappa} + KS_t \qquad (3)$$

where π_t, RD_t, and L_t are the independent variables for this period that influence aggregate investment (I_{t+1}) in the next period, as a multiplicative function. The assigning of profits directly into investment or committing to either of the two innovation variables, all increase

[14] Based on uncertainty, there is evidence that in the 1990s negative tension or concerns related to an innovation-based expansion took root much more in Europe than in the USA and Australia. As a result, in the latter nations, the 1990s information technology-based innovation expansion phase was much stronger than in Europe (see Hollanders et al., 1999).

the ‘efficiency’ of the other independent variables. Then, the whole bracketed term is raised to the power κ to depict cumulative causation due to increasing rate of investment arising from each variable reinforcing the other two. The constant c contains all other influences, including the role of the State. Equation 3 includes the KS_t term which represents the extent that current knowledge spillovers are able to be harnessed by the NIS, but this term is only an addition without cumulative power and also is dependent on the extent of the three major variables.

Equation 3 is the macroeconomic entity which depicts the circular flow process from profits and innovation to investment. The π-to-I flow is the standard Kaleckian link (for detailed discussion, see Courvisanos, 1996). The π-to-KC link is the ‘investment in innovation capacity’ process which can be based on monopoly capital incremental (and evasive) innovation that is pro-cyclical, or based on radical (and transformative) innovation that is anti-cyclical. The other circular flow is the second Kaleckian link from I-to-π, which is the ‘investment in implementing innovation’ process that drives profits. In this context, the aggregate demand effects of investment determine (to a large extent) profits.

Combination of these circular flow processes on a global perspective emerged in the strong post-1992 economic expansion as shown by Hollanders et al. (1999), in which South East Asia and the USA reflected the stronger expansion phase, while Europe, Japan and Southern Asia reflected the weaker expansion phase. The post-GFC economic expansion also showed evidence of the same bifurcation. South East Asia, China and India benefited greatly from the institutional frameworks introduced after the Asian Financial Crisis of 1997, accompanied by new techno-economic systems installed prior to the GFC that replaced pure cheap labour as the only competitive advantage. On the other hand, USA and Europe struggled to rise out of post-GFC recession under culturally embedded institutional frameworks that are very slow to change with relatively older techno-economic systems in operation. What this shows is the convergence within global regions and divergence across different global regions depending on the nature of innovation investment and the institutional background that underpins this innovation-investment process (Kitschelt et al., 1999).

Instead of unidirectional causality, the discussion above clearly leads to a circular flow where one innovation process feeds into the other. Thus, a strong I-to-π flow will feed into endogneous innovation via the π-to-KC link. This invokes Kaldor (1966)’s principle of cumulative causation, which is the “self-reinforcing dynamic” in the circular process of investment demand leading to innovation and which then stimulates further investment. The distinction between exogenous (including ‘semi-exogenous’) and endogenous innovation specifies how innovation enters this cumulative causation process. In this context, Gomulka (1990, pp. 45-7) sees R&D expenditure as central to the endogenous innovation process, with large firms with strong profit results having the ability to activate large R&D spending. Then patents seem to reflect more the outcomes of this process (Geroski and Walters, 1995, p. 924). On the other hand, exogenous innovation relates to the installation of a techno-economic revolution as specified by Perez (2002), and the short-term cyclical process arising from the cumulative causation of paradigm shift.

Political Aspects of Innovation

As explained in the previous section, dominant mature industries with older technologies have economic power that ensures continued operation within the current profit-making paradigm despite economic and ecological crises. This systemic failure enshrines economic, political and innovation systems within all nations. It is the reason why there have been massive

bailouts of corporations that failed; huge financial support for nations with no means of repayment; and large industry and political support for minimal climate change processes and no addressing of food security issues.

In this section, the "Political Aspects of Full Employment" (PAFE) approach encapsulated by Kalecki in the political business cycle (Kalecki [1943] 1990) is appropriated to critique the process of public innovation policy-making. Whereas above in the PAFE analysis innovation plays only a minor role, in this "Political Aspects of Innovation" (PAI) story innovation is the central character around which policy revolves. Immediately after WWII all the developed economies pledged allegiance to attainment and maintenance of full employment as the panacea for the inherent crises of capitalism. This approach was rejected in the 1970s, with emergence of the contractionary political trend. This, however, raised a significant concern. With no direct employment public policy stance in advanced capitalist economies, conservative budget-balancing fiscal policies provided no (or limited) stimulus out of business cycle troughs. The policy framework thus became one that was more closely related to Kalecki ([1945] 1990), with government policy aiming to stimulate private investment that incorporates some level of technological innovation.

As specified in the Figure 1 framework, innovation is incorporated into investment theory as innovation alters the incentive to invest by changing the cost of production or altering product demand to raise profitability. Kalecki ([1968] 1991) and Laramie and Mair (2007) both imply technical progress in their investment function specifications but only indirectly, the former by theory and the latter by empirical estimation. Salter (1966) links the inducement to invest to new technology by utilising a vintage capital model in which innovation is embodied in capital equipment. Thus, governments have developed innovation policies aimed at stimulating investment with innovation, which Porter (1990) has seen as crucial in building a nation's competitive advantage. Such policies work through various approaches like rearmament, R&D subsidies, technology park infrastructure like incubators, tax credits, and supportive income tax cuts for the higher income groups who supposedly have higher skill. This shift from direct employment policies to stimulating investment policies is exemplified by the reduction in emphasis on tariff protection policies that support employment in mature protected industries. Reductions in tariffs aim to stimulate innovative activity (Sener, 2001), while innovation public policies aim to guide and support transformation of the economy into a new technological age, with employment seen in the role of a useful spillover (or externality) to the technological imperative.

PAI can be recognised in all periods of capitalism when innovation brings about creative destruction and structural change that threatens existing powerful capitalist interests. This aspect became much more significant with the shift in State industry policy from protection to innovation. Conforming to PAFE, the PAI approach identifies the same three fears of capitalists, but this time in the context of the State's commitment to growth *via* innovation on the supply-side and not fiscal stimulus on the demand-side. The three fears of creative destruction need to be fully reinterpreted as they apply to capitalists and their impact on the State's public innovation policy agenda.

Loss of *economic*control by capitalists is the first fear. This occurs with respect to capitalists' individual market power as innovation encourages new entrants that have the potential to reduce the incumbents' market share and ability to control the market. Along with this comes the fear of the lack of adequate financial capital to support incumbents' innovations. Governments have various innovation policies to support the incumbents; notably, R&D

subsidies and tax concessions for incremental innovations, patent protection and other IPRs. For supporting evidence, see Perez (2002).

Loss of *policy* control by capitalists is the second fear. This occurs as innovation becomes distributed across society through the public institutions and public infrastructure that create the national, sectoral and regional innovation systems. Governments have developed various strategies that support incumbents to regain some policy control through systems that operate across specific boundaries. Notable examples of policy support for incumbents are deregulation, privatization, public-private infrastructure programs, and public contracting. For supporting evidence, see Patel and Pavitt (2000).

Loss of *industrial* control of the workforce is capitalists' third fear of radical innovation if governments maintain industrial relations policies that reflect the full employment-type high-union membership structure of the first twenty years after WWII. Since then, governments in advanced developed and emerging economies have introduced new industrial relations policies aimed at supporting and encouraging 'flexibility' in the workplace in the name of innovation. This flexibility relates to the ability of firms to lower labour cost and structures which reduce marginal costs of old technologies, delaying introduction of new product and process innovations. For supporting evidence, see Harcourt (1997).Such flexibility includes established firms engaging in enterprise bargaining contracts with employees and unions to ensure stability without industrial action (for the firms) and job security (for employees/unions). Innovative new entrepreneurial firms in related industries (e.g. renewable *c.f.* fossil fuel energy) are factions of capital that threaten this cosy industrial management deal. Therefore, the focus of 'industrial control' is not only on industrial relations with employees *per se*, but also on how innovation and its flexibility in labour processes affect the power balance between different factions of capital (Jonas, 1996).

As with PAFE, PAI is a class-based approach over the political business cycle. It is based on rent-seeking 'distributional coalitions' formed in specific industries by established powerful firms in the context of the three PAI fears that vary in intensity and effect over the phases of the business cycle. Towards the top of the expansion phase of the business cycle, the negative shift in the state of business confidence identified above has implications for innovation. Incremental innovation is strongly working through all the industry sectors in order to reinforce benefits of prior significant innovation with minimal new investment. Pressure is placed on governments to underpin minor innovation by increasing their efforts to ensure minimising capitalists' loss of economic, policy and industrial power. Strengthening policies (and more effectively enforcing existing policies) that support incremental innovation can be applied in a boom period with minimal negative political repercussions. Such policies include increased privatisation of established areas of the public sector with easily available funding; stronger pro-business industrial relations with increased efforts to lower wage share (not necessarily lower absolute wages) and thus retain old technology; and greater IPR support for established large companies emboldening them against increased competition from new small entrepreneurial players. In booms, there is a coalition between powerful industry players (both firms and unions) to ensure benefits of the boom continue to accrue to the incumbents. This also includes attempts to ensnare employees/unions support with enterprise contracts that include higher wages, even if the wage share is falling. Accrual of incumbent market power is supported by Bhuamik et al. (2009) in their study of Indian manufacturing to show that industry concentration has a negative impact on new business entry rates.

All such actions undermine 'true' transformational innovation and encourage 'spin-doctoring' by powerful commercial organisations. This ensures the sedation of radical innovation that could be transformative, preventing stimulation of new activity during the cyclical expansion. Renewal is delayed. Any delay in transformational innovation means that much of the financial resources in the boom are siphoned away to create financial bubbles. This 'bubble mania' has been identified in two different decoupling mechanisms that separate the real and financial economic sectors. Both mechanisms are influenced by Schumpeter's recognition that the roles of entrepreneur and financier as interdependent (Schumpeter, 1939, p. 104). Perez (2002) identifies the first 'bubble mania' as a hiatus between installation and deployment of new technology. This is a period when the new technology is exploited in a reckless frenzy of 'irrational exuberance' for capital gains on any business plan that has a link to the newly installed technology (e.g. 1840s USA railway boom and the late 1990s global dot.com craze). Perez sees this period as an inevitable delay in the ubiquitous deployment of the new technology. In terms of Kalecki's political business cycle, government innovation policy support through the boom for the newly established capitalists, along the lines of the PAI framework. This 'sows the seeds' of the cyclical contraction that follows the inexorable bursting of the bubble. The trend of the cycle remains on the upward part of the long wave as this contraction is only a hiatus in the unfolding technological trajectory (or diffusion) of the new technology system (e.g. information and telecommunications in the post-WWII period; Freeman and Perez, 1988, p. 53).

Minsky (1982) identifies the second 'bubble mania' that follows the maturity of the new technology, as financiers search for alternative highly speculative (or 'Ponzi') schemes. As the PAI framework explains the continued public innovation support for mature technology, then significant installation of radical innovation in new technology systems is delayed. Despite expansionary monetary policy to ameliorate the previous 'installation' contraction, government support for mature industries makes financiers wary of investing in new basic innovations (e.g. green innovations in the early 2000s), and instead support 'old' technologies (e.g. petrol-guzzling automobiles in the early 2000s) which augment excess capacity already building up in the latter. Mature industries will not be able to soak up the available funds, so another round of Ponzi financing develops around financial assets (e.g. sub-prime mortgages and collateralized debt obligations in the early 2000s). Again, Kalecki's political business cycle operates as governments' PAI approach provides the deregulatory space and financial wherewithal for non-productive financial innovations (Kregel, 2008). This bubble 'sows the seeds' of the 'deployment' contraction and further delays the deep installation of new technology systems, with monopoly capital arguing that the economy cannot afford governments providing support and stimulus to new, untried and expensive activities like climate change based ecological innovations (or eco-innovations). The trend of the cycle is more problematic in this contraction, with the depth of the contraction impacting on the long wave trend downwards (e.g. electrical and heavy engineering in the Great Depression; Freeman and Perez, 1988, p. 51).

When the business cycle is well into contraction, the circumstances for innovation substantially alter. Limited new capital investment during the downturn from peak activity results in very little innovation. This is despite much R&D and patenting still going on. There is a large corpus of knowledge that is not being commercialised, with attendant concerns that rates of return are falling from old capital stock. As some companies fail to sustain themselves through the contraction, the remaining firms begin to feel the pressure of potential new entrants eager to test themselves in the market that has been comatosed. Distributional coalitions start to fray. Employees and unions pressure their constituent politicians for

intervention. Support for government stimulation in effective demand by economists and business commentators manifests itself by significant initiatives in the area of innovation policy. Strong debate on the nature and extent of this innovation-based stimulation will result in some form of stimulatory package (but within institutional constraints such as the contractionary 'political trend' identified earlier). The question arises whether new capital stock will come forward on the basis of transformational innovation incorporating newer technological developments. The PAI framework provides a critical realism focus on the delay in transformational innovation, despite the recognised need for such a change in an ecologically unsustainable world.

A political economy example can be cited to bear out this sustainable development dilemma. Up until late 2007, the national governments of both Australia and the USA had a long standing objection to ratifying the Kyoto Protocol on greenhouse emission targets. It is interesting to note that USA is the absolute leader in greenhouse emissions, while Australia is the per capita leader. Both see the economic interests of powerful incumbent corporations as being much more important than greenhouse warming and the consequent ecological destruction. This encourages the continuation of incremental evasive innovation that has only marginal benefits to the ecology but maximum benefit to incumbent enterprises, while ignoring the massive potential ecological (and national economic) benefits accruing from a transformative pro-ecology innovation trajectory.

A Prelude to the Eco-sustainable Framework

In the sense of removing the chaff, the analysis in this paper is a prelude to a sustainable development framework with guided strategic intervention by transformative eco-innovation as a public policy path. The framework itself is the subject of other full papers that are based on the theory of instrumental analysis developed by Adolph Lowe, integrated with the more recent work from complexity theory dealing with uncertainty led by Brian Arthur and the Santa Fe Institute.[15]This framework provides a public policy guide tostrategic intervention by transformative eco-innovation.

The core political and social institutions developed since The Industrial Revolution have embedded knowledge, and the innovation that comes from it, in the economic power of a capitalist development process. This process has been shown in this paper to be an inadequate ecological compass towards a sustainable planet. Following this same development path is only a recipe for further exacerbation of cycles and crises. The Kaleckian-Schumpeterian innovation-investment circular flow framework outlined in this paper, and the accompanying set of investment adaptation equations, shape a cumulative causation path with self-reinforcing dynamics. These dynamics has been hijacked by powerful entrenched capitalist forces that have limited innovation to incremental unsustainable activities, as set out in thePAI analysis. From this perspective, there is an urgent need to change the development dynamics under which innovation operates. This is the task on an eco-sustainable framework which guides public policy onto a path of sustainable development.

This paradigm shift of a development path only succeeds if the specifics of an eco-sustainable framework can be clearly enunciated and its vision seen to be practically achievable. This requires the synthesis of ecological and economic objectives so that profits are, through continual regressive inference (or iterative feedback), effectively and proactively invested in transformative innovation that is ecologically sustainable. The process requires co-evolution

[15] See Courvisanos (2005) for the theoretical structure and Courvisanos (2009b) for its application to Australia.

by the private and public sectors to produce an ecological sustainable technological and social paradigm shift. An overall investment planning strategy is the essential adaptation mechanism that allows for eco-innovation to flourish. Three criteria sets up this framework, as detailed in Courvisanos (2005): (i) sustainable ecological rules (or conventions) with specific ecologically-based targets, e.g. temperature rises under 2 degrees and 350 parts per million carbon dioxide emissions, (ii) perspective planning that readjusts the development process as it moves through time, and (iii) cumulative effective demand built on transition management from niche markets to critical mass. What is required is a broad based strategy for public and private organisations and institutions towards a dual ecology/economic outcome. Then, if successful at the nascent level, cumulative causation with much less crises-prone economic activity can lead the planet to enhance ecological outcomes over time.

Trajectory under the eco-sustainable framework would be 'powered' by low carbon emission renewable energy, low resource depletion rates, and high resource-saving capital stocks. Allowing for the most appropriate locally-based forms of innovation to emerge and prosper. What this framework ensures is that innovative diversity consistent with regional development dovetails with eco-sustainable national and multilateral institutions together with procedures agreed to at these broader levels of governance (Courvisanos, 2009b). An eco-sustainable strategy needs to identify the specific innovation problem(s) of regions, engage the community in an instrumental analysis to develop an effective regional plan, and instigate processes that will allow private sector entrepreneurs to engage in eco-innovation that enhances existing, or creates new, competitive strengths in the global marketplace. Four components in this innovation strategy need to occur for success: (i) paradigm shift or transformation, (ii) co-evolution of clusters and networks, (iii) social learning adaptive iterative steps, and (iv) PAI analysis resolved through circular flow of profits and investment that allow a broad range of participants. The plan will only succeed if there is 'room to move' in the political landscape. There are 'straws in the wind' that point to a larger 'room to move' emerging – for example the Arab Spring, the Occupy Movement, the nascent Burma 'democracy', the Greek and French rejection of austerity ("Austerity is not inevitable"François Hollande), the Slow Food Movement, public research on food security, and the large expansion of renewable energy in Western Europe and China. If all these straws are grasped and augmented, then unsustainability is also not inevitable.

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