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Dark and Light: Entrepreneurship and Innovation in New Technology Spaces

Philip Cooke *

ABSTRACT: Notable changes to human comfort are underway that add greatly to the complexity of existential processes. These are «inter-ethnic violence» and «economic polarisation». Historically, these have resisted resilience from urban recovery in intractable contexts. Among the «wicked problems» confronting future actors and agents of newly emerging frontiers of research and policy are those addressing the «dark side» of innovation and entrepreneurship. This is seldom studied in economic geography but such are the negativities associated with so many dimensions of not only technology but its deformations and inhuman inversions that there will, for sure, be future growth for a wide range of social, natural, applied sciences and technology fixes for human dilemmas into the foreseeable future. We consider «resilience» in prefatory remarks on two intractable cases. Contrariwise, in this brief paper on «new technological spaces», attention is devoted to two new «cybersecurity» spatial types, each of which consists in an under-explored «dark side». In this, not in the long term, the naturally optimistic research outlook of the academic will be obscured by the demands of a more pessimistic outlook for the short term. Two of our selected sub-fields, in cyber-security and structured finance, reference both the «dark web» for illegal and terroristic communication and «dark pools». The paper reviews the economic geographies of these «apocalypses» and draw conclusions.

JEL Classification: O1; O3; R1; K4.

Keywords: new technological spaces; innovation systems; entrepreneurial ecosystems; resilience.

RESUMEN: Se están produciendo notables cambios en el comportamiento humano actualmente en curso que afectan a la complejidad de los procesos existenciales. Entre ellos están la «violencia inter-racial» y la «polarización económica». Históricamente, estos se han enfrentado con la capacidad de reacción de las áreas urbanas en contextos realmente difíciles. Entre los «problemas perversos» que

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enfrentan a los futuros actores y agentes de las nuevas fronteras emergentes de investigación y de diseño de políticas están los que afectan al «lado negro» de la innovación y el emprendedurismo. Esto raramente se estudia en geografía económica, pero los aspectos negativos asociados a estos procesos tienen muchas dimensiones y no sólo se vinculan a la tecnología sino a sus deformaciones y a los retrocesos humanos, que a buen seguro darán lugar en el futuro a futuros incrementos de un amplio conjunto de impactos sociales, naturales, de ciencias aplicadas y de la tecnología. Nosotros hemos considerado de forma preliminar la «*resilience*» (capacidad de reacción) con referencia a dos casos muy relevantes. Por contra, en este breve trabajo sobre nuevos espacios tecnológicos, la atención se centra en dos nuevos tipos espaciales de «*cybersecurity*» (seguridad cibernética), cada uno de los cuales constituye un ámbito muy poco explorado del «lado oscuro». En este caso, aunque no a largo plazo, la visión investigadora naturalmente optimista del académico quedará oculta por las demandas de una visión a corto plazo más pesimista. Dos de los sub-campos seleccionados, seguridad cibernética y finanzas estructuradas, hacen referencia a cuestiones que se mueven en los ámbitos de la ilegalidad y de la comunicación terrorista y de los «*dark pools*». El artículo revisa las geografías económicas de estas «apocalipsis» y extrae algunas conclusiones.

Clasificación JEL: O1; O3; R1; K4.

Palabras clave: nuevos espacios tecnológicos; sistemas de innovación; ecosistemas de emprendedores; capacidad de reacción (*resilience*).

1. Introduction

We live in unstable times. But a popular theme in contemporary social science is building new bridges with older ecological science; especially the latter's discovery back in the early 1970s of the widespread relevance of and interest in system «*resilience*» (Gunderson & Holling, 2002). Arising from their and ecology's recognition that system-thinking had opened up a route way into deeper understanding of non-linear, interactive and self-organising relationships among species of flora and fauna, helped understanding of their survival or extinction capabilities. In turn, such a way of thinking became more widespread in the social sciences, including economic geography, as the «Grand Challenges» of climate change, energy deficits, demographic ageing, and failures of «governance» that justified «free market» ideologies confronted all kinds of unanticipated «shocks», «crises» and worse. The litany is endless, including, health disasters (SARS, etc.), food crises (BSE, E-coli, lithium etc.), climatic impacts (storms, hurricanes, floods, droughts and desertification) and terrorism that «thrives on the weakness of states» (Gray, 2007, 75). Such states include especially those imploded internally, invaded illegally or hosting urban communities in exile populated by economic migrants or refugees originating, for example, in the Islamic world.

Despite the optimism of academics, practitioners and others who believe in the long-established values of the Enlightenment and its belief in progress, the scale, complexity and — indeed — «wickedness» — of the crises having to be confronted today are of a combined magnitude that invokes more sober judgement. While it can be argued that sovereign communities have faced worse existential threats during times of global warfare, as in the Second World War, climate change expresses a kind of war against the world in its planetary meaning. In healthcare, many diseases seem to be almost demonically «wicked», notably cancer in its determination to metastasize and kill the patient. Of course therapeutic progress occurs, but often at such cost that society has to «ration» the drugs that may help some if they can benefit from «free market» mechanisms. The Middle East evidences swathes of war-torn desert and urban destruction with implications for hitherto «safe» cities in East Asia, Europe and the Americas. Without labouring the point, some of the conditions just discussed do not seem to be very expressive of a notion of «resilience» where, for example a burnt forest regenerates in a few years. Some of these «wicked problems» (Rittel & Webber, 1973) are, in effect «peak crises» (like transitioning fossil fuel energies) that humans have not had to deal with in historic, or even prehistoric, time.

Accordingly, the technologies and their spatial or non-spatial incidences that are advancing stutteringly into the innovative future, are each relatively new, often quite «informational» and surely «digital» but confronted with thinking and action that is also new. They do not share the old technology dream of «discovering the silver bullet» which, to some extent characterized the era of antibiotics, aeroplanes, communication (ICT) or personal mobility (combustion engines). To be sure, such innovations were real combinations or re-combinations of knowledge and artifacts much as Schumpeter observed innovation. So, it could be argued, were the «policies» that gave them purpose. They contributed to the «resilience» of «creative destruction». But now, such resilience is less clearly purposive because the problems denoted are far greater in scope, more diffuse and generally complex. Accordingly «action» and «policy», much of which has not escaped from its «one-off problem-solving» inheritance, must also become a «never-ending story» of evolutionary management of change (Uyarra & Flanagan, 2013). Some of these technologies allow for such a perspective to seek to respond (not always easily or optimistically) to the «Grand Challenge» of «wicked problems», one of the worst being the failure of «resilience». In what follows the exemplars will point the way to more hopeful indications.

2. From Detroit to Sarajevo: Some Failures of Resilient Cities

Resilience is a wonderful thing. When it is expressed as «hysteresis» it seems to make a metropolis bounce back to square one like a giant rubber band. Where the elasticity is less evident, it may not suffer very deep recessions because it is unaffected by the cause of the recession, or it may experience a modest return to its hitherto moderate performance (Martin, 2012). An alternate but seldom explored condition is expressed in the city (or region) that is neither revitalizing nor returning to a modest

growth-path but continually sliding (like Black Death villages or coastally eroding medieval towns) into oblivion. An emergent critique of «resilience» explores aspects of its «failure» (Gong & Hassink, 2016). Archaeologists alone show any interest in such locations since there are only remains of ruins, bits of ceramics and human or animal bones for them to record the passing of time. Our two cases are not yet in that quiescent state. But they are not especially good examples of resilience either. Why? Because in «resilience theory» they lack two key attributes for recovery, namely «connectivity» to sustain networks and «potential» that gives impetus to innovation (Folke, 2006). Connectivity is a weakness discovered in parallel, if not in derivation from resilience thinking, by complexity thinking. There the developmental weakness of a given topology (absent an economic geography) is a low density of «energy» points across a possibly abstract space. Without such «attractors» among which «interaction» can occur and the exchange of useful or relevant information can ensue, no endogenous interaction can occur. «Potential» is where one or more abstract «energy» points or «clusters» find opportunities and reasons for interaction to occur. Creative energy combinations may ensue, resulting in innovation and ecological or non-ecological growth.

2.1. Detroit in Ruins

If we consider the case of Detroit for a moment, it is almost a text-book case of the unresilient city because it was designed to be so. The key *absence* in Detroit, even in its economic heyday, was variety. It was set up to be, as it became labeled at its peak in the 1960s «Motown» or the classic «Fordist» city. It can be argued that it evolved variety in its music and wider cultural scene but Motown soon migrated to Los Angeles rather like the «Merseybeat» migrated from Liverpool with the Beatles to London. Detroit was heavily (over-) specialised in the automobile industry just as Liverpool was heavily specialised in trans-shipment of goods and people. When the market was strong for both sectors, investment in slum housing but relatively expensive residential real estate and symbolic architecture associated with consumption goods and a consumer culture were marked features. Even today visitors to the bombed-out suburbs of Detroit often remark on the scale and generosity of the housing plots and Art Deco grandeur of the cinemas and other public buildings from the first half of the twentieth century (Apel, 2015).

The lists of famous persons emanating from Detroit is huge for entrepreneurs, greater still for entertainers but greatest of all for successful musicians from Aretha Franklin, Martha Reeves, Madonna, Diana Ross, Alice Cooper, Iggy Pop and Smokey Robinson and many more. But even the Detroit Art Institute's fabulous collection of paintings, threatened with monetization to pay the city's pension debt was trumped by the objection that the city's bond insurers had legal priority over the retirees (Apel, 2015).

But while the car industry contains many differently originating trades and skills ranging from metal and mechanics, through rubber, trim, glass and so on including financial, design and organizational management skills, it is clear that Detroit's main industries were «locked-in» to car production. Moreover, as in a military or govern-

ment bureaucracy, controls were exercised top-down with no significant horizontal knowledge flows. Workers were actively discouraged from taking initiatives and, on top of that, hierarchies were enforced, labour processes were «time-and-motion» regulated and Ford even had an infamous Sociology Department that snooped on workers» extra-curricular, «free-time» activities. Such was the «command-and-control» mentality of the city notables (who resided elsewhere) giving little civic leadership. This was expressed in the person of Henry Ford, who professed to despise his workforce as much as his peers while also being a rabid racist and anti-Semite. The one saving grace was that the automotive workforce was relatively well-paid, meaning once they escaped the clutches of the Sociology Department, workers could enjoy some high-quality musical and artistic popular entertainment epitomized by the likes of blues original John Lee Hooker to film maker Francis Ford Coppola.

However, once as is well-known, the heyday of the mid-century, gas-guzzling American automobile was in decline in the 1970s, signaled by the rise in Middle East fuel prices and the appearance on the US market of higher quality and more reliable Japanese products at an affordable price, Detroit's fate was sealed. Interestingly, Detroit continues to be a city-region in which automobile production remains as one of its major but much weakened specialist manufacturing industries. This legacy is shared with other single-industry survivals, Manchester, UK being a case in point for surviving cotton textiles trade. But it is testimony to the other resilience characteristic, *potential*, which signifies the capability to arise from a negative lock-in condition through innovation which caused the main blow to its evolution. For redundancy, down-sizing and general job-loss multipliers resulted in widespread rioting, especially in ethnic majority residential areas, which have accordingly been torn down (many as crack houses) and in many cases reverted to fields. Despite municipal and government efforts, Detroit has not recovered and continues to display the characteristic absence of revitalization that is associated with the «unresilient city». So, despite its history of cultural and creative innovation, with evident *connectivity* in the entertainment sphere alongside strength in limited kinds of entrepreneurship, this was not carried over to the industrial sphere (Klepper, 2010).

We move shortly to a totally different exemplar of «inhibited development», indeed it may be rare for these cases to be compared; such is the academic preference for «success stories» rather than their obverse. The etymology of each is very different, although both were once success stories. The first was fatally weakened by the geography of economic decline, over-specialisation and the regime shift from Fordism to «Toyotism» (Dohse, Jürgens & Malsch, 1984), the second by the break-up of an east European state system, accompanied in Bosnia and Sarajevo, by religious sectarianism and brutal «ethnic cleansing».

2.2. Sarajevo: Forerunner of Syria's Besieged Cities

Numerous news articles recall how Sarajevo foretells the contemporary plight of Aleppo, Damascus and Homs in Syria's «conflict urbanism». Observers and experts

would say that two historic periods highlight the twin peaks in the fortunes of Sarajevo. The first of these was in the era directly before the First World War when the city was industrialized by the Austro-Hungarian imperial regime that, nevertheless, exploited it as a kind of metropolitan innovation laboratory, for a pioneering streetcar system. Hence, in 1885, Sarajevo was the first city in Europe and the second city in the world, following San Francisco, to have a full-time electric tram network running through the city. Because of its long Ottoman history the city was multi-cultural and labelled the «Jerusalem of Europe» as the only large European city to possess a mosque. After a fire that engulfed the city centre, architects and engineers swiftly arrived in the city to re-plan it in modernist style at this time. Numerous factories (e.g. the landmark Sarajevo brewery) and other significant buildings originated in the 1890s. These included the Cathedral, National Museum, National Theatre, National Library and Academy of Fine Arts, the Central Post Office and City Hall which were built then, and a number of institutions altered (e.g. widespread use of Latin script in place of Cyrillic after centuries of Arabic in the Ottoman era) being both Westernized and modernized. The decline set in following the assassination of the heir to the Habsburg Empire in 1914.

Despite the preceding transition, where rapid urbanisation, industrialisation and modernisation occurred without notable socio-cultural tensions in a multi-ethnic and multilingual context, the aftermath for the urban political economy was shocking. The Austro-Hungarian Empire lost the Great War and the new Slavic country of Yugoslavia was created. Sarajevo became a sub-centre of a small, divided and poor kingdom. Unlike the dominant Serbian centre of Belgrade, it was not treated with the same attention or considered as significant, being at least partly Muslim, being perceived picturesquely as a lethargic rather than vibrant city as it had been in the past. Unlike the late nineteenth and early twentieth century modernisation in Sarajevo, apart from the National Bank of Serbs, Croats and Slovenes (sic), the predecessor of today's Bank of Bosnia and Herzegovina, virtually no significant contributions to the city were made during this period. Accordingly, Sarajevo stagnated under the Kingdom of Yugoslavia.

During World War Two Sarajevo became part of the fascist Independent State of Croatia with many Serbs and Jews being massacred. In that time Bosnia's Muslims signed a resolution seeking security for all citizens, particularly the persecution of Serbs, of whom some 20,000 found refuge in Sarajevo. Secular demographic decline resulted in an inherited city population that had slowly receded from hundreds of thousands to some 80,000 at the end of World War Two. But under Tito it boomed once again, echoing something of the rapid modernisation that characterised its fate at the end of the Austro-Hungarian Empire. Hence, the growth rate subsequently benefited once again from rapid investment after liberation when Sarajevo became the capital of the Socialist Republic of Bosnia and Herzegovina within the new Socialist Federal Republic of Yugoslavia. Tito's federal government spent heavily in Sarajevo, building substantial blocks of social housing in «new town» municipalities nearby. Moreover, Sarajevo experienced a second «modernisation» by state development of the city's industry. Sarajevo's city population was 115,000, by the end the war but by

the end of Yugoslavia, Sarajevo had a city-regional population of 600,000. Its peak of achievement was hosting a successful Winter Olympic Games in 1984 after which international tourism boomed. Thereafter, the Balkan war-era led to the Siege of Sarajevo (1992-6) in what became the horrific Bosnian War. This massively reversed its fortunes compared to its Socialist growth-era development. Planned as a significant regional industrial centre, Sarajevo returned to its former marginalised condition.

After the Bosnian War and Siege of Sarajevo by 13,000 armed Bosnian Serbs of the Republika Srpska, Sarajevo's fluctuating historical demography resulted in a decline from 453,000 before the Siege to a city size by 2013 of some 350,000, a reduced scale which remains after twenty years alongside that of the metropolitan area of 688,000. By the summer of 1996, the city was in ruins, industry was destroyed and there was high unemployment. The massacres by Serbs of Bosnians, especially the «ethnic cleansing» of the Muslim population, still affect Bosnia like a dark, toxic cloud. Although the Bosnian rape camps were well known among international human-rights organizations, there have been attempts to deny their existence or erase that part of history. Abused women have almost no institutional support in a country now rigidly divided into Serb and Bosniak-Croat areas. Surrounded by the Dinaric Alps, in the valley of the Sarajevo (Milijacka) river, the reminders are everywhere: countless bullet holes in buildings and homes that are flanked by recently built apartment blocks and shopping malls selling designer wares that only the wealthy few can afford. International winter sports tourism has revived somewhat with Sarajevo being a destination of choice for wealthy Arab visitors.

Despite the Arab tourism, Bosnia's economy has been developing lethargically. Its GDP per capita is 28 percent of the EU average (compared to the poorest member state, Bulgaria with 45 percent). Unemployment also runs at 28 percent, and the average monthly salary is 425 Euro (NATO Review, 2015). By July 2015, all levels of government adopted a comprehensive economic and social Reform Agenda. Implementation of this agenda has occurred. If it continues, and growth targets are met, the EU has promised to accept a membership application from Bosnia. Making for a dispiriting urban future for Sarajevo (let alone smaller, damaged towns like Tuzla, Srebrenica and Mostar) are the remaining empty and bullet-ridden hulks of the Tito-era residential blocs, disused central train station, children's memorials and the emergency transformation of former parks and stadiums into overflowing cemeteries. Clearly, Bosnians and Sarajevans, more particularly, have experienced a resilience-defying triple shock from war to peace again, from a planned economy to a market economy and from a socialist state to a liberal democracy. Elsewhere in Eastern Europe it is well-reported that many older residents regret the loss of security that transition brought. Similar regrets may be heard in former Yugoslavia, which offered decent living standards, freedom to travel, and secure jobs. Except that unlike elsewhere in Eastern Europe, socialism disappeared in times of war, rather than being dismantled, mostly peacefully.

What are the contrasting and comparative elements of change that such widely differing exemplars reveal of the difficulty of «bouncing back» swiftly from disas-

trous resilience shocks? We may draw attention to the following. The most obvious wide-ranging condition that is recognisable, despite some periodic variations, is the general absence of what is called elsewhere «generative growth» (Cooke, 2016). Increasingly, this occurs in firms, regions and countries coming to terms with new realities, of globalisation, interaction and collaboration. It obviously entails entrepreneurship but not just of a kind of race to the bottom of profit-seeking (as we shall see, below). Generative growth involves intensifying direct and indirect capabilities for knowledge-intensive production, enhanced productivity, innovation and new firm formation that accompany integration of local and global value chains. Generative growth feeds off these interactions rather than being unproductively transplanted, as often occurs with «redistributive growth», the style of incentivised and regulated movement of jobs and capital from locations where they were abundant to those where they were not.

3. Entrepreneurial Ecosystems & Regional Innovation Systems in New Economic Spaces

Moving from the discourse of decline, through a «minefield» of new digital technology applications, to the «new technology spaces» in which article space only allows for two exemplars, we briefly underline the important distinction between entrepreneurial and innovative activity. Accordingly, three key lessons can be learned from the «innovation systems» literature, especially that associated with regional development, for reference to both the contrasting and competing interests of «entrepreneurial ecosystems». These are, in no particular order of preference, the following.

- First, innovation (after Schumpeter, 1934) is inherently recombinant, drawing inspiration from several cognitive and material sources. These «new combinations» are inherently socially interactive in nature,
- Second, while commercial exploitation is the purpose of successful combinations, they may nevertheless be socially useful innovations for the innovator much more than the entrepreneur. There are many cases of altruistic innovation.
- Third, innovation is fundamentally a «learning» procedure involving networks of innovators in «gift exchange» or «studied trust» type interactions. These help to achieve the «adjacent possible» innovative event or aid the crossing of «structural holes» from the known to the unknown.

We have argued that entrepreneurial ecosystems can be capable of generative growth where that is accompanied by a high degree of social cohesion, social stability and low social exclusion. By example, we concluded that these three characteristics were not enjoyed by troubled cities like Detroit and Sarajevo, which clearly express insufficient resilience to decline (Hospers *et al.*, 2012; Polenske, 2014). In our first two «new technologies in new economic spaces» narratives we will draw attention to the «dark side» of entrepreneurship that has become pronounced due to heightened global and urban security conditions in the twenty-first century. The first two of our

new entrepreneurial settings depend heavily upon data encryption, hyper-competitive advantage and intense, defensive security criteria. The first of these is «Cybersecurity Digital Forensics» (CDF) and the second is «High Frequency Trading» (HFT). Both are heavily dependent on complex communication algorithms and highly skilled entrepreneurship but the second is complex yet surprisingly simple and linear. The HFT phenomenon has an economic geography in a single US platform space at present, though it is developed in London and the M4 Corridor and slowly emergent in the EU. The CDF space is more widespread, international, with leading innovative and enterprise edges in Israel and strategic US and UK locations, signifying a broader geography and history of Islamist jihadi violence that has provoked the emergence of specific centres of expertise. We begin with CDF.

3.1. Cybersecurity

Prefiguratively, as a guide, the top 500 cyber-security firms—a broader population than CDF—show a concentration of some 19 small-medium enterprises (SMEs) in Israel, overwhelmingly in Tel Aviv, but with an emergent incubator space housing multinationals, SMEs and incubator start-ups in Be'er Sheva in the Negev Desert. Elsewhere, the bulk of the remaining top 500 are found in or near «Edge City» (Garreau, 1991) locations in the US, such as Reston-McLean-Herndon in Fairfax County on the boundary of north Virginia and Washington DC. McLean hosts the Langley headquarters of the CIA as well as the most luxurious residential location in the Metropolitan Area. Altogether, the Dulles Technology Corridor houses some 38 cyber-security firms; exactly double the total of Israel. A further 11 cyber-security firms are found over the Maryland state-line which carries the Edge City to satellites such as Bethesda, Columbia and Rockville.

But the 800-pound gorilla of this world is California. Here, mostly in Silicon Valley, in the San Francisco-Santa Clara-San Jose axis, in particular, are found 125 such companies. Clearly, this is not a new economic space for technology companies, rather it expresses another round in the previously documented mutation of varieties of technology from semiconductors to personal computers to cellphones, search engines, biotechnology and clean technologies, now including further varieties of cybersecurity. The third competitor technology space for cyber-security firms is Massachusetts, mainly in the Edge City to the west and north of the Boston Beltway, a once declining computer cluster replaced twenty years ago by the globally most significant biotechnology platform. However, the number of cyber-security companies in the Massachusetts complex reaches only 24 companies, focused mainly on Waltham (6 firms), Burlington (4) and Boston (4).

In Europe, some 20 firms concentrate in London and its technology corridor to the west along the M4 motorway including the former military, now privatised, Malvern signal intelligence (SIGINT) platform. Munich has six such firms. All locations are to some degree exploiting their pre-existing technology strengths in digital communication. The new twist is that while information technology had originally

been subsidized by government defence research budgets, these have shifted to some extent from information and communication hardware to software, systems, algorithms and encryption software technologies. Noteworthy also is the proliferation of SMEs and start-ups in the population of such firms. It is hypothetically the case that, especially where firms concentrate spatially, they form a potential entrepreneurial ecosystem, imitating each other. Foremost this involves applying related or likely differentiated applications of computer science and profiting from government contracts either singly or in «Eco-nets» or ecosystems.

The clearest illustration of the intimate interactions between spatially co-located firms, government contracts, the military, university research, talent formation and specialist infrastructure occurs in Israel whose Unit 8200 is at the epicentre of today's CDF industry. Celebrated by Senor & Singer (2009) —until 2003, Unit 8200 was a secret military department of the Israeli Defence Forces (IDF). Unit 8200 is the SIGINT and code deciphering arm of the IDF being its largest unit, and headquartered at Camp Gilot, north of Tel Aviv. In 2004 a Knesset committee recommended turning the unit into an autonomous entity separate from the Defence Ministry, along the lines of its equivalent, the US National Security Agency (NSA). Unit 8200's most important and powerful SIGINT base is located near the village of Urim in the Negev desert, to which it began re-locating in 2015. Israeli Prime Minister Netanyahu had earlier promised that Be'er Sheva was destined to become «the cybercenter of the Western hemisphere». This decision would transfer army SIGINT bases, start-ups and university expertise from central Israel to the south and act as major boost to Be'er Sheva as «world cybercapital». Land agreements to include bases in Gilot and Ramat Gan that house military SIGINT facilities, including the world-renowned 8200 unit, thus have a planned location at the perimeter of the new technology park in Be'er Sheva beginning in 2020. Tenants of the Advanced Technology Park already include *Deutsche Telekom*, *IBM*, *Oracle*, *Lockheed Martin*, *EMC* and *PayPal* —with Be'er Sheva's Ben-Gurion University and its Cyber Security Research Centre in attendance.

This confirmed a path dependence that began in the 1990s with Unit 8200 start-up successes: *Check Point* (a world-leading IT Firewalls security firm); *Metacafe* (a world-leading video site); *Comverse* («Logger» telecom software, 4,000 employees); and *NICE* (data security) with 3,600 employees and a 2015 NASDAQ valuation of \$5bn. Another contemporary Unit 8200 alumnus *New Dimension Software* (enterprise software) was sold (1999) for \$675 million to BMC Software of Houston, Texas. This directly led to reinvestments by founder Roni Einav in dozens of Israeli tech start-ups. *Palo Alto Networks* (cybersecurity) was in 2015 NASDAQ valued at \$10bn. Meanwhile *ICQ* (instant messaging) was sold in 2010 to *Digital Sky Technologies* (Private Equity: HQ Moscow) for \$200 million.

Senor & Singer (2009) showed Israel had more venture capital investment *per person* than anywhere in the world and the largest number of NASDAQ-listed companies (63) after the US and China. So, in 2010, Unit 8200 alumni decided formally to offer their expertise to other young Israeli entrepreneurs. The result was the 8200

entrepreneurship and innovation support program (EISP), a five-month high-tech incubator in which Unit 8200 alumni volunteer to mentor early-stage startups. Between 2010 and 2013, 22 received funding totalling \$21m (£13.5m) and employ 200 people, joining the 230,000 employees of Israel's 5,000 tech companies that earn \$25bn a year—a quarter of Israel's total exports. This can be judged, on a scaled measurement, as a remarkable achievement, which has become a model for cybersecurity entrepreneurial ecosystems, now including corporate technology investors. All the main elements for generative growth are present: collaborative institutional and pioneering enterprise pursuit of social value, cohesion and solidarity that is driven, not foremost by profit, but collective citizen security. As a model of enterprise ecosystem practice, it is already influential.

Accordingly, in the UK, budding GCHQ spies may become entrepreneurs by exploiting GCHQ «Big Data» intellectual property (IPRs) for Cybersecurity applications or «Apps». The scheme is based on the UK's «Teach First» programme success whereby selected bright graduates work in challenging schools for two years on the promise of a commercial job if they leave teaching. To further this, the UK's Government Communications Headquarters (GCHQ) set up 11 university cyber-research centres & 2 virtual-research institutes. In 2014 its first cryptography «app» was released under National Cyber Security Strategy designed for firms and the public sector to combat cyber-attacks (e.g. N. Korea). Today, it is often overlooked how much *innovation* originates at public initiative (as «collective» or «demand-driven» innovation). Historically the public sector has had traditional conventions and rules against exploiting taxpayer funds for risk-investments. But where funding is strategic (and enormous) as in defence and healthcare, this risk-fear is lower. With the threat of Islamist-inspired jihadi terrorism at home and abroad, the strongest source for public innovation today is from spying. As we note below, this means Big Surveillance Data for Cybersecurity, especially as evolved over time in Unit 8200, NSA & GCHQ.

Derived from the «dark web» skills obtained over decades by SIGINT that USA, UK and Israeli exporters of cyber security products find in demand, are the following. They include algorithms designed to protect companies, banks, governments and—since 9/11, 7/7, Madrid, Mumbai, Paris and Brussels—citizens far away from the Middle East war zones—from the growing «dark web» of hackers, fraudsters, snoopers and terrorists. As noted above, such exports from Israel alone topped \$6bn, about 10 per cent of the global cybersecurity market in 2015, exceeding Israeli exports of military hardware for the first time. Today this market is also growing rapidly after high-profile hacks that in some cases—such as at US retailer Target and Sony in 2014, more recently the «Panama Papers»—have cost CEOs and even a Prime Minister their jobs.

As in other spy agencies, a key focus is data mining, and specifically the ability to sift through mountains of information to find the one menacing email, or the recurring patterns that suggest something is suspicious. To get a clearer idea of the tools the unit uses in its work, Reed (2015) visited Tel Aviv University to interview Oded Maimon, a leading expert on data mining and artificial intelligence—teaching

computers to do not just what they have been told but to predict things that have yet to occur. Maimon edited the manual called the definitive *Data Mining and Knowledge Discovery Handbook*. Like other Israeli mathematicians, he has worked for both the intelligence services and the private sector. In the past, he advised *Verint*, an Israeli-founded video-and-audio-monitoring company now based in Melville, New York. The first step is to obtain raw information, where in Israel - «8200 is very important here». Once intelligence is gathered and organised into a database, an analyst needs to seek a common denominator.

«Big data» experts call this *fusion*: the ability, for instance, to interpret an object identified from different angles by different means —possibly a drone in the air, a camera on the ground, or a listening device in a phone. Human senses can do this naturally but computers have to be taught. One intelligence source might have identified someone talking in a car on a phone while another, using a camera on a plane, identifies the same car. «You create a knowledge base», Maimon said. «You now know not only that a person is in a vehicle but you have the information that his phone is interesting to you.» Analysts can then apply data mining algorithms to this «knowledge base» —determining, for example, from a base of several million conversations, which two are relevant. Algorithms also do what Maimon calls «data compression» —for instance, to establish that a target makes calls every day at 7.30 am and 4.00 pm. This can then be matched with other intelligence. «Finding a *modus operandi* is important,» Maimon said. Only at the end of this process is human intervention needed. Among the options available might be an arrest, a drone strike or another military operation. These are the «regional» even «local» conditions for systemic innovation rooted in pure and applied mathematics and computer science that create the invaluable but purposive, albeit «disinterested» science that creates potentially profitable enterprise ecosystems from trained cadres of entrepreneurs.

3.2. High Frequency Trading: From the «Dark Web» to «Dark Pools»

Much encryption protects information, transactions and criminal acts on the «dark web» and much cyber-security entrepreneurial activity is involved with «hacking» or data espionage into such information flows, especially where they are intended for nefarious practices. As we have seen and can be further understood from analysing cyber-security company prospectuses on websites such as Cybersecurity 500 (2015) their interests are focused upon such activities as: adversary pursuit; cyber threat/attack protection; cloud content security; forensic analytics; file encryption; anti-terrorism and homeland security; mobile forensics; enterprise identity management; cyber security analytics and many more. In contemporary digital finance, decentralisation to competing exchanges and financial facilities has created a new financial communication ecosystem. However, amid the distributed stock exchanges, «matching exchanges» (see below) and data centres we conclude with a brief and relatively straightforward light-speed «new economic space» without such complexities. Indeed it is a single, linear light source targeted directly at massive profitability,

involving much geographic proximity, a singular business, involving questionable legality, which has, even so, out-performed the regulators in its application of hyper-advanced technology. The subject, in brief, is High Frequency Trading (HFT).

The «Dark Pools» in the sub-title here, are hidden deposits of enormous investments by global investment banks, pension funds and hedge funds, also occupying parts of the «dark web». Such dark *pools* are inaccessible even to investors whose investments are directed to «dark pools» by their chosen financial institution. Like pilot fish accompanying the bow-wave of the shark swimming in the ocean, the ecosystem of broker intermediaries is large in number but small in scale. The obvious reason for «dark pools» is privacy, but for whom? Actually it is especially for the investment banks and what Michael Lewis (2015) calls

«the hidden passages and trapdoors that riddled the (stock) exchanges (mean)... the world's financial markets were designed to maximize the number of collisions between ordinary investors, and for the benefit of high-frequency traders, exchanges, Wall Street banks, and on-line brokerage firms. Around these collisions an entire ecosystem had arisen» (Lewis 2015, 179).

An irony of this ecosystem is that it evolved as a low-trust zone of individualism and predatory exploitation of tiny margins, «front-running» property, in effect, stolen from investor accounts. Where these are hidden in «dark pools» obscured from investors, HFTs pay enormous up-front fees to the nine banks responsible for designing the dark pools and controlling 70% of Wall Street stock market orders (Patterson, 2012). These were, by 2011 market share, *Credit Suisse, Morgan Stanley, Bank of America, Merrill Lynch, Goldman Sachs, J.P. Morgan, UBS, Citi, and Deutsche Bank*. The banks also have their own HFTs, which are in competition with the rest of the ecosystem. To these can be added a variety of hedge funds with their favoured or captive HFTs. Characteristically, HFTs are populated by engineering and technology doctorates recruited by the «big nine» banks who subsequently move on to found or consult for smaller HFT firms. It is estimated that in Wall Street the technical «king-pin» elite of HFT innovators number no more than twenty-five experts, many of them Russian mathematicians.

The unique HFT selling point is speed. Through the computerisation of stock trading by direct orders to HFTs or through the dark pools, the first HTV to the order (the «front-runner») wins the business in a zero-sum game that rewards the winner. The manner in which market signals travel to and from the now digital public and private exchanges by means of fibre-optic cables creates two new levels of «new technology space». These are found at two types of location, meso and micro, determined the cost of their different geographies. These, in turn, are determined by the ecosystem imperative of destroying historic stock exchange monopoly by the introduction of competition. Thus until the New York Stock Exchange (NYSE) had evolved to become an electronic hybrid market, it was the main US stock exchange. The introduction of exchange competition thereafter had spatial implications at what can be termed the meso level based on the decentralisation of a total of 13 public markets. These are run by the New York Stock Exchange, NASDAQ, BATS (Better Alternative Trading System) and Direct Edge. Between the public stock exchanges

and the dark pools were in 2015 nearly 60 private exchanges, most of them in New Jersey, where an investor could buy any listed stock. Associated with the exchanges were various infrastructural facilities such as data centres, server farms and what are called «matching engines». These match stock market bids to offers.

Now the digital geography can be outlined: hence the NYSE can be accessed through Manhattan and Newark, NJ but it has its matching engine in Mahwah NJ. IEX (the private exchange set up by Royal Bank of Canada with speed-equalising algorithms of 350 microseconds aimed at defeating Wall Street's «rigged» markets) has its «matching engine» in Weehawken NJ and a «point of presence» (POP) in Secaucus, NJ. In 2015 BATS moved its stock exchange, contracted to global «colocation» «services ecosystem» specialist *Equinix*, to its NY5 data centre in Secaucus, NJ from its former Weehawken NJ2 data centre. *Equinix* now also hosts the Direct Edge public exchange, which BATS acquired in 2014, itself moving to NY5 in Secaucus a year later. The BATS and Direct Edge secondary data centres remain in Chicago. NASDAQ's primary data centre is located in Carteret, NJ and its secondary one at Ashburn VA. Its first POP was also located in *Equinix*'s NY4 facility in Secaucus NJ and connected by high-speed wireless to Mahwah NJ. Other proprietary data centres in the «service ecosystem» include the likes of *British Telecom's BTRadianz* in Nutley NJ. A similar meso network links the City of London (LSE) to competing exchanges in Docklands (BATS) and along the M4 Corridor to Basildon (NYSE) and Slough (BATS-Chi-X *Equinix*) data centres.

Among NASDAQ's recent announcements was its New Wireless Express offering from Carteret to Aurora, Illinois near Chicago with its specialist stock exchanges. This is the simple part of the complex story of HFT because the demand for ever-increasing millisecond speed advantages using fibre-optic light in as near as possible to uninterrupted space led to the cabling by the *Spread Networks* company of the New York to Chicago exchange system with a private fibre-optic connection. This cost the first two hundred members to invest in the service some \$14.0 million for a five year contract. At higher than the meso to the macro-regional level this enhanced relational proximity as follows. It enabled a trader needing to be at both places at once to reduce signal time from Carteret to Aurora and back from some 17 milliseconds to 12. The geographic distance of the return journey is 2,300 km or 1426 miles.

This returns our narrative in this entrepreneurial ecosystem, of little social value compared to individual avarice, back to the micro-local scale because all HFTs want to be in the closest proximity to the public, private, «dark pool» exchanges and POPs. There thus grew a remarkable boom in demand for an HFT firm's terminal to be—in the jargon—«colocated» with or preferably «within» the exchange. This was for the advantage gained through gaming the meso-regional light speeds connecting other public and private exchanges. But now, with the macro-line to the Chicago exchanges, added value to «front-run» and «rig» a further variety of markets had occurred. As hinted, one upshot was that firms demanded colocation presences inside the exchange. The NYSE and other exchanges leased these spaces at a handsome profit, allowing HFTs to be located nearer to the servers than their competitors. Some

demanding shorter or faster fibre-optic cable or better intra-exchange locations. Thus the economic asset of «proximity» (which is a word that has no legal representational status) became legally and economically acceptable if termed «colocation». As an indication of the cost of these milliseconds, Lewis (2015, 64) estimated *BTRadianz* alone paid \$80 million between 2005 and 2008. This was purely to allow HFTs to colocate their computers near to the relevant stock exchange matching engines. The *BTRadianz* public relations discourse, legally more flexible, announced in 2015 the launch of «BT Radianz Proximity Solutions» combined with «BT Radianz Ultra Access» allowing customers to have direct market access to global stock exchanges via *Spread Networks*.

4. Conclusions

These two attempts to demonstrate some key nuances of «new technology spaces» reveal some similarities and some differences. The most obvious difference is that privacy, confidentiality and avarice combine in ways that are legal in a neo-liberal ideological era. Regional and global «innovation», if that is an appropriate word for it, has been reduced to dog-race scrabbling for a privileged location for profit-seeking. In the pursuit of zero-sum outcomes that transmutes into a struggle even to «colocate» on the floor of a data centre in proximity to a stock exchange's «point of presence» or in the dusty corners of an actual digital exchange. As we have seen entrepreneurial ecosystems of greater or lesser moral hazard display shared, tightly circumscribed network cultures. Contrariwise, at first compared to finance's «dark pools,» the «dark web» of cybersecurity activities can seem almost honourable. But SIGINT can have an even deeper dimension when it comes to «neutralising» Islamist terrorists, implementing drone attacks or intercepting jihadist signals, all in the name of security.

The technologies that allow for these kinds of entrepreneurial «new frontiers» are ultimately similar. They use the «light» of fibre-optic technology to explore the «dark» side of the evolving digital world of communication. Both are a triumph of an ancient contrast in social science between «community» and «association». Possibly the entrepreneurial ecosystem of HFT finance is more anomic than those forged in the solidarities but also the atrocities of contemporary civil and guerrilla wars. It is always more obvious that entrepreneurship can involve simply the banal pursuit of profit at the expense of innocent participants in stock market speculation. Many of the originators of structured finance were semi-disinterested innovators more animated by their innovation more than pure profit. A comparison of a kind can be drawn with the military service innovations from Unit 8200 that were only later turned towards commercial markets by talented or at least professional entrepreneurs. Finally, the focus has also been on the way resilient places may never revive, while others, blessed with new kinds of knowledge, institutions and resources may thrive. Thus the Negev remains a natural desert but has been stimulated into growth by military research and entrepreneurship. HFT has spread to the Edge Cities of New Jersey and, to a lesser

extent, the M4 Corridor near London. Meanwhile Detroit and Sarajevo, once global innovator cities, remain in ruins, isolated as a consequence of marginalisation, social polarisation and «conflict urbanism» which are exploited elsewhere in today's «new technology spaces».

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