Chapter 5
Global Innovation Networks, Territory and Services Innovation

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1 Introduction

The study of services innovation is in its infancy. However services, like manufacturing, are becoming increasingly globalised. Accordingly, this chapter will pay special attention to globalised services innovation. The subjects of the chapter require the combination of theoretical concepts. The first of these refers to design theory related to services innovation (Lester & Piore, 2004; Martin, 2009). This involves research on business models, especially around the distinction between exploration and exploitation knowledges. The second perspective involves examination of the extent to which services fit the idea of global innovation networks. This is the latest evolution in thinking beginning with global value chains (GVC) that later became elaborated as global production networks GPN) and has now been re-theorised as global innovation networks (GIN). Finally, for services related to advanced technologies, it has been found that the global connections relate to regional and national—hence 'territorial' innovation systems (TIS) and this is the final element of the proposed conceptual framework.

Each concept refers particularly strongly to a strand of the GIN. Thus design of devices and services used in ICT has both a history of globalisation, but more recently the 'emergence' of a global innovation network for ICT services utilising new 'convergent' communication design and technological services. Contrariwise, financial services, especially the securitisation innovations that brought the Great Recession to us, are the most globalised services of all. Its crisis has spatial origins in US 'sunbelt' housing developments, but how that was 'securitised' then globalised holds important lessons for the future. A key one of these is that a great deal more 'examination' knowledge needs to be introduced to augment the

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somewhat instant exploration into exploitation mode of implementing financial services innovation.

So the empirics of the chapter in the last main section will compare and contrast services innovation in two fields. The first is the ‘smartphone’ ICT globalisation of telecom services. These include ‘apps’, social networking and the regionalised design of these. Other service elements include chip-sets and systems from ICT design ‘hotspots’ like Cambridge, with ‘apps’ in places like Sweden, Canada etc., assembly by Taiwanese firms in China and global sales revenue to US proprietors like Apple and Google. The second and final study focuses on the financial services GIN, the apotheosis of innovation ‘at the edge of chaos,’ as it is known in complexity theory. The chapter thus proceeds with theoretical and literature review sections and moves to conclusions via accounts of the ‘emergence’ of GINS in two important global, innovative services platforms; ICT and finance.

2 From Complexity to Simplicity: Emergence, Self-organization and Modularisation in GIN Evolution

Writing about the dynamically changing manner in which economic activity now evolves globally is an exercise in the analysis of complexity. The principal aim of the student of such processes has always to be twofold namely to understand what is really occurring beneath the surface appearance (which can often look chaotic) and to communicate the results of such analysis with simplicity and clarity. Because so much of design and production service innovation occurs, like innovation in general, as non-linear, contextual, networked, emergent, distributed and apparently ‘self-organizing’ elements of definable global systems, the analytical toolbox must be suited to the task in hand. As Beinhocker (2006) argues at length, this means adoption of an Evolutionary Complexity Theory (ECT) not a Traditional Economics(TE) approach since the latter is linear, equilibrium, reductionist and non-systemic: hence it will not, despite its pretensions to predictability, be able to grasp satisfactorily the fundamentals of the complex processes under inspection.

So what are some of the key concepts that *will* assist analysis of the evolutionary dynamics we have chosen to try to explain? First, let us recognise that ECT, like TE and the variety of perspectives in between are metaphors. They are conceptual models of reality deployed as a means to grasp understanding of core elements and processes of interest. Thus a hybrid approach to understanding the rise of globalised relationships in manufacturing when they started to become widespread was the concept (and metaphor) of the global value chain (GVC). By now, and in the light of the foregoing discussion, the very language of the descriptors reveals the notion to be both linear and reductionist (to value). Ultimately, these characteristics can be traced to the idea of the value chain as promulgated by neoclassical corporate strategists like Michael Porter (1980). The approach was betrayed primarily by its equilibrium assumptions of market stability, a failure to account for change over time in representations of competitiveness, and reification of the large multinational corporation as the strategic ‘global controller’ of the globalisation process. To try to improve things, adherents of the GVC idea like Gereffi, Humphrey, and Sturgeon (2005, pp. 84–86) developed a theory of value chains based on three factors: the complexity of the knowledge transfer required to sustain a particular transaction; the extent to which this knowledge could be codified; and the suppliers’ capabilities in relation to such transactions. On the basis of these three factors, they identified five different GVC patterns:

1. Market-based chains characterized by low complexity of transactions, simple and easily codified product specifications and capable potential suppliers
2. Modular chains characterized by highly codified links simplified by technical standards, where suppliers make products to a customer’s specifications and take full responsibility for process technology
3. Relational chains characterized by complex transactions and highly idiosyncratic relationships which are difficult and time-consuming to re-establish with new value chain partners
4. Captive chains characterized by suppliers with low capabilities, dependent on larger, dominant buyers, who exert a high degree of monitoring and control
5. Hierarchy, implying vertical integration when transactions are complex and not easy to codify and the competence of suppliers is low

While it introduced important nuances to the metaphor, notably modularisation, it remained linear, hierarchical (MNC-dominated) and still generic among increasingly diverse industries and services.

Ripe for critique and re-appraisal in light of certain points raised in describing the objects of interest of ECT noted above, GVC began giving way to a new metaphor of Global Production Networks (GPN) after Henderson, Dicken, Hess, Coe, and Yeung (2002). This brings at least three advantages over the GVC metaphor: first GPNs recognise globally co-ordinated interconnected practices of firms and *non-firm* institutions in producing and distributing goods and services. Second, as noted above for ECT it recognizes the centrality of networks. These are conceived as both co-ordinating firms into relations that may cross public-private organizational boundaries and integrating territorial economies in ways that may enhance their developmental potential. Thus in a more systemic way the technological paradigm relates to a territorial regime for developmental purposes. Third, this process is interestingly complex since ‘regimes’ are territorially specific governance elements while production networks are global. Hence, GPNs interact with territorial ‘regimes’ in distinctive ways, influenced by incentive, subsidy and regulatory elements of their ‘regime’ as well as local ‘conventions’ that contribute to network interactions in *different* relational ways.

This is an improvement in that it allows for some non-linearity in the notion of networks and process-governance interactions, which in turn allow for variety in the modules that make up the articulation of global relations. However, despite its recognition of difference arising from this, its focus remains on *production* in the main and that principally at the behest of MNCs in a still linear, hierarchical and dominating relationship with other incumbents, whether firms or regimes. Most of all, it fails to recognise the dynamic element in such relationships which is accounted for by innovation. Essentially it shares Porter's assumptions of equilibrium, stable market conditions and neglect of change, which through its metric of time measures *entropy*, which marks the erosion of all three in reality. Erosion but, through negative feedback—negentropy—also the aftermath of the creative destruction process in the form of and as driven by innovation. So the GPN like the GVC was locked in a phase of the development of globalisation but both missed the key change element in the broader economic development process, which is capitalism's innovative impulse. Most radically, this impulse is not eternally located in the R&D laboratories of 'global controller' MNCs, rather it can come from anywhere in a self-organizing system, which leads to the need to replace both GVC and GPN metaphors with a more appropriate one which recognizes this, namely the GIN.

The GIN metaphor keeps a few of the GVC ad GPN notions such as *modularization* from the former alongside *networks* and diverse *governance* from the latter (on the contribution of *diversity* to economic growth, see Page, 2006, 2011). However, in order to articulate these in manageable yet clear ways it is useful to introduce two more heavy duty concepts from ECT. The first of these is *emergence* which allows us to situate *modularity* in an innovation process that relates to the second, which links *different* territorial innovation systems (TIS) together across the globe. The nomenclature TIS is needed because some are *regional*, some are *national* and some are strictly-speaking indeterminate, as we shall see.

To summarise the GIN representation, it consists of the following key elements:

1. A definable economic system with global reach in its innovation, production and distribution elements
2. Within that system different territorial innovation systems (TIS) that relate to the technological paradigm in question
3. Networks of innovators and non-innovators interacting in the system
4. Innovation modules that 'self-organize' into successful knowledge combinations
5. Processes of 'emergence' that organize innovation modules into higher order commercial products and services

In what follows, after a brief services innovation literature review, this chapter will show how this module works out for the selected GIN paradigms of ICT design services and financial securitization services. In each case there will be background reference to certain hardware innovations that relate to the service innovations in question. It may be considered unoriginal to admit that services are not freestanding in the economy but retain an intimate relationship with hardware production especially where innovation is concerned. This 'rule' is captured in the insight that IBM's innovative re-invention of itself as a services business was built on the back of its globally extensive installed hardware base and that 'nobody ever got fired for buying IBM' (Raymond, 1999).

3 Services Innovation Analytical Review

3.1 Architectural Innovation: IBM's Transition to Services

It was suggested earlier that services innovation has, with a few notable exceptions, been largely overlooked and this has tended to be even more the case with regional services innovation and its TIS relationships (but for a recent exception, see Cooke, 2011). To begin with, it is instructive to elaborate on Eric Raymond's (1999) insightful point about the relationship of services innovation to manufacturing innovation. He, like others, noted how the apparently radical decision by IBM to concentrate its core competence upon ICT services *exploited* IBM's previous hegemony in the installation of computer *hardware* in many of the largest corporations in the world in the postwar years. Accordingly, although successful, it was not a typical radical innovation decision to escape risk and uncertainty but more in the nature of an architectural 'no brainer'. That is, IBM's hardware markets were being assailed by still stronger competition at the mainframe end of the market than hitherto by the 'BUNCH' (Burroughs, Univac, NCR, Control Data and Honeywell). The new competition came with the rise of minicomputer alternatives such as those marketed by Amdahl, Digital, Data General, Prime and Wang. On top of that was even more acute competition from what IBM considered the 'hobbyist' PC end of the market represented by the likes of Apple, Hewlett Packard, Compaq and Dell and their Asian 'clones' (e.g. Toshiba, Sony, Acer).

Former food and tobacco firm RJRNabisco chief executive Lou Gerstner was hired to take over as chief executive and chairman on April 1, 1993. He overturned predecessor John Akers' plan to divide IBM into separate entities, envisaging a superior future. By 1995 the R&D budget had been reduced and the Lotus software company bought for the company as a supplier of comprehensive business solution services to existing and new clients. Now began the architectural reconfiguration of IBM from a manufacturing to a services innovator. Ill-fitting parts of IBM were divested and new service 'modules' were bought such that new path creation by knowledge recombination became 'emergent'. Thus in 2002 IBM bought the consultancy arm of PriceWaterhouseCoopers (PWC) for $3.5 billion. By 2004 IBM had departed the PC segment, selling its Personal Systems Group to Chinese flagship Lenovo for $1.75 billion. It also sold its PC factories in Research Triangle Park, North Carolina to Sanmina-SCI of Taiwan, its hard disk drive (HDD) facility to Hitachi and it also sold its memory chips, printers and IBM Networks divisions. By 2006 IBM had acquired a further 31 software firms: these gave the company the broad-based portfolio to allow it to build so-called services-oriented architectures (SOAs). 'Architectural innovation' of this kind is described by Henderson and Clark (1990) as *disruptive* because although it may utilise standard elements in its design these are re-configured in ways that make preceding configurations redundant. By then, IBM was competing with Oracle, SAP, Microsoft and Sun Microsystems as a one-stop shop for corporate customers. SOA was an innovative way to build 'back-end' systems to industry standards integrating modular systems and forcing the competition to reconfigure their systems around SOA too. Indicatively, one IBM modular acquisition, Webify, enabled the building of a framework of pre-written software code for specific applications in industries like banking or insurance, reducing development costs accordingly. Other IBM architectural innovations included Radio Frequency Identification (RFID), a printed electronics consignment tracking system, developed to manage its own logistics but sold to Wal-Mart as what is widely perceived to be their key global supply chain management advantage.

3.2 Service Innovation by 'Modularisation'

Another service innovation that originated in the ICT hardware industry as described by Grove (1996) from his time as CEO of Intel is 'modularisation' (see also Sturgeon, 2002). While 'architectural innovation' is emergent through the dispensing of redundant elements and reconfiguration of pre-existing with new elements, 'modular innovation' is emergent through the assembly for a higher purpose of new elements. Even in hardware terms there may be little scope for recombination with pre-existing modules. A good example of modularisation in the software and systems design elements of an innovation is demonstrated by reference to Apple's origination of the iOS system used since its earliest iPod 'smartphone'. This involved co-evolving new combinations of modular elements that would come to characterise smartphones in general. This was achieved through integration of wireless communication, powerful core processors, optical systems, music, video, software 'apps', flat panel display, touchscreens and the various system controls to implement interactions among these. To achieve this, Apple had to make a number of acquisitions of small, specialist companies and decide on key members of its GIN for reliable delivery of robust components. With respect to the latter, a core processor supplier was ARM, the Cambridge (UK) 'fabless' chip design company specialising in cellphone systems, with chipset assembly from the likes of Taiwanese innovator Mediatek. This is a good example of modular emergence requiring new hardware and software elements since Intel had been Apple's preferred supplier for computer chips but it was deemed 'too slow' logistically as well as insufficiently integrative technically for more complex 'smartphone' inter-operability and mobility requirements (Isaacson, 2011; Sturgeon, 2002).

To realise the smartphone's innovative, technically convergent services design, involving telephony (by now the least challenging element), digital camcorder, 'apps', music, TV and video communication capabilities, Apple had to put together new modules. These included the following acquisitions:

- **Emagic**—a music software and hardware company based in Rellingen, Germany with a satellite office in Grass Valley, California. Purchased in 2002, the company was best known for its *Logic* music sequencer, used in Atari and the Apple Macintosh since 1992.

- **Lala**—an online music store acquired by Apple in 2009, whose Palo Alto music engine service allowed members legally to upload their own music for sharing, accessing Apple iTunes and MP3 content. Lala claimed availability of over eight million songs.
- **FingerWorks**—a touchscreen spinout from the University of Delaware known mainly for its *TouchStream* multi-touch keyboard. Initially designed as a service to help sufferers of repetitive strain injury (RSI) the company founded in 1998 and was acquired in 2005.
- **PA Semi**—acquired by Apple in 2009, this Palo Alto fabless semiconductor SME specialised in making powerful and power-efficient Power Architecture processors. The acquisition also added lead designer engineering experience of designing StrongARM processers to Apple's workforce to implement custom chips for the iPod, iPhone and iPad.
- **Intrinsity**—an Austin, Texas based fabless semiconductor design SME acquired by Apple in 2010. Its service was for advanced semiconductor logic design for proprietary ARM, MIPS and Power Architecture cores. Specifically, it enhanced high performance microprocessors by implementing fewer transistors and low power consumption (typically required in smartphones).
- **Nothing Real**—from Venice Beach, California was acquired by Apple in 2002 for its *Shake* advanced digital effects software applications for feature film, broadcast and interactive gaming services.
- **Siri**—acquired by Apple in 2010, San Jose-based Siri was a spinout from Stanford Research International (SRI) Artificial Intelligence Centre at Stanford University funded by DARPA. It specialised in human-computer voice communication. It was launched as a service of the Apple iPhone 4S in November 2011.

Hence we see how modular innovation in this advanced software development-based service industry fits very well with the complexity theory perspective upon innovation. This, it will be recalled, proposes innovation occurs by assembly through recombination of existing, distributed knowledge modules. These combine to implement a higher-level purpose of integrated service provision in the form of a new system. In this respect, inside the system of the firm, *downward causation* is exerted on subsidiary elemental levels in an endogenous developmental manner. This counters the physico-chemical reductionist metaphor of causality, which is that causality is always upwards from the atomic and/or molecular level.

Downward causality of this kind is, in fact, normal in service and other industrial or even public policy innovation, as only the following paragraph-length summary testifies. Thus in pharmaceuticals services, for example, evolutionary transition in business strategy typically produces comparable 'modular innovation' results. The Swiss pharmaceuticals company Roche, third biggest in the world, is in 2012 engaged in a transition from expensive cancer drug research and design towards expansion of the diagnostics side of its business. This led to it acquiring tissue diagnostics firm Ventana Medical Systems of Tucson, Arizona, expert in determining effective treatments for cancer and other infectious diseases, for $3.4 billion in 2008. In 2010, it was announced that Ventana, as a member of the Roche Group, would acquire BioImagene, a digital pathology company based in Sunnyvale, California. Digital pathology is a suite of dynamic, image-based technologies that enable image capture, information management, image analysis and virtual sharing of patients' tissue samples. Other acquisitions at the time included Almira and Allied Medical. In October 2011, the company announced a $17 million cut in its R&D budget because of concerns that government and academic institutions would reduce laboratory drug research funding. In July, the company bought cervical-cancer diagnostic maker mtm laboratories of Heidelberg, Germany for €190 million. In the same year Roche announced the acquisition of PVT (*Probenverteiltechnik*) based in Waiblingen, Germany and of PVT Lab Systems, based in Atlanta, Georgia. PVT was a global market leader in providing customised automation and workflow solutions for in-vitro diagnostic (IVD) testing in large commercial and hospital laboratories. In December 2011 Roche Diagnostics bought Verum Diagnostica, based in Munich, a leading company in platelet function testing, the fastest-growing field in the coagulation diagnostics market. By 2012 Roche was bidding to acquire San Diego gene-sequencing firm Illumina for $5.7 billion. This was to meet accelerating demand for gene-based treatments and speed up the use of DNA research in medical diagnostics.

3.3 Innovation by Exploration

This is the third type of service innovation model to be explored in this analytical review. It builds on the distinction utilised widely in ECT made by March (1991) in regard to firm strategies when confronted by circumstances of severe uncertainty bordering on 'creative destruction'. In this circumstance they should engage in *exploration* strategies. In times of stability between the span of the business cycle or crisis punctuation points they should engage in strategies of knowledge *exploitation* of the fruits of the exploration phase. Much organisational learning literature finds firms do this and many are in more or less permanent tension between the professional cadres associated with either side. Martin (2009) shows this for firms like Lucent and Ericsson in telecom services where the accounts-led professionals on the exploitation side found the exploration engineering practices on the exploration side to exist 'on the edge of chaos' and to wish to re-exert system control on the company as soon as possible once the crisis was over (Cooke, 2012). The distinction is also discussed in relation to business innovation by Lester and Piore (2004). While, from an ECT perspective in general the relationship is discussed by Page (2011) and from an evolutionary economics viewpoint by Beinhocker (2006). Here, we seek only to consider the *exploration* dimension and that from the viewpoint of a style of service industry innovation. The exemplar is Microsoft Research, a key division of Microsoft, having six distributed research centres around the world.

The first of these was established at Microsoft's Redmond, Seattle homebase in 1991. Redmond researchers developed Wearable Multitouch Interaction, which turns any surface in the user's environment into a touch interface, while PocketTouch enables users to interact with smartphones inside small surfaces like a pocket or purse. A different team developed much of the computer graphics software that is implemented in the modern visualisation and simulation systems used in films, games and serious games for training and remote monitoring (including military 'drones'). Established in 1997, Microsoft Cambridge has innovated mathematical proofs for verifying programming logic (the Four Colour Theorem) and Kinect, the controller-free interface that enables users to interact with the XBox 360 by the wave of a hand or the sound of the voice, with a system for programming computers to recognise skeletal movements and body parts in gaming. Microsoft Silicon Valley, opened in 1998, also contributed to Kinect, and developed a landmarks-based shortest drive path algorithm for routing European journey directions. Opened in 2008, Microsoft Research New England works on computational biology and social networking. A further centre, established in 2005 in Bangalore, India makes fundamental contributions to software checking and verification while the centre for Microsoft Research Asia, based in Beijing, China since 1998 has worked on face recognition and visualisation, innovating the Kinect Identity player recognition tool-set for the X-Box 360 gaming device. Across its twelve research groups, the Adaptive Systems & Interaction group is also associated with innovations in 3D virtual reality, while the Programming Languages group has evolved TouchDevelop allowing programming on a Microsoft-enabled smartphone (e.g. Nokia Lumia). All in all, exploration innovation at Microsoft Research has produced some significant successes. For example, many of those listed above became modules of the Kinect device, although Microsoft acquired the 3DV firm behind the Z-Cam camera technology from Israel. This is a good example of how acquired and indigenous, long-term *exploration* innovations like surface touch, facial recognition, voice recognition, and skeletal mapping make their way into the marketplace through a variety of mechanisms, including a dedicated technology-transfer team, product incubations, IP licensing, and the sale of Microsoft Research products through the online Microsoft Store. However, Microsoft suffers from the 'innovator's dilemma' (Christensen, 1997) which occurs when a company focuses on protecting existing markets, rather than trying to create new ones, worried that new markets may eat into existing revenue streams. Accordingly, with more than twice Apple's patents, Microsoft is less than half as innovative.

3.4 Innovation in Other Services

Deliberately concentrating on obviously innovative services companies like IBM, Apple and Microsoft gives the lie to the claim that services are not innovative. They clearly are. For the first time, in the present account, an original explanation of the nature of distinctive modes of service innovation has been worked out and demonstrated. However, it can be that this gives a misleading impression of just how innovative service industries actually are. Accordingly, with reference to recent reviews a brief attempt is now made to estimate the innovativeness of other services than those evolved from high-tech manufacturing. In this account, after Aoyama and Horner (2011) we shall summarise the following: retail, logistics, contract R&D and public services innovation. In Cooke (2011) a review is offered of the views of the main experts on regional services innovation and it is summarised and updated in the paragraph which follows these specific accounts. It will be seen that the first two involve both architectural and modular innovation due to the re-architecting of the retail and logistics industries into an improved digital fit. Meanwhile, the second two include re-architecting, modular and exploration innovation for R&D services and modular innovation for public services. In each case, modular innovation involves reconfiguration by 'bundling' of technologies and procedures of an emergent nature. For example, mobile telephony is configured with positioning (GPS), scanning and imaging modules in innovative ways in one of the chosen cases of public services innovation while electronic point of sale, consignment tracking, printed electronics and data-mining were 'emergent' in retail and logistics innovation, as will be seen below.

3.4.1 Retail Services

Retail innovation is common, nearly ubiquitous among retail chains and largely defines price and non-price retail competitiveness. Such innovation can also involve branding or re-branding strategies. Cases in point are BP replacing its traditional 'British Petroleum' tagline with 'Beyond Petroleum' in 2002 as it both globalised even further and tried to re-position itself as a 'greener' corporation—more successfully in the former aspiration than the latter. Another would be Wal-Mart that similarly sought to change a bad, exploitative image as an arch-discounter that drove its suppliers to the wall (Fishman, 2007) into an environmentally friendly corporation that painted its stores a solar reflective white in place of its traditional battleship grey(MacDonald, 2008). Technological innovation advanced Benetton's global entry into the fashion retail market in the 1980s, its electronic point-of-sale (EPOS) programming enabling rapid shelf-replenishment from instantly informed supply-chain management. By the 2000s Spanish emulator Zara had successfully augmented Benetton's EPOS system with a fashion forecasting facility that further boosted 'quick fashion' emanating from elsewhere in Italy as the 1990s 'pronto moda' innovation. Japan's convenience stores were something of a role-model here, making larger IT investments than other retailers to abbreviate restocking time. The first EPOS system was developed by 7-Eleven Japan in 1982 to rationalise delivery trips with a view to raising efficiency in overall cost reduction (Aoyama & Horner, 2011). In the UK, Tesco the world's third largest retailer, gained enormous efficiencies from a related innovation that connected loyalty cards to customer profiling. Tesco tripled in size after 1995 when it agreed to work with a start-up company established by Edwina Dunn and Clive Humby. Their contract followed a now legendary presentation to the board in which Lord MacLaurin, Tesco's chairman, replaced Green Shield stamps with the Tesco customer-loyalty ClubCard. The service innovation in question used data-mining to analyse and predict customer purchases The couple's company, Dunnhumby, is now 90 %-owned by Tesco, its most important client. Clearly, retail innovations of the kind described tend to be implemented in large corporations for whom resulting efficiencies can often justify heavy up-front ICT investments. As with Wal-Mart and Tesco, observed efficiencies are achieved through such discount retailers using online networks to drive down supplier costs by adopting the innovation thereby contributing to network efficiencies as returns to innovation diffusion (Miles, 2000). Of course, such modular innovations swiftly migrate and coalesce as drivers of recombinant knowledge among competitors seeking temporary advantage in global markets.

3.4.2 Logistics Innovation

Many of the innovations in retailing are forms of logistics innovation but there are others that belong to the world of logistics itself. Wal-Mart is widely praised for the efficiency of its Radio Frequency ID (RFID) stock consignment logistics system which, as noted earlier, was actually invented by IBM to control its own supply chain. In the case of IBM this also involved out-sourcing logistics below a nominal value to external suppliers. In Germany, for example, IBM's preferred logistics supplier for low-value items was for a time Bertelsmann, the global media corporation, considered more efficient in the 1990s than the majority of pre-logistics 'haulage' firms then prevailing (Cooke & Morgan, 1998). Later, haulage and general transportation companies modernised through innovations utilising ICT and eventually the Internet to consolidate delivery loads. These were absolutely inefficient in the earlier period and, it is widely understood that, even today, some 40 % of average truck volume consists of air rather than goods (McKinnon & Piecyk, 2010). Accordingly, the logistics industry has emerged somewhat as a strategic and knowledge-intensive industry that at its best provides crucial services to many sectors of the economy. This was testified to above in respect of ICT logistics requirements of flagship marketers in ICT who demand 98-2 service: that is 98 % of an order of, for example, Taiwanese chipsets, must reach their Cupertino, California destination in the case of Apple, within 2 days. As Yeung (2011) makes clear the ability of firms like DHL to fulfil these requirements goes a long way to explain the feasibility of long GIN (global innovation networks) and the profitability of firms that can achieve or surpass 98-2.

Aoyama and Horner (2011) argue that the Internet revolutionized logistics through providing new on-line ordering tools and stimulating the rise of new e-logistics providers. The latter can be divided into those that provide logistics services exclusively in virtual space (non-asset-based), and those that provide services in both virtual and geographic spaces (asset-based). The rise of e-logistics suppliers is witness to the organizational decomposition of the physical movement of goods (see also Schmitz and Strambach (2009). Meanwhile, the related transmission and processing of information has been accelerated by the introduction of B-to-B e-commerce. Largely virtual e-commerce providers include internet brokers, online auctions, and online exchanges of the kind routinely utilised by aerospace clients often purchasing from global single sources (Cooke & Ehret, 2009). Such businesses estimate at least one-third of supplies are purchased on-line, including deliveries of special alloy blocks that may only be available from a single source located in, for example, Wichita, Kansas.

3.4.3 R&D Services

It was a standard belief in innovation studies that R&D and, to some extent, innovation associated with it would be the 'stickiest' part of any business to offshore in any evolving global value chain (Pavitt, 1984). This view has been shown to be a sound judgement but the implication that R&D might never move has proved less reliable. Already by the 1990s Chesbrough (2003) showed that outsourcing and indeed, offshoring of R&D had moved ahead apace. In markets like pharmaceuticals, the onset of biotechnology meant that large firms, who initially tried to master the new technology by acquiring smart start-up businesses, soon found they were ill-equipped to conduct non-chemical research and changed their business model accordingly (Cooke, 2007). By the end of the 2000s most 'Big Pharma' was suffering from drying pipelines for new chemical entities from traditional fine chemistry sources and was becoming ever-increasingly reliant upon biotechnology innovations from dedicated biotechnology firms and biotechnology R&D from university biosciences and medical schools to fuel their businesses. Thus in early 2012 AstraZeneca announced 7,350 R&D redundancies over the 2012–2014 period because its 'pharma' innovation model was broken. As noted above, a celebrated global pharmaceutical services company like the Swiss firm Roche had been re-positioning itself as a diagnostics more than a therapeutics medicaments company, while its global neighbour Novartis had been investing enthusiastically in generic drug companies such as Lek (Slovenia), Hexal (Germany) and Eon Labs alongside Bristol Myers Squibb's (US) over-the counter drug divisions. This is because both, like their global rivals, find medical services markets more profitable than drug production markets in the new biopharmaceuticals era. This is also re-architecting innovation, involving modular recombination and exploration anew in unfamiliar fields.

Other, longer-established R&D services innovation markets include those associated with contract companies like Cambridge Consultants and PA Consultants, Cambridge who pioneered the software and systems design capabilities that took advantage of, for example, the kind of 'fabless' chip design industry that now dominates the ICT industry and in which virtual designs are fed by the likes of ARM to countries like Taiwan who invested heavily in silicon foundries to produce and 'chipstack' their products for implementation by the likes of Apple in their iOS smartphone systems. This externalisation model was subsequently exported to emerging market economies like India and China, especially in the former case regarding software checking, de-bugging (as with Y2K work) and back-office design contracts. One belief is that Indian 'body shops' like Infosys and Wipro were the mechanism that started this process because the Y2K scare required in the short-term many programmers familiar with COBOL, the computer language that set the clocks and other controls at the time, and India was the only place that had enough (Yeoh & Willis, 2004). It still remains the case that much software-related work in innovation-related services in the Indian centres in Bangalore, Hyderabad and Mumbai involves back-office software services exemplified by the fact that China's telecom flagship Huawei joined western outsourcers in contracting out its telecom services software checking and de-bugging requirements to such former 'body shop' providers. Singapore's HDD sub-contractors and inward investors like Seagate and Western Digital have similar Indian software development clients. But this is hardly R&D, of course—though it is somewhat indicative that much of the growing outsourcing of such services to China and India involves more checking, de-bugging and following blueprints than truly inventive or even innovative work. Space does not permit further investigation of this fascinating element of 'open innovation' in R&D services but reviewer advice suggests the following should be consulted by interested readers (Castellaci, 2010; Martinez-Noya, Garcia-Canal, & Guillen, 2011)

3.4.4 Public Services

Innovation in public services may seem rare but the reality is that much innovation occurs in public services and, on balance, probably more of it is directly helpful to the health and education of users than much other service innovation that has been discussed thus far. The subject itself is globally under-researched; hence this review is even more reliant on a few indicative examples than in other fields. Let us start with the 'bottom-of-the-pyramid' innovation inspired by Prahalad (2005) who pointed to the vast amount of individually small profits that could be made by global corporations selling services to the poorest strata of societies in developing countries. One such innovation that has proved successful for global information and medical technology firm General Electric is described by Immelt, Govindarajan, and Trimble (2009) as a form of retro-innovation. The case study GE CEO Jeffery Immelt contributed to in the Harvard Business Review concerned body scanners, for which GE is a leading global producer and marketer. The price of an MRI scanner varies, depending on the strength of the scanner. Scanners with more strength produce more detailed images; therefore, these scanners cost more. MRI machines can thus range in cost between $1 and $3 million. Such costs mean installing MRI equipment is unthinkable in most developing country contexts. Alerted to this, GE began exploring the bottom of the pyramid and developed a hand-held device connected to a mobile phone for transmitting scans to a central imaging facility at a cost of some $1,000 per item. This sold very well in developing country markets and saved sufficient lives that a market opened up for such low-cost hand held scanners on the part of police forces and paramedics dealing with highway and other accidents back in the US.

Perhaps the most remarkable platform of innovations to have reduced death rates in western countries has been that part of the medical services dealing with heart disease. Once the number one killer, heart disease has now declined by half 2002–2010 to one of the lesser life-threatening diseases. Research showed that just over half this decline was caused by fewer people having heart attacks and just under half by more people who had heart attacks surviving. In the latter case, angiogram technology that improves diagnosis, angioplasty that facilitates strengthening blocked arteries with medical ‘stents’, and improved cardiac by-pass survival rates explain much of the improvement. Moreover fewer heart attacks have occurred in recent years and of those that did occur, fewer were fatal. As the authors conclude, the evidence suggests that these remarkable results are caused by healthier lifestyles, better prevention for those at risk and improved medical treatment for heart attack patients (Smolina, Wright, Rayner, & Goldacre, 2012). Thus it can be seen that services innovation can be relatively straightforwardly found in the public services; in the two cases given these were linked to technological change but not all such change relies on increased technological innovation (viz. GE’s hand scanner) although angiograms and angioplasty are different. The key is that both service innovations had a clear purpose and attention was devoted in technical and pedagogic means to achievement of the service innovation *through* technological innovation in a demand-driven rather than a traditional technology-push manner. Thus it can be seen that the borderline between services and manufacturing can be quite fragile in connection with high-tech services like control system software design. In this respect, as Metcalfe and Miles (2000) say—technology-based services are not so dissimilar from high-tech manufacturing. However, other services operate differently, with fewer investments in R&D and intellectual property tools like patents. Nevertheless, some services both invest in patents and, more frequently, copyrights and trademarks. Metcalfe and Miles (2000) also argue, correctly, that there is greater focus upon organizational innovation involving training and skills upgrading (Cooke, 2011).

4 The Question of Territory

The chapter turns now to reflections on the territorial dimension of what has been disclosed about GINs for services innovation. Like much other innovation, services innovation has the objective of ‘annihilating space with time’. This is especially clear in retail and logistics innovation but is also true of Apple’s 98:2 demands described above to achieve exact time-to-market scheduling. IBM’s shift to services increased its turnover and its turnover time compared with its mainframe computer business, and so on. Paradoxically, however, achievement of these time for space economies requires an increased spread over and utilisation of spatial locations of economic activity. Furthermore, GINs rely on modularization which is far more complex organizationally than vertical integration. Accordingly, the space of location for service innovators in GINs is extensive but granular. We will see this for financial services later in the chapter, but for the moment consider the pre-crisis advantage to, for example, the Morgan Stanley investment bank, of its Mumbai back-office where some 2,000 employees worked in IT, finance and accounting. Among the 2,000 were 500 knowledge process outsourcing (KPO) workers. A crisis-invoked task for KPO was to value the tranches of millions of sub-prime mortgages Morgan Stanley had invested in. This was achieved, in effect, over a weekend at a billed cost of $95,000, anything between a tenth and a hundredth of what it could have cost in the same timeframe in New York. Accordingly, time annihilated space with low-cost skills, which is a key asset in Mumbai's locational offer for what is described in another US investment bank JPMorgan's website as often innovative KPO work (Cohan, 2010).

What is new in this otherwise unremarkable tale of financial services outsourcing is the emphasis investment banks put on the *innovation* capabilities of a portion of their back-office functions. It remains to be seen precisely what such innovation comprises and, for Morgan Stanley, it involves equity research, complex financial modelling and portfolio analysis while for JPMorgan it is a KPO call centre. These are merely illustrative vignettes of the emergence of at least some elements of novelty in what have hitherto been mainly locations for more humdrum tasks. It is something, as we shall see, displayed also in the changing work content in the ICT services GIN where locations that have self-organizing capabilities to evolve capabilities in knowledge *exploration* in addition to the more familiar and routine knowledge *exploitation* (March, 1991) nowadays win out as the GVC, or its evolved sub-form, the GPN, transitions into a more demanding GIN. Such self-organizing capabilities as those that engage governance accomplishment, on the one hand, with entrepreneurial or innovative attributes, on the other, are scarce and, accordingly, highly valued. In the GIN analysis offered here, they are referred to as territorial innovation systems (TIS). As noted, they engage an exploratory sub-system composed of knowledge and connectivity infrastructures that help form research and technical talent, with a commercialisation or knowledge exploitation sub-system that includes opportunities for creative as well as routine professional or corporate employment in addition to innovative entrepreneurship. While in India, mention must be made of such exemplars as Bangalore and Hyderabad where financial ICT services also proliferate alongside an embryonic biotechnology platform. Other such 'rising' as well as 'setting' TIS locales concomitant with the shift from GPN to GIN in ICT and financial services are discussed in the section which follows.

5 Global Innovation Networks in Services

We now come to the final main section of this chapter, which explores the emergence of global innovation networks (GINs) in a few representative service industries that are not primarily local, yet whose outlines can be readily inferred. Such inferences arise in part from the foregoing discussion of architectural, modular and exploration innovation in advanced technology services like ICT and biotechnology, on the one hand, and, on the other, certain other global services, like retail, logistics and R&D that often sustain them in particular ways. Innovation,

Table 5.1 Main debtor nations, 2011

Country	Foreign debt to GDP (%)	Government debt to GDP (%)
Ireland	1,093	109
Iceland[a]	1,003	100
UK	436	81
Spain	284	67
Greece	252	166
Portugal	251	106
France	235	87
Germany	176	83
US	101	100
Japan	50	233

Source: Bank for International Settlements; IMF; World Bank
[a]NB 2009; Reinhart and Rogoff (2010); IMF

in general, is by now a global business and there is every reason to highlight those global service industry innovations that often drive such emergent processes forward because of service industry demand, as we have seen. We shall give two brief accounts of quite complex GINs in ICT-related services of the kind alluded to earlier, followed by a mirror-image 'scowling curve' GIN derived from recent experience of financial services innovation in securitisation where the upper part of the smile is represented by the kind of debt to GDP ratios revealed in Table 5.1. This is also a markedly more hierarchically (though without a single 'global controller') structured GIN driven mainly by Wall Street, notably that part connected to securitisation of assets that was the proximate cause of the current global economic downturn. In the first of these, we see complex adaptive systems of globalised service innovation emerging in diverse locations from earlier forms of more value chain and production-centred system hierarchies.

5.1 Innovative ICT Services GINS

It is important in this section to try to separate global production networks (GPNs) which are still mainly related to production of hardware like hard disk drives in places like Singapore from global innovation networks (GINs) in ICT services. Such centres as Singapore have long animated their own production sub-networks in neighbouring countries like Malaysia, Philippines and Thailand alongside US MNCs like Seagate and Western Digital, something just beginning in ICT services GINs. The ICT services GIN works as follows, with a result sometimes known as the 'smiling curve' of global value appropriation (see also, Mudambi, 2008). The highest value attractors in this model remain the western design, software and systems companies, while the lowest value attractors are the 'world factory' assemblers in China and even lower-wage economies. In truth, the latter do not

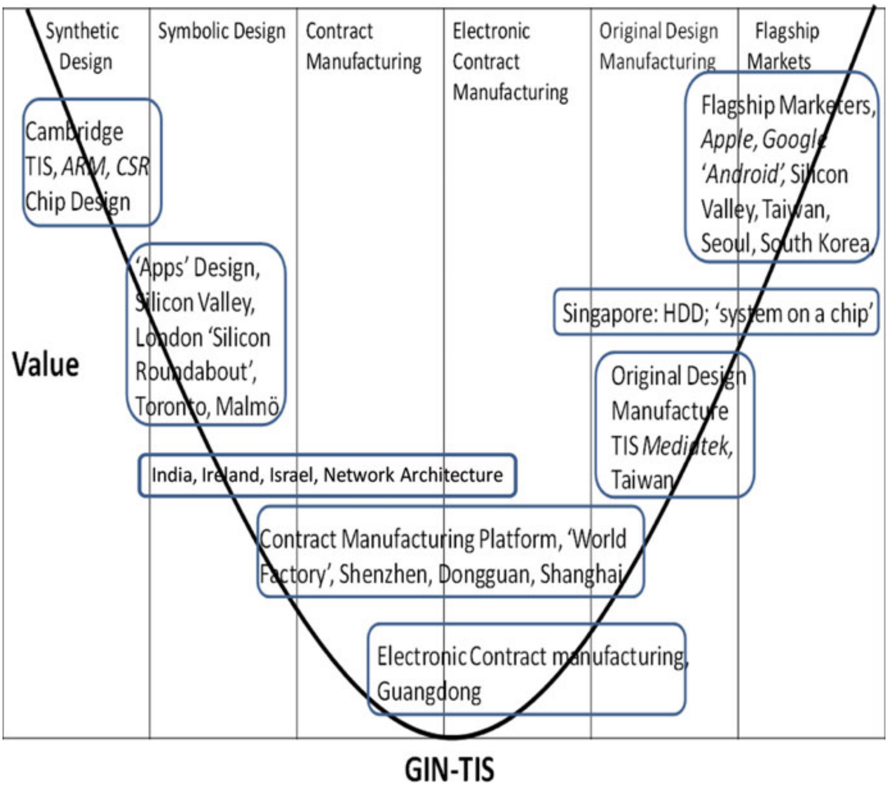

Fig. 5.1 'Smiling curve' of value in ICT Global Innovation Network (GIN)

specialise significantly in services but rather assemble the componentry that allows service innovation to be carried out either in production or the final consumption of such devices as smartphones and tablets that enable ICT services to be accessed. The basic picture is characterised first by the demise of some North American and the main European mobile telephony pioneers like Motorola, Research In Motion (BlackBerry), SonyEricsson and Nokia who are following Siemens and Alcatel into oblivion. Meanwhile the GIN displays the rise in hardware but also services of Asian innovators. Added to this is a question mark about the continued significance of the Singapore part of the old GPN in the new GIN world because its model was very tied to PCs rather than smartphones and market analysts expect the growth rate of tablets to be greater than PCs just as smartphones have outpaced cellular telephony-only devices. As noted earlier, the latter transition caught nearly all declining incumbents unawares.

So how is the ICT services innovation GIN structured? Each sub-unit of the GIN in Fig. 5.1 has some degree of involvement in the service innovation dimension of the GIN for ICT. Even at the bottom of the value curve are B-to-B network relations between the assemblers and the recipient firms in locations such as Guangdong that assemble the simplest parts of the final device. Above them, at a marginally higher point in the ICT services innovation network are assemblers of more complex chipsets or, increasingly, 'chipstacks' that integrate more efficiently relationships between microprocessors (increasingly 'power chips' that are both powerful but economic in their power usage) produced by diverse—often European—companies like ARM, Infineon and ST Microelectronics or US ones like Broadcom, National or Qualcomm. Such system design for chipstacks is a market currently cornered by Taiwanese firms like Mediatek and Wintek who have innovated around Taiwan's early investment in the world's most advanced silicon foundry. This advantage is now waning as South Korea and China, in particular, invest in their own silicon foundries. However, this is a key part of the ICT GIN where Asian producers have implemented software and systems design innovations that Broadcom, Qualcomm and Texas Instruments can no longer compete with.

Approximately level with such original design manufacturers (ODMs) as Mediatek and Wintek from Taiwan are India, Israel and Ireland. India is, as has been indicated, an important back office design and testing location for outsourced software and systems implementation initiated, first, in Bangalore by western firms like Texas Instruments, IBM and Cisco Systems and more recently by Chinese telecom giants like Huawei. This company is active in all spheres of telephony from traditional landline infrastructure through ground stations for cellphones to the Chinese TD-SCMDA standard, lower-end mobile phones and, increasingly, more expensive smartphones. As noted, Huawei has developed offshoring software links to Indian software companies (the former 'body shops') as well as making inroads in European markets (e.g. traditional infrastructure upgrading in the UK and Finland) and hiring redundant telecom engineers from Ericsson in Sweden (Lund, Gothenburg and Stockholm) and possibly in future Nokia in Finland. Israel is expert in software and systems design, especially in security software ('firewalls') and optical systems utilised in smartphones and gaming devices. Ireland hosts software development (e.g. Customer Relations Programming/Management—CRP/CRM; SAP, Symantec), administrative functions for the likes of Google, PayPal and McAfee, and 'cloud' computing services (Hewlett-Packard, Dell).

Above Ireland in value appropriation are the many small and micro-firms that specialise in the writing of software and systems for the 'Apps' that predominate in smartphone and tablet 'culture'. There are concentrations of 'Apps' writers although they can easily be located more or less ubiquitously. Continuing up the symbolic and synthetic (engineering) part of the curve are the power chip designers like ARM (formerly Acorn) and CSR from Cambridge plus others either acquired by 'flagships' like Apple or co-located in Silicon Valley. ARM also provides chip designs to Samsung, LG, Microsoft and Fujitsu while Samsung and LG have launched 'smart' Internet-enabled TVs that use ARM processors (Buncombe, 2012). On the other 'markets' side of the GIN service innovation 'smiling curve' are the flagship providers themselves like Apple and Google (Android) with the latter having twice the market share of the former, and Asian flagships like Samsung and LG from South Korea and HTC from Taiwan, each of which combine competitive ICT service functionality vis à vis the US flagships (Chen & Wen, 2011; Ernst, 2009).

5.2 Financial Securitisation GINs

For this service GIN, the equivalent of the 'smiling curve' presented above would be its inversion to a 'scowling curve' of indebtedness incurred first by various banks in specific locations and then by the countries in which the majority of such debtor institutions were to be found during the post-2008 credit crunch era. The whole of this sorry picture rests upon service innovation in the finance industry, especially the innovation of the credit default swap (CDS) a financial derivative that evolved (mutated) into the subsequent innovation of the collateralised debt obligation (CDO) and other futures and options-derived financial products and services. There are even names and companies associated with the innovation biographies in question. The principal locus of creativity was Wall Street, New York City where a few innovators noticed an opportunity to make huge profits. Traditionally, home loans (mortgages) were in the US provided by community-based 'savings and loans' companies. A loan was made by the bank and stayed with the bank until it was paid off 25 years or some other agreed term later. However, with the growth in the market for owner-occupation fuelled by the postwar 'baby boomer' generation, market observers noticed the 'savings and loans' companies had inadequate capital resources to satisfy demand for new mortgages—especially in the fast-growing Sunbelt states of California and Florida. Meanwhile, in the 'Rustbelt' local banks were faced with the opposite problem of too much capital and too little demand. Economic geography thus lies at the heart of the prevailing global financial crisis that began in 2008 and remains unresolved 4 years later at this writing.

The 'emergent' solution to the double supply and demand problem was perceived by a Salomon Brothers bond trader, Bob Dall, to be their recombination through the mechanism of securitisation. This would be a major re-architecting of the home loans business in which the modules involved in the recombination were the following. Salomon would be the catalyst, or first module, shifting inactive assets, second module, from Rustbelt to Sunbelt, garnering a transaction fee in reward as a third module, then securitising the resulting repackaged transfers into bonds—fourth module—to be sold, fifth, around the world. To achieve the last requirement of selling the newly created bonds, Dall turned to Salomon colleague Lew Ranieri who persuaded banks and legislators at state and federal level to adjust to the new model. Everyone benefited: more loans were available where demand was highest; interest rates were lower due to greater demand for loans to securitise from Wall Street; loan companies had shifted default risk to bondholders; the banks received fees; and investors could acquire relatively low-risk assets. Incremental innovation ensued as Salomon's 'rocket scientists' or 'quants' first evolved collateralised mortgage obligations (CMOs), which sliced a number of already securitised mortgages in a bond according to risk, with the greatest risk yielding the greatest return (Patterson, 2010). Then, securitisation began to be applied to varieties of loans—for students, car purchase, credit cards etc.—before by the late 1990s credit default swaps (CDSs) emerged. These were insurance certificates against mortgage defaults which could be bought and sold on the derivatives market. The next innovation was the securitisation of these derivatives in which banks bundled the securitised loans into collateralised debt obligations (CDOs) which were slices of all kinds of debt reincarnated as bonds. Eventually 'slicing and dicing' of pieces of other CDOs emerged, known as CDO-squared. Finally, Wall Street bank J.P. Morgan produced a 'synthetic' CDO composed of CDS 'swaps'—an insurance on insurances. This allowed the bank to move its own under-performing loan inventory off its balance sheet and onto the market. The CDOs were priced using an algorithm that calculated probabilistic interaction effects of defaulters—in the form of a multidimensional bell curve (the Gaussian copula). The law of large numbers meant that this curve was expected to remain relatively stable, which it was until banks began filling CDOs with the sub-prime mortgages that were by the mid-2000s the main or only source of new mortgage demand. Under these circumstances, volatility began rising as mortgagees began defaulting when repayment terms ended or mortgage costs otherwise began to increase (Tett, 2009).

Such innovation was clearly exploratory, architectural and modular in its recombination of derivative securitisation knowledge. Moreover, there was no single 'global controller' of the system but rather competitive emulation, imitation and incremental innovation in evidence, albeit focused on the Wall Street TIS. The key question is where did the emerging volatility, leading to the bankruptcy of numerous Wall Street and other US banks, produce the greatest impacts as the financial securitisation GIN worked through the investor communities of different parts of the world's financial innovation system? For this we may turn for guidance to Lewis (2011) who investigated the countries who had lost most from bailing out their sub-prime CDO financial innovators. They can be listed and then dealt with in turn as follows. First is Ireland, where the relation between bank indebtedness and national GDP at the peak of their financial crisis was of the order of 1, 267 %. Second is Iceland, where it was some 1,000 % at the peak of their crisis in 2009. Switzerland and the UK were second and third in late 2011 at 422 % and 408 % respectively. Greece, where total debt was only 252 % of GDP in late 2011 but government borrowing was expected to reach 166 % near the end of 2011. Table 5.1 gives foreign and public debt magnitudes end-2011. Of interest is which countries and their banking systems most engaged with the opportunities misleadingly promised by the evolution of securitisation such that it massively affected the viability of those states and banking systems. In the space available it is only possible to be indicative by referring to the cases of the first three 'worst offenders' with commentary in passing of relevance to absorptive capacity to financial innovation by other countries of interest such as Germany and the US. Briefly we may say something about the last two before summarising the key points of relevance in the case of the financial services (securitisation) GIN as it affected Ireland, Iceland and the UK.

Clearly, from what has been noted already in this sub-section, the securitisation innovator was Wall Street, aided by regulatory loosening, notably the repeal of the Glass–Steagall Act that had maintained 'firewalls' between risky investment banking and normal deposit-based banking. This repeal meant that depositors' money was available for speculation by investment bankers. As we have seen US banks, followed by UK and other banks securitised these as well as the loans and mortgages they had issued or bought from community ‘savings and loans banks. A further reason, beyond deregulation, why this was done on such a massive scale is that interest rates were lowered by the Federal Reserve after the US terrorist attacks in 2001 and vast surpluses, notably from China were fuelling low interest rates by means of their purchase of US debt. In Lewis’ (2011) account, the connections in the GIN ran as follows:

> ....From 2002 there had been something like a false boom in much of the rich, developed world. What appeared to be economic growth was activity fuelled by people borrowing money they probably couldn’t afford to repay.......Critically, the big banks that had extended much of this credit were no longer treated as private enterprises but as extensions of their local governments, sure to be bailed out in a crisis. The public debt of rich countries already stood at what appeared to be dangerously high levels and, in response to the crisis, was rapidly growing. But the public debt......included the debts inside each country’s banking system, which, in another crisis, would be transferred to the government (Lewis, 2011, xi–xii).

Because in the US this process on the one hand threatened to bring down the global banking system and potentially bankrupt the US Treasury, Lehman Brothers was allowed to go bankrupt ‘to encourage the others’ but AIG, the huge insurer of enormous quantities of toxic debt, was saved by the Bush administration, thus proving the ‘too big to fail’ thesis to be true. Various bailout mechanisms were then in a period of institutional panic put in place to facilitate bailouts in the US and other countries, notably the UK, Ireland and Iceland.

Germany was not an innovator and not even a very good learner about the benefits but also the pitfalls of the innovations that had occurred in financial securitisation. According to Lewis, German banks were even more reckless in their appetite for the new derivatives and known to be so by Wall Street and London. As he puts it: ‘....other countries used foreign money to fuel various forms of insanity. The Germans, through their bankers, used their own money to enable foreigners to behave insanely’ (Lewis, 2011, p. 145). Thus they lent to US sub-prime borrowers, to Irish real estate speculators, and to Icelandic banking raiders, building up losses of $21 billion to Icelandic banks, $100 billion in Irish banks and $60 billion in US sub-prime bonds. Because there had been so little *innovation* in German banking they were wholly ill-prepared. They were particularly ill-prepared for the evolution of the global financial system into a means for the strong repeatedly to exploit the weak. The securitisation model that had emerged had, as we have seen, extremely smart traders devising fiendishly complex bets they then scoured the world to find ill-informed customers to accept the bets. These often turned out to be the German Landesbanks like WestLB or Rhineland’s IKB, each of which, like Commerzbank, had to be rescued either by other banks or the federal government.

This gives a little further perspective upon the plight of the small economies that also fell foul of securitisation innovation in Iceland and Ireland, and the larger debacle in the UK. Ireland represents the most palpably massive debt to GDP ratio. Based on the data in Table 5.1, Ireland’s ratio stands at a frightening 1,093 having been 1,267 % in 2009. Ireland’s crisis is like Iceland’s mostly a banking driven one.

With the Irish government having forecast a contraction in GDP of 8.3 %, the debt-to-GDP ratio will continue to increase, even without additional foreign investment. However, Irish taxpayers are only responsible for a portion of the debt responsibilities. But even if the banking sector is removed from the total external debt number, Ireland would still have a significant debt to GDP ratio. In Iceland's case, and according to the country's central bank, Iceland's external debt was measured at $104 billion in mid-2009. With a GDP of $10.4 billion, that amounted to a debt-to-GDP ratio of 1,000 %. The Icelandic economy was the hardest hit of any in the financial crisis, and although the country's external debt was not solely to blame, it had a major hand in the country's downward economic spiral. When this is combined with a dramatic drop in the value of its currency the result was a near-government bankruptcy.

Meanwhile, the UK's 'Great Recession' started in early 2008 and ended in the summer of 2009, based on the technical measure of 'recession' as two consecutive quarters of GDP decline. The UK economy shrank by 7.1 % in this period. The economy then slowed after a short revival in the first half of 2011. Government tax rises in VAT—income tax went up temporarily for the richer middle classes, declining again in April 2012—have been made and wider austerity cuts are still kicking in. The final negative factor—and possibly the biggest—is that consumers, companies and the state are all locked in a race to pay down their debts, a toxic combination for the economy in the short and medium term. Much of this contraction arose from the combination of the government having to nationalise or semi-nationalise a number of large banks like RBS and Lloyds alongside the smaller Northern Rock. Much of the debt built up by these banks was tied to toxic sub-prime US investments or over-ambitious corporate and property investments based on inflows of cheap capital. Government policy of running a lightly regulated finance industry and spending tax receipts on the health and education sectors also came unstuck when the downturn began in 2007.

6 Concluding Remarks

This chapter has sought to show that, unlike a widespread perception that the services industries are somewhat overshadowed by manufacturing in relation to innovation, an increasing amount of contemporary innovation actually occurs in services. This occurs in relation to technological change, as it does in manufacturing, but it also emerges in relation to application of recombined or 'modular' knowledge bundles, which occurs but is more rarely written about from the perspective of manufacturing industry. In conducting this analysis the perspective of evolutionary complexity theory (ECT) was deployed. Certain core concepts in this approach, notably 'emergence' proved extremely useful in untangling the key variables that require analytical focus in untangling evolutionary change processes in complex industries operating at global scale. Thus the transition from hierarchical, linear GPNs to distributed, nonlinear GINs could be theorised and given a convincing evidential base according to this methodology.

One of the contributions of the chapter was to show that service innovation, especially in more advanced economic platforms like ICT services and biotechnology takes one or a combination of three forms—architectural, meaning a major reconfiguration of the key elements of the innovation network; modular, meaning recombination of separate but related elements to contribute to the implementation of innovation; and exploration innovation where the result of knowledge exploration, or research, can be the catalyst for innovation on a large, including global scale as with the other modes. A large measure of the weakness of service innovation analysis in the past has been its vertical, sectoral and piecemeal observational method. Clearly, service innovations are horizontal, combining related modules and, accordingly, integrated with hardware innovations in many, but not all, instances rather as Raymond (1999) and Metcalfe and Miles (2000) once observed.

It was further shown that these ECT categories were useful in framing the nature of innovation in a number of major service innovation areas like retail, logistics, R&D services and public services. Accordingly the underlying model was retained as a guide to the understanding of service innovation on a global scale in ICT related to modern smartphone and tablet services such as software and systems design, the development of social networking and 'apps' and the manner in which innovation was shown to be decentralised rather than especially hierarchical in this platform. Elements of architectural, modular and exploration service innovation could also be observed. Finally, this was contrasted with the far more hierarchical financial services global innovation network or GIN for securitisation of financial assets where the elements of architectural, modular and exploration innovation in different aspects of service evolution were again pronounced. However, the very hierarchical nature of the GIN and the relatively poor absorptive capacity and considerable myopia of actors in the GIN meant basically untested, untrialled innovation somewhat typical of services industry in general, led to financial catastrophe from which the advanced world has yet to emerge.

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