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AN ENTREPRENEURIAL CANADA?

Understanding Canada's Chronic Lack of Innovation and How We Can Fix It

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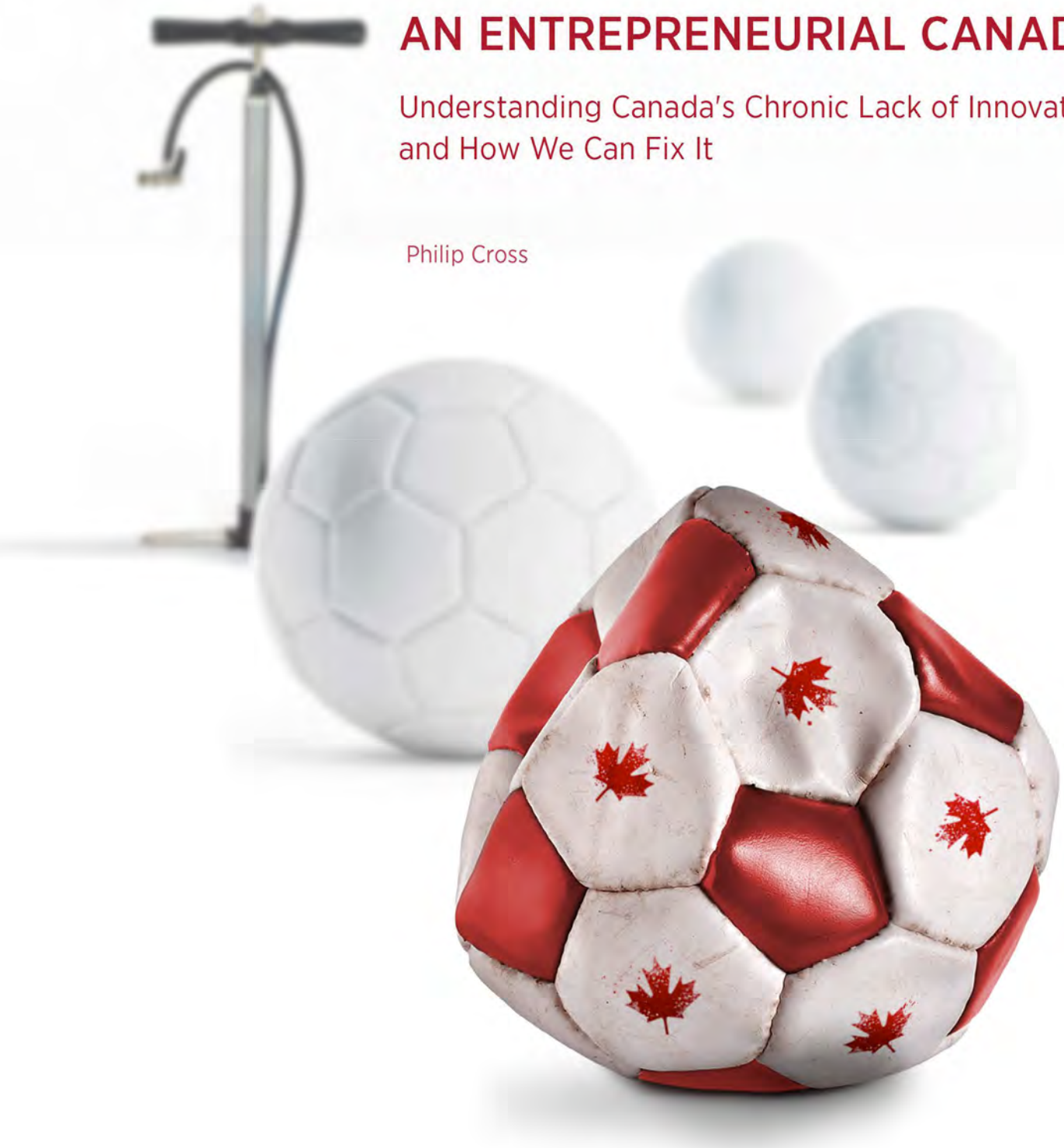

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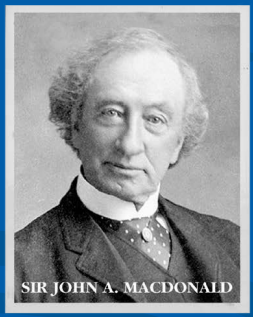
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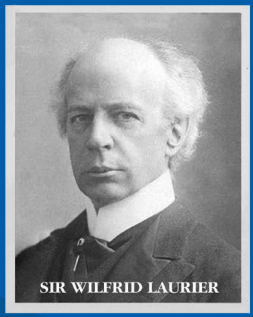
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Executive Summary

Canadians have been debating for decades why their country lags in innovation, whether measured by a shortfall of productivity growth, surveys of business leaders, a failure to create global brands, or its falling number of startups. At first, the explanation centred on the supply of innovation inputs such as research and development, science, education, infrastructure, and investment. This focus is consistent with the view of economists and policy-makers that innovation serves mainly to reduce costs and raise productivity.

However, a broader analysis shows that the essence of innovation is the commercial success of new products and processes. Unfortunately, economics has comparatively little to say about this type of "Schumpeterian" innovation, and public policy has followed its lead in largely ignoring it. A policy based on an incomplete understanding of its subject is doomed to fail from the outset.

More recently, there has been a growing realization that the emphasis on the supply of inputs into innovation is not enough and the demand for innovation also needs to be addressed. While this corrects the over-reliance on the supply side of innovations, the problem is more than a deficiency of demand from the business sector.

This paper criticizes Canadian governments and society for not building a culture more tolerant of "creative destruction" and supportive of entrepreneurs and business innovation. Canada's leaders lavish praise on our bloated and pampered public sector and shelter many rent-seeking businesses from competition, while deprecating many businesses in our resource and manufacturing sectors which have to compete on the global stage.

The need to prioritize innovation has never been clearer. The unique nature of the 2020 pandemic in particular means entrepreneurs can help bring it to an end through new treatments of the coronavirus or vaccines that help immunize most people. Beyond medicine, innovation will have to play an even larger role for a full recovery of the economy from its government-mandated coma.

The coronavirus pandemic overnight destroyed the business models of established firms and whole industries such as department stores, eat-in restau-

rants, and many modes of travelling. This opens up the landscape for new firms to flourish with innovative ways of delivering services such as at-home shopping, entertainment, and telework or entirely new ways of meeting the human need for face-to-face interaction. This is a classic opportunity for Schumpeter's "creative destruction," where we have already seen much destruction and now wait for an offsetting creative response.

> *The current federal government's priority should focus on restoring earned incomes.*

Canada can use this period of upheaval to renew and grow its economy. However, taking full advantage requires the cultivation of a more entrepreneurial mindset in our culture, a long-overdue shift. The current federal government's priority should focus on restoring earned incomes, partly to pay for the huge expansion of government debts during the pandemic. The least expensive and possibly the most effective way of boosting incomes is to change the political rhetoric and societal attitudes so entrepreneurs, investors, and innovators know that government will actively welcome and encourage their efforts and not raise taxes and regulations to interfere with plans to renew and expand their businesses.

Implementing changes to bolster a more entrepreneurial culture will take time, but less than the decades already wasted on government efforts to boost innovation through changing the supply of inputs. Encouraging innovation and entrepreneurship will have an immediate payoff, notably reassuring the business community that government regulations and taxes will be curbed and the attitude of political leaders will be more positive. Other changes will take longer, but their payoff – as measured in terms of higher growth – would be sustained for years.

Sommaire

Les Canadiens débattent depuis des décennies des raisons pour lesquelles leur pays a du retard en matière d'innovation, qu'on mesure cette dernière par la croissance insuffisante de la productivité, les enquêtes auprès de chefs d'entreprise, l'incapacité à créer des marques mondiales ou la baisse du nombre de sociétés en démarrage. Au départ, on a cru que l'innovation était d'abord fonction de l'offre d'intrants, par exemple la recherche et le développement, la science, l'éducation, les infrastructures et l'investissement. Cette vision concorde avec l'opinion des économistes et des décideurs, à savoir que l'innovation sert principalement à réduire les coûts et à augmenter la productivité.

Cependant, une analyse plus large montre que l'innovation tient essentiellement à la commercialisation réussie de nouveaux produits et procédés. Malheureusement, l'économie est une discipline qui a relativement peu à dire sur ce type d'innovation « schumpétérienne », et, en prenant exemple sur elle, les politiques publiques n'en tiennent pas compte en général. Une politique fondée sur une compréhension incomplète de son but est vouée d'emblée à l'échec.

Plus récemment, on observe une prise de conscience grandissante à l'égard du fait qu'il ne suffit pas de mettre l'accent sur la disponibilité des intrants, et qu'il faut également tenir compte de la demande. Si cela corrige l'insistance excessive placée sur le côté de l'offre dans le domaine de l'innovation, il reste que le problème va au-delà d'une carence de la demande de la part des entreprises.

Cette étude reproche au gouvernement et à la société canadienne de ne pas avoir bâti une culture plus tolérante à la « destruction créative » et favorable aux entrepreneurs et à l'innovation des entreprises. Alors que nos leaders louent excessivement notre choyé et opulent secteur public et protègent de la concurrence de nombreuses entreprises à la recherche d'une rente, ils déprécient un grand nombre d'entreprises de ressources et de fabrication aux prises avec la concurrence étrangère.

Le besoin de donner la priorité à l'innovation n'a jamais été aussi évident. La nature unique de la pandémie de 2020 signifie notamment que les entrepreneurs peuvent aider à y mettre un terme au moyen de nouveaux traitements et de vaccins pouvant immuniser la plupart des gens. Hors de la médecine, l'innovation devra jouer un rôle encore plus important pour que l'économie se rétablisse pleinement à la suite du coma dans lequel le gouvernement l'a plongée.

La pandémie de coronavirus a détruit du jour au lendemain les modèles commerciaux des entreprises établies et des pans entiers de l'activité comme les grands magasins, les restaurants intérieurs et de nombreux modes de déplacement. Cela ouvre la voie à l'essor de nouvelles entreprises pourvues d'outils innovants pour offrir des services tels que le magasinage et les diver-

tissements à domicile, le télétravail ou des moyens entièrement nouveaux de répondre au besoin des gens en échanges en tête-à-tête. C'est une occasion de « destruction créative » classique à la Schumpeter : une réaction créative vient compenser de nombreuses destructions passées.

> *Le Canada peut mettre à profit cette période de bouleversement en contribuant au renouveau et à la croissance de son économie.*

Le Canada peut mettre à profit cette période de bouleversement en contribuant au renouveau et à la croissance de son économie. Cependant, pour y arriver pleinement, il doit cultiver une mentalité plus entrepreneuriale, un changement qui se fait attendre depuis longtemps. La priorité du gouvernement fédéral actuel devrait être axée sur le rétablissement des revenus du travail, en partie pour assumer l'énorme expansion des dettes publiques pendant la pandémie. Le moyen le moins coûteux et probablement le plus efficace d'augmenter les revenus est de changer la rhétorique politique et les attitudes de la société afin que les entrepreneurs, les investisseurs et les innovateurs sachent que le gouvernement reconnaîtra et encouragera activement leurs efforts et n'augmentera pas les impôts et les réglementations de manière à faire obstacle aux plans visant à renouveler et à faire prospérer leurs affaires.

La mise en place de changements visant à encourager une culture plus entrepreneuriale prendra du temps, mais il sera court en comparaison avec les décennies déjà gaspillées par les gouvernements à stimuler l'innovation en agissant sur les intrants. L'appui à l'innovation et à l'entrepreneuriat aura des retombées immédiates, notamment en rassurant les milieux d'affaires quant au fait que les réglementations gouvernementales et les taxes seront réduites et que les dirigeants politiques auront une attitude plus positive. D'autres changements nécessitent plus de temps, mais leurs bénéfices plus élevés, mesurés en terme de croissance, seraient maintenus pendant des années.

Introduction

Innovation, despite its ubiquitous place in policy discussions, is one of the most used and misunderstood words in the lexicon of public policy debates. There is a good reason for its widespread use, since innovation is increasingly the main driver of growth for many major industrial nations where labour force and population growth rates are slowing. It is also often misunderstood because many reflexive policy responses target presumed inputs into innovation, such as pouring more money into basic science or subsidies for formal research, even as higher output of innovation remains elusive. There is a widespread misperception that innovation is linked to scientific invention, when in reality new ways of doing things that are commercially viable are more closely related to entrepreneurship.

> *Innovation and entrepreneurship are closely linked to the process of creative destruction.*

In turn, innovation and entrepreneurship are closely linked to the process of creative destruction, from which governments instinctively recoil since it imperils existing institutions that enlist government support to preserve the status quo. This paper looks at why innovation in Canada has lagged and what can be done to spur it. Because governments reflexively shy away from the turmoil of creative destruction, Canada's innovation policy remains focused on the supply of stereotypical inputs, which has failed to spark the inherently unpredictable process of innovation. Worse, political leaders in Canada seem unwilling to extol the benefits of entrepreneurship and commercial success, lionizing our bloated and pampered public service and demonizing some of our most successful businesses. While there is no precise formula for successful innovation, placing ideology before innovation guarantees falling behind.

What Is innovation?

Defining *innovation* naturally begins with the Austrian economist Joseph Schumpeter, since "the study of technological innovation … consists of a series of footnotes upon Schumpeter" (Rosenberg quoted in Becker, Knudsen, and Swedberg 2011, 2). Schumpeter described innovation as "the profitable application of new ideas rather than invention" (quoted in Nasar 2011, 190) manifest in "the appearance of new goods, new markets, new methods of production and transportation, [and] new forms of industrial organization" (Warsh 2006, 123).

For a time, the definition of innovation regressed in the hands of statisticians after Schumpeter's bold original statement. The 1992 definition of innovation by the Organisation for Economic Co-operation and Development (OECD) "was limited mainly to manufacturing … and it involved only technological product and process innovation. The process was the production of a product" (Gault 2016, 3). At that time, spending on research and development (R&D) was the standard measure of innovation in an economy. The OECD's original focus on R&D reflected a belief that the early success of systematizing R&D in corporate labs in the 1920s and 1930s[1] and in government in the 1940s and 1950s (notably, developing the atomic bomb and then the space race) defined how innovation would proceed. Instead, the success of these early research efforts inside bureaucracies proved to be an aberration.

As the growth of services continued to outpace manufacturing, in 2005 the OECD broadened its definition from a tangible thing, such as an investment or a product, to include organizational and marketing innovations (Gault 2016, 4). Innovation could now be everything from marketing (Nike's famous swoosh symbol) to an organizational change by a firm taking advantage of a new technology (the creation of multi-unit enterprises linked by modern communications) to new ways of interacting with customers (such as online shopping). The OECD also emphasized the implementation of innovation. However, implementation was defined as "when it is introduced on the market" (Gault 2016, 7), which ignores how the innovation was received in markets. The OECD's authoritative *Oslo Manual* defines innovation as the commercialization of a product that "objectively" delivers new or improved services, but it does not state how "objectively" is determined. The only objective evaluation, Deirdre McCloskey points out, is "the test in trade. Are people willing to pay for it?" (2016, 95). Innovation should prove itself with customers and not just the research laboratory.

Innovation is derived from the Latin word *nova*, which means new. However, newness is not enough to qualify as innovative, according to the modern understanding of the word. Most analysts emphasize innovation has to be useful to people and not just new or inventive. Statistical agencies like Canada's still equate newness with innovation, asking in surveys about innova-

tion, "Has your business developed or introduced … a new or significantly improved good or service?" when the key is whether the new product or process was successful as judged by the customer and not the producer (Statistics Canada 2020).

Invention without the market's validation of usefulness is just self-indulgence. Unless put to practical use, Schumpeter said, "inventions are economically irrelevant" (Schumpeter 1934/2011b, 67). Innovation is not an end in itself. Commercial success separates useful innovations from mere newness or inventiveness: "Innovation is to society what mutation is in biology. Not all mutations are good. Some are just poor and unfortunate experiments" (Cipolla 1970, 9). Natural selection roots out bad mutations, and failure in the marketplace eliminates poor or outdated innovations.

Economists have continued to elaborate on the importance for innovation to be commercially useful. Atkinson and Ezell (2012, 129) stressed that "organizations ultimately innovate in service of their customers and that genuine innovation must create real value for them, even if it's an innovation they never see, such as new kinds of machines to produce a product at a lower price." Boyd and Inch more pointedly stated, "Innovation is the process through which new economic and social benefits are extracted from knowledge" (2003, 3).

The two types of innovation

There are broadly two types of innovation. The first raises productivity by lowering the cost of existing goods and services. This is the conventional conceptualization by economists of technological innovation changing the neoclassical production function – "an alteration of relationships between inputs and output across the entire array of known techniques" (David 1975, 2). Since the ratio of inputs to output is the very essence of productivity, this is relatively easy for economists to quantify and study. From this perspective, innovation can be measured by multifactor productivity (MFP), which is the difference between GDP growth and the growth of capital and labour inputs.

However, some dissenting economists argue that defining innovation as MFP is too limited because it largely ignores a key component of innovation. In their view, "innovation is the ultimate source of all growth in output per worker-hour, not just the residual after capital investment is subtracted out. … Without innovation, there would be no accumulation of capital per worker" (Gordon 2016, 569). In this view, defining innovation needs to include "how societies create new forms of production, products, and business models to expand wealth and quality of life" (Atkinson and Ezell 2012, 293).

This more expansive view is covered by the second type of innovation, which results in new goods and services that did not exist before but are valued

by customers. This type of innovation is much harder to measure and understand using the conventional tools of economics and therefore has been largely overlooked by economists. The two types of innovation are often at loggerheads: For example, General Electric's approach to management featuring the "relentless pursuit of efficiency was counter to the pursuit of the bold and the new" (Smith and Free 2016, 139).

How knowledge is applied in the two types of innovation helps clarify the difference. Knowledge allows us to achieve both types of innovation. However, raising productivity means applying "knowledge to tasks we already know how to do," while creating new products or processes means applying knowledge "to tasks that are new and different" (Drucker 1993, 26).[2] Mokyr differentiated between "Smithian" and "Schumpeterian" growth, where the latter is driven by "continuous, though fluctuating, technological change and innovation" (1990, 6). This paper follows suit by labelling the type of innovation focused on productivity "Smithian" and designating the more original type of innovations "Schumpeterian" (Mokyr 2016, 16).

> *Commercial success separates useful innovations from mere newness or inventiveness.*

However, unlike Smithian innovation, there is no consensus on how to measure the Schumpeterian type of innovation. Clearly, productivity is not enough or even relevant, since it is nearly impossible to measure the change in the cost of producing something that did not exist before. Several measures of global innovation have been proposed over the years. One is opinion surveys of business leaders, such as the World Economic Forum's *Global Competitiveness Report*, but opinions are inherently subjective. Others try to count the number of "important" innovations, but the definition of important will vary from researcher to researcher (for example, Alfred Kleinknecht identified 39 most important innovations between 1850 and 1970).[3]

The difficulty in measuring innovation goes back to Solow's original 1956 explanation of innovation and economic growth. While acknowledging its importance, Solow assumed innovation was exogenous to the economy. It fell like "manna from heaven" (Atkinson and Ezell 2012, 295) and therefore did not need to be rigorously defined or measured. Measurement issues also contributed to economics' ignoring the particular role of knowledge in inno-

vation, because "knowledge is an unmeasurable variable" (quoted in Atkinson and Ezell 2012, 295).

As a result of the limitations of both theory and data, the study of innovation in economics has become divorced from the world of business. For firms in the real world "it seems clear that it is innovation, not price-setting, to which management gives priority in important sectors of the economy" (Baumol 2002, 5). Baumol criticizes "the static efficiency properties that are stressed by standard welfare economics" because "the prime weapon of competition is not price but innovation. As a result, firms cannot afford to leave innovation to chance. Rather, managements are forced by market pressure to support innovative activity systematically and substantially" (2002, viii-ix).

Management guru Peter Drucker described how Jean-Baptiste Say in the early 19th century grasped that entrepreneurship[4] was the essential difference between "doing something different rather than doing better what is already being done. This is basically what Say, two hundred years ago, meant when he coined the term entrepreneur" (Drucker 1985, 130).[5] Unfortunately, entrepreneurs do not exist in conventional economics: "The idealized perfectly competitive baseline model of economics has no room for entrepreneurs because nobody can affect market outcomes on their own" (Mokyr 2016, 65-66).

Despite Say's insight, economists have concentrated on the productivity approach to innovation because "it emphasizes cost, about which they are expert, and because it is easy to describe statistically and mathematically" (McCloskey 2010, 75). Conventional economics came to define itself as "the study of allocating scarce resources among competing ends" by "how commodities are exchanged in price-mediated markets" (Atkinson and Ezell 2012, 293). As a result of this limited focus, "the central body of microeconomic analysis gives its attention primarily to price determination, and by doing so may, arguably, be omitting a critical feature of the competitive process" (Baumol 2002, 5).[6] That critical feature is the creation of new products and processes, not the cost of production.

As economists continued to stray from Schumpeter's conception of innovation, it is not surprising innovation policy followed them down the wrong but easier to navigate track. The focus on Smithian efficiency over a broader concept of innovation had larger implications for policy regimes and economic growth. One was that "neoclassical economics is a straitjacket when it comes to innovation policy" (Atkinson and Ezell 2012, 293). The mainstream view of innovation that is limited to efficiency and productivity resulted in many policy recommendations that failed to address the more fundamental determinants of innovation in culture and attitudes (as is discussed later).

The attempt by economists to reduce innovation to a mechanistic approach came to dominate much of what masquerades as innovation policy in most

countries. Innovation policy in Canada has focused on the type of innovation that favours price competitiveness rather than the creation of new products or processes, although in practice it has not done either very well. A broader implication was that many economists overlooked that socialism was doomed not because of its growing inefficiencies, myriad that they are, but because it "would become less *innovative*" (Phelps 2013, 127).

The main benefit of innovation is a diversity of products

The main benefit of innovation has been broadening the range of new products and expanding available choices for customers. The diversity of offerings within consumer products also has increased exponentially: By 1998, the US had 185 TV channels, 400 types of personal computers, 87 soft drink brands, 340 types of breakfast cereal, and 50 brands of bottled water (Coyle 2014, 122). However, the proliferation of new products creates difficulty for economists trying to measure innovation and its importance to economic growth.

Nordhaus provides a way of understanding the problem innovation creates for economists trying to measure economic growth. He classified three types of innovations according to their impact on prices: run-of-the-mill, seismic, and tectonic (Nordhaus 1997, 58). Run-of-the-mill innovations leave the basic product mostly unchanged, and therefore the impact on prices is relatively easy to measure. Seismic changes leave the basic product recognizable but vastly improve the quality. Most semi- and non-durable goods today such as food, clothing, books, watches, and basic house furnishings would be familiar to people from the 19th century even if their design and packaging are new. Tectonic innovations mean a completely new product has been introduced, a shift that in statistical terms is "so vast that the price indexes do not attempt to capture the qualitative changes" (Nordhaus 1997, 58). In the 20th century, tectonic changes proliferated for durable goods such as motor vehicles,[7] appliances, and electronics. Services saw even more tectonic innovations, with almost two-thirds of services new to the 20th century, including communications, financial services, mass transit, airplane travel, and most medical care (Bresnahan and Gordon 1997, 39).

As Coyle concludes about GDP, "A better metric than the *size* of the economy might well be the variety of goods and services available" (2014, 91). This increase in variety likely means official price indexes overstate inflation and therefore understate the real improvement in the Western world's standard of living. On average, new products are not introduced into the Consumer Price Index (CPI) until five years after their arrival in the market (Bresnahan and Gordon 1997, 24). This imparts an upward bias to prices because it misses what is often the period of their most rapid decline in prices. Most notoriously, autos were not introduced into the CPI until 1935 (Bresnahan

and Gordon 1997, 19). This meant the CPI missed several decades of falling prices that made autos affordable to the masses and auto assemblies the largest manufacturing industry in the US (Raff and Trajtenberg 1997, 72). The counterpart of price increases being overestimated is that the growth of real GDP is underestimated (the CPI is a major input into price deflation in GDP), as is the contribution of innovation. To give an idea of the possible magnitude of these biases, Nordhaus estimates that properly adjusting prices for improved quality would raise the increase in real incomes between 1800 and 1992 from the official measure of a factor of 13 to somewhere between a factor of 40 and 190 (Bresnahan and Gordon 1997, 19).

Consumers have been the main beneficiary from this outpouring of new products. Nordhaus estimates that the producer receives only 2.2 percent of the economic gain from an invention: "Only a miniscule fraction of the social returns from technological advances over the 1948-2001 period was captured by producers, indicating that most of the benefits of technological change are passed on to consumers rather than captured by producers" (quoted in McCloskey 2010, 348).

The dazzling array of new products has an important implication for economic growth theory, which is that "innovation is multiplicative, not additive" (Kurzweil 1999, 32). New products like autos and computers not only create whole new industries, they also spawn related industries such as truck transport and computer software production (Bresnahan and Gordon 1997, 4). Paul Romer explains that since ideas are a nonrival good, the crucial difference between objects and ideas is that "when we share objects, we make them less valuable. You don't pay as much for a used car because it's already been used. But ideas don't work like that. We can share ideas without devaluing them. … When ideas are shared, the possibilities do not add up. They *multiply*" (quoted in Lehrer 2012, 222). As a result, new ideas and innovations can be traded and "trade makes innovation a cumulative phenomenon" (Ridley 2015a, 111).

Innovation is not a benefit that ends with its use but is a building block that increases the opportunities for further innovations (Brynjolfsson and McAfee 2014, 81). The development of the printing press created a surge of demand for spectacles. This sparked more production and experimentation with lenses, which led to the invention of the microscope (Johnson 2014, 4). Most innovation comes from recombinations of existing things, "not *de novo* invention": Schumpeter made the point in the 1930s that "innovation combines components in a new way" (Ridley 2020, 174).

Innovation theory and process

While economists are almost unanimous in viewing innovation as the fundamental force driving economic growth, there is no consensus about a theory of what drives the process of innovation. Ridley observes that "apart from some vague hand-waving about institutions, economists still have very little to offer in the way of prescriptions for innovation" outside of free societies that are open to trade and resist top-down solutions (Ridley 2015a, 109). Summarizing the results of a panel convened by the Government of Canada, the former Bank of Canada governor David Dodge said, "What we don't know is what the right formula is to get innovation" (quoted in Chiose 2015).

There are no useful data measuring innovation, and "bottom-up innovation is almost impossible to quantify through modeling" (Smick 2017, 31). Without precise data to test, most economists (except some economic historians and growth theorists such as Schumpeter, Mokyr, McCloskey, and Romer) are reluctant to explore and propose an integrated theory of innovation and growth. Romer admitted in 2015, "For the last two decades, growth theory has made no scientific progress toward a consensus" (Romer 2015, 89). This leaves largely unchallenged the long-standing presumption of policy-makers that increasing the supply of inputs into innovation results in more innovation.

Another difficulty for economists in formulating a theory of innovation is that most economic analysis assumes that technology, tastes, and institutions are fixed or "given." In reality, far from being fixed, these variables "are the key actors of historical change, and hence most economic theory has, at best, only limited relevance to understanding long-term change" (McCloskey 2010, 356). William Baumol goes further, criticizing most economists for treating innovation, investment, and education "as exogenous products of happenstance, not as a predictable product of the free-market growth machine" (2002, 26).

By treating innovation as endogenous and not exogenous to capitalism and growth, Baumol restores to economists the responsibility to understand and cultivate the conditions for growth, even if those conditions are as much cultural as economics. The refusal of most economists to accept this responsibility does not absolve them from better understanding the importance of innovation. Not having an agreed-upon theory of innovation also has discouraged economists from analyzing its impact on long-term growth. After all, emphasizing the role of innovation in growth is rather embarrassing if economists cannot then prescribe the conditions or policies that will encourage innovation. Peter Drucker admonishes economists for understating the impact of innovation because of the difficulty developing a purely economic theory about its origins: "We may never arrive at a theory of innovation in the sense that we can explain innovation in economic terms and anticipate it

by economic analysis. For non-economic factors, intellectual and perceptual, are crucial to innovation. But we should be able to understand how innovation affects an economy and what its economic consequences are likely to be" (1968, 149).

The process of innovation Is rooted more in biology than economics

Some analysts, most notably Matt Ridley, compare innovation to an evolutionary process grounded more in biology than economics. Innovation makes slight improvements upon what already exists, moving to the "adjacent possible," which is "a key characteristic of evolutionary systems" (Ridley 2020, 241). One reason why economics has struggled to arrive at a theory of innovation is that "innovation is to society what mutation is in biology. Not all mutations are good. Some are just poor and unfortunate experiments" (Cipolla 1970, 9). Just as natural selection roots out bad mutations, business failures eliminate poor or outdated innovations. However, Mokyr cautions against taking the analogy between technological progress and evolution too literally, because "technology is information acquired by learning, not through genes" (Mokyr 1990, 279). Markets are the environment that determines survival; they, not firms, do the selecting.

One difficulty is that it takes years to know which mutations are useful and which ones are not: What may seem a poor mutation of biology may suddenly prove critical to survival in a radically new environment. The same is true in the marketplace. Nylon was discovered in 1928 when a lab assistant left a burner on over the weekend, boiling the interior of a kettle until it congealed into fibres. It took DuPont another 10 years to learn how to make Nylon fibres intentionally (Drucker 1985, 43). The long gestation period paid off immediately in the marketplace; DuPont sold nearly 800,000 pairs of nylon stockings on the first day of sale on May 14, 1940, and 64,000,000 by the end of the first year (Drucker 1985, 62). Similarly, some innovations are not revealed as harmful for years. The US financial services industry innovated in response to government incentives by selling subprime mortgages, collateralized debt obligations, and mortgage-backed securities starting in the 1990s, which helped lay the foundation for the Great Financial Crisis beginning in 2007 (Lepore 2014, 35).[8]

Because innovation can resemble an evolutionary process, the hope of both statisticians and policy-makers to systematize it is unlikely to be realized any time soon.[9] Most attempts at studying innovation use presumptive inputs such as R&D, university education, patents, and the publication of scientific research (the latter three are used to compile the Global Innovation Index[10]; see Parkinson 2013) as proxies of innovation.[11] The problem is that there is no rigorous theory or evidence that demonstrates these inputs actually are reliable parts of the innovation process. Moreover, the supply of inputs into innovation is not enough; firms must also be receptive and motivated to innovate.

Innovation by its nature cannot be forecast or planned in advance at the level of either the whole economy or the firm. This is because "innovation and growth generate a milieu of pervasive uncertainty: since the process of innovation itself transforms the future, there is no capacity for a rational anticipation of it" (Keen 2017, 15). Since Schumpeterian innovation by definition alters an industry or economy – or it would not be innovative – it changes the future and therefore inherently creates uncertainty, which makes precise planning impossible. Reflecting on the uncertainty about the future, Keynes threw up his hands, saying, "We simply do not know" (quoted in Keen 2017, 15). Because the entrepreneur is doing something never done before, "there exist no 'data' for his or her decisions and no 'rules of conduct'" (quoted in Becker et al. 2011, 23).

> *Commercial success separates useful innovations from mere newness or inventiveness.*

The total novelty and uncertainty confronting the entrepreneur forces them to draw on "intuition and not on rational thought" (Becker et al. 2011, 7). Without data or a roadmap, Schumpeter concluded that for entrepreneurs "the success of everything depends on intuition" (quoted in Becker et al. 2011, 23). Intuition is difficult, if not impossible, for organizations, either public or private, to anticipate, plan, and control. As much as they would like, governments cannot simply order the production of a coronavirus vaccine or carbon sequestration technology by a certain date or be sure they will ever happen. The best public policy can do is encourage a cultural environment in which innovation has the best chance to flourish.

Capitalism is the best economic system to cultivate innovation because innovation is a matter of life and death for most firms to thrive and survive. Beinhocker touts free markets as "innovation machines … not because of their *efficiency* at resource allocation in equilibrium, but because of their *effectiveness* at innovation in disequilibrium" (2006, 294-295). The superiority of free markets in delivering innovation is evident in the long-term increase in living standards in the Western world.

Conversely, it is difficult, bordering on impossible, to translate the entrepreneurial mentality into the bureaucracy of government. As Steve Johnson concludes, "Top-heavy bureaucracies remain innovation sinkholes" (2014, 236). This is why Mazzucato was fundamentally wrong to argue, "There is

nothing in the DNA of the public sector that makes it less innovative than the private sector" (2013, 197). On the contrary, a lack of diversity of views is hard-wired into government bureaucracy, with its fixation on process, hierarchy, regimentation, and avoiding controversy and confrontation at all cost. Civil service culture is the very opposite of Hayek's observation, "The growth of reason is based on existence of differences … [between] individuals, possessing different knowledge and different views" (quoted in Easterly 2013, 300).

Economists and historians accept the importance of good institutions such as property rights, law and order, and honest government as necessary, if not sufficient, conditions for investment and capitalism to flourish. Nevertheless, good institutions alone are not enough: "The puzzle is that better markets, more cooperative behavior, and more efficient allocations simply do not in themselves account for modern economic growth. What is far harder to explain is the growth of technological creativity and innovation in Europe and especially the surge following the middle of the eighteenth century" (Mokyr 2016, 5). Joel Mokyr calls this lack of a well-defined link between institutions and innovation "the great dilemma of the new institutional economic history" (ibid.). This dilemma extends to innovation policy; turning the crank on inputs of R&D, education, or subsidies usually reveals "a crank that's not attached to anything" (in Savoie's [2013, 148] famous phrase about policy-making) instead of generating more innovation and faster economic growth.

Innovation is too important a driver of long-term economic growth for economists to avoid, even if understanding innovation requires economists to abandon their favourite tools of statistics and modelling. Peter Drucker articulates well the importance of innovation to the economy and economics:

> Technological change and innovation are primarily economic events. Their purpose is economic to begin with. They consist in a change in the deployment of economic resources and result in shifts in the allocation of resources. Their purpose as well as their test is economic performance. They are major economic events determining the productivity of land, labor, and capital. For the economist to brush off such a central phenomenon as not truly part of his subject is like the mathematician's saying, "Number is outside of mathematics." (Drucker 1968, 148-149)

The supply of inputs does not drive innovation

This section reviews why government attempts to stoke innovation via the supply of inputs such as invention, investment, science, education, and research have failed to consistently generate more innovation.

(i) Invention

Scientific discovery is not innovation. Innovation has to be commercially useful; being scientifically novel alone may be of interest to other scientists, but not to entrepreneurs or the market. Many discoverers cannot imagine the utility of their breakthroughs; when Orville Wright was asked what use could be made of airplanes, he replied, "Sport mainly, and scouting in war" (McIntosh 1921). It can take decades for inventions to be widely used. The economic historian Paul David estimates that it took 50 years or longer for fundamental inventions such as electricity to be widely adopted (electricity was invented in the 1870s but was not widely used until the 1920s; Coyle 2014, 79).

Lind (2012, 93) was wrong to say that inventors should really be called "improvers"; improvement is what innovators do with inventions. The World Wide Web was invented by Europeans, but American companies commercialized it, paving the way for their domination of the information revolution (Greenspan and Wooldridge 2018, 348). Apple did not invent the smartphone but improved its design and marketability.

Moreover, the common assumption may be erroneous that causality flows from invention to innovation, with entrepreneurs linking the two because they are the ones who "convert a new idea or invention into a successful innovation" (Mazzucato 2013, 58). Schumpeter argued the causality is the reverse: "It is not inventions that have made capitalism, but capitalism that has created the inventions it needed" (1911/2011a, 167). No matter which way causality flows, a single-minded pursuit of innovation by government policy has not produced and is unlikely in the future to produce more of it.

(ii) Investment

Investment is not innovation, although innovations may result from or require investments. Simply encouraging more capital investment, such as with accelerated depreciation allowances, will not reliably lead to more innovation.

Evsey Domar famously wrote in 1961 that capital accumulation without technical change amounts to "piling wooden plows on top of existing wooden plows" (quoted in Gordon 2016, 569). McCloskey observes, "The routine repetition of investment, neatly arranged by capital accumulation in buildings and roads and machines and even educations, doesn't swing. … Innovation does. If it ain't got that swing, it don't mean a thing" (2010, 76). She elaborates, "The world did not change by piling up money or capital. It changed by getting smarter about steam engines and wiser about accepting the outcome of innovation" (ibid., 75). Innovations are the source of improvements in the quality of capital, evident in the difference between a rotary dial telephone and today's smartphone.

The economic growth theorist Robert Solow in 1952 defined innovation as everything that contributed to economic growth except labour and capital inputs, where income (Y) was a function of an exogenous time trend (A) that includes productivity gains from innovation as well as capital (K) and labour (L):

$$Y = A(t)\ F\ (K,L).$$

This formulation explicitly separated investment from innovation; an economic environment conducive to innovation was more than its stock of factories and machines (Nasar 2011, 443). In so doing, Solow famously seemed to "take the capital out of capitalism" (Gordon 2016, 569). Solow maintained that the innovation that drove capitalism was an exogenous process that came rather mysteriously from outside the economic process and certainly not from labour or capital inputs. McCloskey proposes that the separation of capital from innovation is so complete and innovation is so fundamental to growth that what is commonly called *capitalism* should be labelled *innovationism* (Ridley 2015a, 108).[12]

> *The growth of GDP or investment is not a useful measure of dynamism or innovation in a society.*

The history of national economies shows that the growth of GDP or investment is not a useful measure of dynamism or innovation in a society. The Soviet Union proved that large doses of capital investment do not produce innovation. The Soviet Union posted superficially impressive growth rates starting in the 1930s through extensive growth from adding more labour and capital inputs.[13] The problem with such extensive growth is that it is subject to diminishing returns. Centrally planned economies like the Soviet Union's posted high rates of growth for decades by accelerating the shift from agriculture to industry and mobilizing large quantities of capital and labour, without mastering how to combine labour and capital in ways that raised multifactor productivity (MFP). The Soviet Union floundered at intensive growth, which reflects better ways of using workers and capital that allows for sustained high-income growth. Inevitably, its growth rate floundered when labour and capital inputs tapered off.

China has raised its growth rate by a similar process of extensive growth, with an added boost from widespread theft of intellectual property. Stealing or copying intellectual property has a long history in the growth process. The United States stole technology from Europe during the late 18th and early

19th centuries, to the point that Doron Ben-Atar claimed, "Lax enforcement of the intellectual property laws was the primary engine of the American economic miracle" (quoted in Clay and Phillips 2015, 79). Europe and Japan returned the favour after World War II, when they "were far behind the United States technologically … but they borrowed American technology, grew far faster than the United States, and very nearly caught up with the United States in both technology and per capita income in less than twenty-five years" (Olson 1982, 176). Replicating existing technology helps a lagging economy catch up to more advanced nations, but it is a self-limiting process. Eventually a nation must develop its own technological innovations or remain dependent on developments elsewhere for growth.

(iii) Science

Science does not automatically lead to innovation. The two can remain separate in perpetuity if science concentrates on "blue sky" research, a term coined after the Irish physicist John Tyndall in 1869 asked the basic scientific question: Why is the sky blue? (Turk 2015, 323). This question may have been of interest to scientists but for years had little innovative application in the marketplace.

Politicians want to believe the link between science and innovation is a well-defined process in which pure scientific insights are translated into applied science and then become useful technological innovations. In this model of technological innovation, by ensuring "a ready supply of money to scientists on the top floor of their ivory towers … technology will come clanking out of the pipe at the bottom of the tower" (Ridley 2015b).

In practice, the flow usually is the reverse, from innovation to science. Firms finance most science, either in-house or in universities, when they need it. By the 1980s, one million Americans worked in corporate research labs (Lind 2012, 192). One eminent historian of technology even asserted that there was a negative correlation between scientific and technical progress, "because the social conditions that promote science are antithetic to technology and vice versa" (Mokyr 1990, 168).

Confusing science with innovation is common. A recent *MIT Technology Review* cover featured former astronaut Buzz Aldrin with the headline, "You Promised Me Mars Colonies, Instead I Got Facebook" (Weinersmith and Weinersmith 2017, 6).[14] This ignores the huge popular appeal of Facebook, while interest in colonizing Mars remains limited to space cadets. Commercial success proved Facebook was the more innovative idea.

Our society erroneously has made science synonymous with technology and innovation. Many sciences, such as astronomy and theoretical physics, have no economic use. Nor is technology always based on science. Historically,

there has been little connection between science and technology, which largely evolved through non-scientific methods such as rules of thumb, learning by apprenticeship, chance discoveries, and trial and error (Taleb 2012, 222). Most late 19th century innovations, including concrete, air brakes on trains, engines, elevators, electric motors, and tin cans, did not depend at all on science. As Mokyr observes, "It seems likely that in the past 150 years the majority of important inventions, from steel converters to cancer chemotherapy, from food canning to aspartame, have been used long before people understood *why* they worked. … The proportion of such inventions is declining, but it remains high today" (quoted in McCloskey 2010, 359). Ridley concludes, "Technology comes from technology far more often than from science. And science comes from technology too. … But the Baconian model, with its one-way flow from science to technology, is nonsense. There's a much stronger flow the other way: new technologies give academics things to study" (2015a, 135).

Nathan Rosenberg, a historian of technology, reached the same conclusion at the national level: "Before the twentieth century there was no very close correspondence between scientific leadership and industrial leadership" (quoted in McCloskey 2010, 358). For example, the United States had achieved little in science by 1890, yet had emerged as a leading industrial power (partly, as noted earlier, because it copied existing technologies). The US did not become truly innovative until the early 20th century. The same pattern was true for Japan before and after 1970.

There is little evidence to support that governments' pouring more money into education in science, technology, engineering, and mathematics (STEM) boosts innovation in a society. The United States remains an innovation leader despite not doing well in international comparisons of either the percentage of students graduating with STEM degrees or achievement in international tests of aptitude (Schwanen 2017, 10).

One reason for the weak relationship of STEM studies and innovation is the presumption that STEM were all the same. Combining science and technology in one slogan "mistakes the past, and much of the present" (McCloskey 2010, 357). Pundits especially like to combine science and technology as an explanation of the world because, on the left, "you will not need to admit that the bourgeoisie has created massive and colossal productive forces," while on the right "you can admire the aristocratic genius of the great scientists – and disdain the alertness of the mere vulgar businesspeople who made science economically relevant" (McCloskey 2010, 357).

A review of the literature by a panel of experts for the Council of Canadian Academies (2015, 29) concluded that "the relationship between STEM skills and innovation is limited and evidence is light." Moreover, there are diminishing returns to STEM skills. As the relative size of the STEM workforce increases,

MFP growth (a proxy of innovation) declines. The obvious conclusion is that innovation starts with the lowest-hanging fruit and gets progressively more difficult over time. Industries that hire more STEM workers do not have demonstrably higher productivity. Nor does STEM training boost non-technological innovations such as marketing or organizational innovations that were the key to the success of firms such as Nike or Apple.

(iv) Education

More broadly, innovation does not appear to come from education, let alone education in the STEM fields. Partly this reflects that the payoff from investment in education "is so slow and variable that it is almost useless as a predictor of economic change over a five-to-ten-year period" (Sharma 2016, 16). Taleb noted that economic growth preceded rising education levels in nations such as Taiwan and South Korea; as recently as 1960, 45 percent of Taiwan was illiterate (2012, 204). Conversely, the Soviet Union had both the highest level of average years of schooling (11.5) and the largest share of university graduates (6.4 percent) among emerging nations, especially in science and technology, but floundered at innovation, failed to develop a tech sector, and relied mostly on natural resources for most of its income (Sharma 2016, 17).

There are two other problems with the idea that education is a driver of technological progress and economic growth. First, mass education until the post-war era focused on basic literacy and religion, with little attention paid to the sciences. Most of the great engineers and inventors of the Industrial Revolution were not well educated, although they had good networks with other people working in the same area. The second difficulty for relating education and economic development is that huge investments in education by developing nations over decades have not paid off in much higher growth. The conclusion is "the almost heretical view" that there is "little support for a major role for education in explaining economic progress" (Mokyr 2016, 125-126).

(v) Research

One of the oldest measures of innovation is spending on R&D: It was the only one deployed by Statistics Canada and the OECD when they began to study innovation. One of the problems with using R&D as a proxy of innovation is that, as Nathan Rosenberg observed, most of the money spent on R&D is devoted to "making small improvements on technologies that already exist" (Marsh 2013, 40). Moreover, the term R&D is misleading about the R&D process itself. In reality, "it's a tiny 'r' and big 'D,' and they don't even mention 'I,' for invention, in the process" (Foege 2013, 98).

For most of human history, technological change did not come from specialized research laboratories. Instead, "technological change occurred mostly through new ideas and suggestions occurring if not randomly, then certainly

in a highly unpredictable fashion" (Mokyr 1990, 153). The result of this unpredictability is that "the honest answer to the question 'Where do inventions come from?' is 'Almost anywhere you can imagine'" (Harford 2017, 166). Research and development without the discipline of commercial viability can be wasteful if it only involves organizing "a team of innovators, set[ting] a whiteboard under a blue sky, and never ask[ing] them to make a profit" (Lepore 2014, 36).

The low payoff from R&D in terms of innovation at the macro level is confirmed by data for R&D spending by individual firms. Very few studies find R&D spending has a significant impact on company growth (Mazzucato 2013, 44). More important than the overall level of R&D is spending it in the right place at the right time (ibid., 45). Such exquisite judgement and timing is unlikely to originate in government and is not ensured for the private sector. Nokia spent the seventh most in the tech field, but has fallen behind in technology (Nazareth 2014, 266). Nortel and Blackberry were among the largest recipients of government R&D subsidies in Canada, yet both failed. Auto companies are big R&D spenders, but there were no major innovations in the car industry in the 20th century (discounting larger cup holders as innovative; ibid.). Conversely, companies that are prolific at innovative products, such as Apple, Nike and Google, spend relatively little on R&D. For example, Apple ranked 82nd in R&D spending (Zakaria 2011a, 37). As a result, Mazzucato concludes, "Macro models on innovation and growth … do not seem to have strong empirical 'micro foundations'" (Mazzucato 2013, 44).

"Canada's disappointing record of translating government support for R&D into innovation is far from unique.

Canada's disappointing record of translating government support for R&D into innovation is far from unique. While Southeast Asia is a model for transitioning from poverty to high incomes, they also show the difficulty of designing successful R&D strategies. In *Betting on Biotech*, Joseph Wong (2011, 45) shows how total R&D spending was not a precursor to high growth in South Korea, Taiwan, and Singapore. In the early 1980s, spending on R&D ranged from just 0.31 percent of GDP in Singapore to 0.62 percent in South Korea. Since then, R&D rose fivefold in Korea and Taiwan and eightfold in Singapore, ranking them among the largest increases in the world, with nearly one-third of this devoted to life sciences. However, "these enormous bets on biotech have not, to date, paid off. … Output has fallen well short of expec-

tations. Ratios of sales revenues to R&D investment have likewise been very low in all three economies" (Wong 2011, 5). A major reason for the lack of a payoff is that these nations have no obvious comparative advantage or experience in biotech. Unlike computer peripherals or semi-conductors, biotech is highly regulated, requires long gestation periods, and has a low success rate for new products (ibid., 11).

One can always find some individual firms that succeeded in their R&D efforts for short periods. General Electric established the first US corporate research laboratory in 1901, followed quickly by DuPont, Eastman Kodak, and the legendary Bell Labs of AT&T (Lind 2012, 192). Intel successfully adopted a new strategy of expanding R&D during economic downturns such as those in 1974 and 1981, allowing it to emerge from recessions with successful new products (Garten 2016, 294). Airline manufacturers need to spend lavishly on R&D, although Boeing's disastrous experience with the 737 MAX shows even their success is not guaranteed. It is notable, however, that none of these firms successfully translated R&D spending into innovation over long periods. Their short-term success was not based on a model that can be replicated by other firms, let alone policy-makers.

Government spending on R&D is even more problematic than in the private sector. Extensive studies show government research and development has almost no relation with innovation. The OECD "concluded that government spending on R&D has no observable effect on economic growth, despite what governments fondly believe. Indeed, it 'crowds out resources that could be alternatively used by the private sector, including private R&D.' This rather astonishing conclusion has been almost completely ignored by governments" (Ridley 2010, 269).

The better results for private than public R&D partly reflect their need to be commercially successful: "Valuable learning comes from serving demanding customers – who pay for performance – and from racing to serve those customers more effectively than competitors" (Conrad 2016, 69). The Internet is a telling example, having been invented in government in the 1960s but then remaining obscure for two decades, used mostly by academics (Beinhocker 2006, 143). Then its commercial potential was discovered, and today it is used by billions of people and firms.

Expert knowledge and innovation

One of the reasons that large investments in areas such as research, science, and education have produced disappointing results for innovation is that specialized and expert knowledge is not closely linked to innovation. The highly specialized knowledge required for success in today's academic journals hinders the sharing of knowledge in networks that fosters innovation.

The diffusion of practical knowledge used for innovation refutes the Expert Myth, which "assumes that the hardest problems are solved by the brightest minds in the field, but the evidence supports a different conclusion. The people who solve tough problems often come from the edge of a domain. They have enough knowledge to understand the problem but don't have a fixed method of thinking. Because of this, they possess the creative ability to find the right solution. Their unique perspective allows them to generate a diverse set of ideas and still have enough domain knowledge to evaluate which ideas have merit" (Burkus 2013, 85). Instead of going over the same ground in "re-search," outsiders are more likely to bring original insights from "search" (Lewis 2015, 147).

Tasking experts to work on a problem may even backfire because "as expertise grows, creativity sometimes diminishes. Sometimes the best insights come from those outside a particular field, and the best inventions develop from teams built from these outsiders" (Burkus 2013, 68). At the extreme, Harry Truman observed experts can resist new knowledge because "an expert is someone who doesn't want to learn anything new, because then he wouldn't be an expert" (McCloskey 2006, 73).

Psychologists call the routine way of thinking that results from expertise the Einstellung effect. This effect "can block us from seeing how to do things any other way" than what the expert has learned (Lewis 2015, 151). The problem is that experts with a deep knowledge of a subject, such as chemists trying to solve a chemistry problem, "often suffer from a kind of intellectual handicap. As a result, the impossible problem stays impossible. It is not until the challenge is shared with motivated outsiders that the solution can be found" (Lehrer 2012, 122).

Innovation relies on extensive networks, not expert knowledge

It is the broad diffusion of diverse types of information and knowledge through networks that fuels innovation rather than the accumulation of in-depth expert knowledge within narrow fields of study: "This is not the wisdom of the crowd, but the wisdom of someone in the crowd. It is not that the network itself is smarter; it's that the individuals get smarter because they're connected to the network" (Johnson 2010, 58). Ridley concludes, "Innovation is not an individual phenomenon, but a collective, incremental and messy network phenomenon" (2020, 93), which is why innovation proceeds in an incremental and gradual process, often with many people making the same breakthrough at about the same time.

The power of information networks drove the rise of cities as leaders of higher productivity and economic growth. Cities raise the productivity of their residents by encouraging "information spillovers." People move to Manhattan, despite its higher cost of living, because of "the extensive cross-fertilization that takes place in its various neighborhoods" (Warsh 2006, 246). Italian cities led the Renaissance by replacing the knowledge-hoarding in isolated church cloisters with what Johnson calls "liquid networks" where information easily flows along multiple unpredictable paths (Johnson 2010, 71). Today the most successful companies are not the ones that compete by holding their most coveted resources close to their chest, but the ones "that make their boundaries porous to external ideas and human capital" (Tapscott and Williams 2006, 21).

The power of networks reflects Metcalfe's Law (named after Robert Metcalfe) that the usefulness of a network rises with the square of the number of users. For example, when the number of networks is 100,000, adding one more user creates 100,000 new connections; but adding one more user to a network of 200,000 creates 200,000 new connections (Baldwin 2016, 83). Because knowledge and innovation are not confined to universities or research laboratories, governments can foster innovation by encouraging the broadest possible networks to maximize the flow of information, and not just among specialists. This is what makes networks such as cities or the Internet so productive.

"Resistance to dissenting ideas is why networks flounder inside the echo chamber of the civil service or academia.

Communication within networks is especially useful if it involves new or different points of view. Princeton's Martin Ruef showed that "entrepreneurs are more likely to succeed if they surround themselves with a high level of novel and conflicting information" (Howkins 2013, 217). This is especially true for startups because they "avoid pressures to conform or to follow conventional wisdom" (ibid.), one reason innovation flourishes in smaller firms. Conversely, resistance to dissenting ideas is why networks flounder inside the echo chamber of the civil service or academia.

The lack of a network full of diverse ideas is one reason why the Boston area lost its technological leadership to Silicon Valley. Boston in 1970 was home to six of the world's 10 largest technology firms (notably Digital Equipment,

Wang Laboratories, and Raytheon) and the support of elite universities, Harvard and MIT. However, it could not keep pace with the innovations coming from Silicon Valley precisely because of the dominance of these firms: "These companies were so large, in fact, that they were mostly self-sufficient" (Lehrer 2012, 194). For example, Digital Equipment not only made minicomputers, it built its own microchips, designed its own software, and jealously prevented employees from sharing ideas outside the firm. Massachusetts state law restricted the knowledge employees could take to another firm (not that all this knowledge was useful: Digital Equipment famously declared in 1977, "There is no reason anyone would want a computer in their home"; Tetlock and Gardner 2015, 46). The Bay Area eco-system was more esoteric, including "homebrew hackers, hippies, hobbyists, Whole Earthers, Free Speech activists and radical community organizers" (Shapin 2014). Such a broad spectrum of views could never exist in hierarchal bureaucracies like Boston's tech companies or an authoritarian culture like China's.[15] As Johnson concludes, "We are often better served by connecting ideas than we are by protecting them. … Environments that build walls around good ideas tend to be less innovative in the long run than more open-ended environments. Good ideas may not want to be free, but they do want to connect, fuse, recombine" (2010, 22).

Lehrer cites Ruef's research that "businesspeople with entropic networks full of weak ties were *three times* more innovative than people with small networks of close friends" (Lehrer 2012, 203). Cultivating weak networks and unexpected acquaintances at conventions or in coffee shops leads to the interactions and information entropy (entropy is the presence of disorder). Writing about creativity, Howkins observes, "It is better to wander in and out of a variety of networks, to meet strangers as well as friends, and be challenged by people with new and different ideas. One of the most powerful stimulants of creativity and innovation is the outsider. … Creativity thrives on differences" (2013, 216).

This is one reason creativity shrivels and dies in the bureaucracy of government or large corporations. Command and control organizations like IBM or General Motors lag decentralized workplaces when it comes to innovation because innovations have tended to come from networks more than from hierarchies. Large corporations and state-run economies are "fundamentally hierarchies, not networks" (Johnson 2010, 217). Pharmaceutical companies have largely abandoned trying to develop new drugs themselves, instead relying on what Proctor and Gamble calls an "open innovation" strategy of buying small firms with promising technologies (Ridley 2020, 296).

Innovation is supported by more than teamwork within a firm or an organization. Innovation requires whole eco-systems, such as venture capital to supply finance and universities to provide scientists and engineers. Ultimately, innovation requires good managers "with the expertise and experience to judge whether to attempt development of a new things; whether a proposed

project is worth financing" and customers willing to try the new product or method (Phelps 2013, 20).

The implication is that we should not treat entrepreneurs as individuals acting alone, but as the expressive tip of creative networks. In reviewing Walter Isaacson's book *The Innovators*, Steven Shapin (2014) suggests "that we shouldn't be thinking of lone geniuses, or even of self-sufficient imaginative individuals, at all but of the organizational forms within which innovation takes place." Particular emphasis is attached to creative teams, those "groups whose ideas arose from exchanges among its members and whose inventiveness flowed from their differences in knowledge, skills, styles of working and temperament" (Shapin 2014).

> *We should not treat entrepreneurs as individuals acting alone, but as the expressive tip of creative networks.*

This emphasis on teams parallels how Schumpeter's thinking evolved from "viewing entrepreneurship as an instance of causality to the much weaker idea of interdependence." This resulted in Schumpeter's later "depersonalization of the entrepreneurial function. This view of the entrepreneur is associated with the attempt to downplay the almost superhuman powers of leadership that were imputed to the entrepreneur" (Becker et al. 2011, 13).

The dependency of entrepreneurs on others is also evident in how some inventions or innovations required the development of complementary technology. Edison's big breakthrough was not the light bulb, which had been around for years, but delivering electricity to homes to power his incandescent bulb and eventually a slew of household appliances besides light bulbs. Similarly, the development of container transport was based on the insight that increasing the efficiency of shipping lay in reducing the time large ships stood idle while unloading, not in improving their efficiency while at sea (Drucker 1985, 63). This required international agreements standardizing container sizes, wharves for container handling, the re-organization of factories to take advantage of containerization, and the reconfiguration of railroads, trucks, and ships to handle containers (Levinson 2006, 161).

The sharing of knowledge in networks is one reason why inventions often come in clusters, where multiple people stumble onto the same discovery at about the same time (Johnson 2014, 66). Multiple inventions lead to furious

disputes about intellectual theft; "we know of six different inventors of the thermometer, three of the hypodermic needle, four of decimal fractions, five of the electric telegraph, four of photography, three of logarithms, five of the steamboat, six of the electric railroad" (Ridley 2015a, 120).

Not all innovations occur within specific institutions such as a firm or a university. Some innovations, such as the agricultural revolution in the prehistoric era, happened in many societies at about the same time (Ridley 2020, 217). Social innovations such as language occur across all of a society (Eco in 2019 called the development of new European languages in the Dark Ages "perhaps the most innovative and overwhelming cultural event of the last two thousand years"). Easterly and Levine defined Social Technology as methods and designs for organizing people in pursuit of goals, which includes the rule of law, the existence of property rights, a well-organized banking system, economic transparency, and a lack of corruption (Beinhocker 2006, 261).

There are drawbacks to networks, just as not all innovations better our lives. Networks can spread bad ideas as well as good ones, leading to housing bubbles, bank runs, or outrageous conspiracy theories. Networks also are not easily directed "towards a common objective … that requires concentration of resources in space and time within large organizations, like armies, bureaucracies, large factories, vertically organized corporations. Networks may be spontaneously creative but they are not strategic" (Ferguson 2017, 43).

Innovation requires creative destruction and entrepreneurs

When implemented, innovation disrupts the established order. Therefore, it flourishes in societies open to new ways of thinking and doing things. Networks may encourage the flow of novel ideas, but they will remain locked in the realm of imagination until translated into action by entrepreneurs who are free to develop them.

Innovation is closely linked to the concept of creative destruction, so it is not surprising that Schumpeter was a driving force behind both ideas. Schumpeter defined *creative destruction* as "the process of industrial mutation that incessantly revolutionizes the economic structure from within, incessantly destroying the old one, incessantly creating a new one" (quoted in Meredith and Darroch 2017, 8). For the former chair of the Federal Reserve Alan Greenspan (1994), creative destruction means "newer ways of doing things, newer products, and novel engineering and architectural insights." As a result, Greenspan maintained, "creative destruction is the principal driving force of economic progress. … Creation and destruction are Siamese twins. The process involves

displacing previously productive assets and their associated jobs with newer technologies and their jobs" (Greenspan and Wooldridge 2018, 14).

Creative destruction is a key part of the innovation process because it acknowledges the indispensable role of mistakes and failures. As noted earlier, business failures are one way the market eliminates bad innovations, since every successful innovation has the potential to destroy a part of some other business (this is different from businesses being destroyed by factors other than innovation, such as during a recession; Becker et al. 2011, 18). Setbacks and failures in business, as in life, "[teach] lessons and [make] us more skilled at balancing and preparing for the adversity and opportunity that the future is bound to bring" (Malmgren 2015, 27).

The negative aspects of creative destruction get the most attention, but creation itself is just as important. Creative destruction explains macro-level changes in society and the economy as the outcome of micro-level entrepreneurial activity (Becker et al. 2011, 17).

Many people mistakenly associate entrepreneurs with risk, while for economists it is more closely associated with innovation. Mokyr notes, "Every invention is made only once, and hence the experience of past inventions is at best a limited guide to the success of a new idea. A willingness to take risks by experimenting with never-before-tried techniques is essential if innovation is to occur" (2016, 122-123). However, entrepreneurs are not always risk-takers; on the contrary, most try to minimize risk wherever possible (Drucker 1985, 139). In Drucker's view of entrepreneurs, "They are not 'risk-focused' but are 'opportunity-focused'" (ibid., 140). As much as possible, entrepreneurs shift the risk to the capitalists who finance their projects (Schumpeter 1939/2011c, 302).

Creative destruction disrupts and therefore faces resistance

Creative destruction by definition overturns the existing order with disruptive innovations whose impact is "challenging the status quo and upsetting the established order" (Atkinson and Ezell 2012, 129). Apple created a different, not a bigger, computer in challenging IBM; autos were not faster horses but a completely different mode of transport. When Edison invented the phonograph, he disrupted the development of the telephone, which itself was in the process of destroying the telegraph industry (Foege 2013, 98). The telegraph was revolutionary because it severed the link between transportation and communication. Mokyr summarizes, "Technological creativity, like all creativity, is an act of rebellion" (1990, viii).

Since innovations challenge the existing order, they often face fierce resistance. The economic historian Carlo Cipolla concluded this resistance to

change is because "change hurts vested interests. It is not difficult to explain why change is generally opposed. … The tendency to resist change is strengthened by existing institutions. … Once an institution is in existence, it is very hard to change it or to get rid of it. Owing to its past growth and development, an empire is inevitably characterized by a large number of sclerotic institutions. They hinder change for their very existence" (1970, 11). One student of the history of technology observed, "Every invention is born into an uncongenial society, has few friends and many enemies, and only the hardiest and luckiest survive" (Mokyr 1990, 183). As a result, "innovators need to be *dis*agreeable" not in the sense of being unpleasant but "willing to take *social* risks – to do things that others might disapprove of" (Gladwell 2013, 116-117).

> *Innovation threatens the established order through the process of creative destruction.*

Innovation's threat to the existing order explains why the word "innovation" had negative connotations until recently. Mokyr points out that before the Enlightenment, innovation was a "term of abuse" (quoted in Easterly 2013, 286) because innovators showed "an insulting disrespect for venerated ideas, institutions, thinkers, and rulers" (ibid.). Innovation signified "excessive novelty, without purpose or end" (Lepore 2014, 32). Edmund Burke disparaged the French Revolution as a "revolt of innovation" (ibid.). George Washington, on his deathbed, was said to have warned: "Beware of innovation in politics" (ibid.).

Because innovation threatens the established order through the process of creative destruction, entrenched interests have proved adept at using established institutions to resist changes and preserve the status quo. The result is that "history provides us with relatively few examples of societies that were technologically progressive" because "by and large, the forces opposing technological progress have been stronger than those striving for changes" (Mokyr 1990, 16). The status quo suppresses challenges to entrenched knowledge "using a range of means, from the threat to persecute heretics and the burning of their books, to subtle but effective mechanisms, such as meritocracies in which the key to personal success was the uncritical expertise in the existing body of knowledge inherited from the past" (Mokyr 2016, 340).

The institutions opposing change usually turn to the coercive power of the state, including laws, rules, and regulations that erect barriers to new firms

entering into existing markets or slow the introduction of new products and technologies (such as new drugs or driverless vehicles). These rent-seeking activities are doubly wasteful: Managers of existing enterprises spend time seeking favours from government instead of enhancing efficiency, while innovative firms waste time overcoming costly barriers to their growth (Ricketts 2006, 53). For example, the founder of Uber described how the strongest resistance to the introduction of its taxi service was not ultimately from "city council or government, it's actually about how the incumbent industry is persuading them, let's say, to do what I would consider the wrong thing" (Stone 2017, 194). In Canada, over half of the economy consists of government spending or sectors tightly regulated by government (notably in transportation, communications, agriculture, and finance; see Cross 2014). This sharply curtails the parts of the economy in which entrepreneurs can innovate. It also encourages a culture that reinforces the status quo rather than rewarding disruption.

Economics itself favours the established order over innovation and creative destruction. Economic theory has a long-standing bias to static equilibrium analysis over dynamic innovation. Classical economics is about optimizing what already exists, "focuses on getting the most out of existing resources and aims at establishing equilibrium" (Drucker 1985, 26). Adam Smith and his followers Ricardo and Malthus envisaged a steady state form of capitalism based on equilibrium and order, not dynamic economies of disruptive growth and change (Gilder 2013, 85). After all, Smith's scholarly interest was the *Wealth of Nations*, not the *Growth of Nations*. Economics to this day has lagged in its understanding of the conditions in which innovation flourishes and its appreciation of the importance of innovation.

Creative destruction undermines tradition because "it disrupts settled ways and compels people (and institutions) to alter comfortable habits. It generates insecurity" (Samuelson 1997, 11). However, there are limits to the amount of uncertainty and insecurity any society is willing to tolerate. The Western world developed large corporations[16] and governments partly to bolster security and predictability in its societies. Yet we have come to bemoan the inevitable lack of innovation in the attendant large bureaucracies, which shows that "we can't enjoy all the benefits of greater economic growth (higher living standards, improved technology) unless we also suffer some of the drawbacks" (Samuelson 1997, 11). Our societies are reluctant to accept that the upheaval and dislocation from creative destruction is one of the necessities for innovation and economic growth.

A greater acceptance of change would not only lower opposition to creative destruction but also prepare people for the inevitable and seemingly infinite variety of shocks to which our world is susceptible. The coronavirus pandemic is a vivid example of the futility of pretending we can eliminate uncertainty. The pandemic follows previous unforeseen shocks such as the 9/11 terrorist

attacks, the shale oil revolution, the waves of technological innovation in recent decades (including the unforeseen rise of the Internet and recombinant DNA),[17] and repeated financial crises. Despite this long list of recent shocks, we act as if uncertainty can be eliminated or at least minimized in our world instead of preparing people to adapt and take advantage of the inevitability of rapidly shifting circumstances – in other words, encouraging them to have a more entrepreneurial outlook on life rather than taking shelter in large bureaucracies. Canada's risk-adverse culture makes it especially reliant on bureaucracies in government and large businesses, many sheltered by regulation from global competition.

US culture fosters innovation

The United States for over a century has been able to sustain a culture supporting innovation. It has maintained this leadership mostly because of its cultural values, not because of government programs targeting the supply of innovation. The economic growth theorist Edmund Phelps articulated the primacy of values over policy: "Attitudes and beliefs were the well-spring of the dynamism of the modern economies. It is mainly a culture protecting and inspiring individuality, imagination, understanding, and self-expression that drives a nation's indigenous innovation" (Watson 2013). The US excels at cultivating more of these characteristics than most countries by encouraging competition in free markets, keeping taxes low, a unique cultural tolerance of risk and failure, and a relentless optimism. Even at the depths of the crisis engulfing its financial system in 2009, *The Economist* in a special report on entrepreneurship observed, "America still leads the world" (9). It attributed the success of what it called the United States of Entrepreneurs to "its history. It was founded and then settled by innovators and risk-takers." The public statues raised to Andrew Carnegie and Henry Ford will one day be joined by monuments to Bill Gates and Steve Jobs.

Several authors cite the acute US ability to convert invention into commercial success, something sorely lacking in Canada (as is discussed in the next section). Zakaria (2011b, 201) underlines "America's unusual strength in turning abstract theory into practical products." The relative success of the US in converting its inventions into successful innovations also reflects its genius at marketing – the result, "that is, of the ability to translate the technically new into the economically productive" (Drucker 1968, 51). The US talent for marketing has created the most famous and valuable corporate brands in the world. By contrast, Canada has not had a global brand since the demise of Blackberry.

Innovation in the US is encouraged by its large supply of venture capital, which dwarfs the total supply everywhere else in the world. Venture capital has played a crucial role in the growth of US business. Venture capital-backed companies generate 21 percent of GDP and 11 percent of private-sector jobs

in the US (Cowen 2019, 140), including innovative giants such as Facebook, Apple, Google, FedEx, Starbucks, eBay, Microsoft, Intel, and Home Depot (Tapscott and Williams 2010, 49). The result is that it is so fashionable to start a company, especially in technology, that one anonymous observer said, "When I was in college, guys usually pretended they were in a band. Now they pretend they are in a start-up" (*Economist* 2009, 9).

> *The US talent for marketing has created the most famous and valuable corporate brands in the world.*

Because the chance of making a valuable innovation is small, a large community of people trying to innovate is needed. Therefore, innovation is more likely to occur in countries with a large population, especially if it is concentrated in urban areas. Another reason for America's superior innovation is the huge size of its domestic market. The Council of Canadian Academies concludes that "small markets tend to support less innovation than large markets" (2013, 2), although aggressively pursuing export markets can help a small country compensate. Canada's relatively small population is a drawback, even if highly concentrated in cities. However, the presence of a large cohort of young people also fosters innovation, because they are more likely to "invent, develop, and test new concepts" (Phelps 2013, 50). Here Canada is fortunate to have a relatively young population compared with the OECD average, even if this population is aging (although research in the US found that startups were more successful when the founder was in their 40s than in their 20s; NBER 2018). Innovation favours the young over the old, businesses over government, markets over individual firms, and decentralization over centralization.

The United States takes failure in stride better than most societies. The *Economist* observed that "in some countries bankruptcy spells social death. In America, particularly in Silicon Valley, it is a badge of honour" (2009, 9). Silicon Valley elevated failure as a symbol of the innovative spirit with the saying "fail fast and fail often" (Ridley 2020, 255). Steve Jobs, Henry Ford, R. H. Macy, and H. J. Heinz all went bankrupt before becoming successful, something that would have ended their business careers in Japan (Greenspan and Wooldridge 2018, 439). The US is much more accepting of failure than rigid societies such as Japan and Europe, where failure is stigmatized. It is unimaginable that Japan could organize a conference like Silicon Valley's FailCon, where "the rule there is that people can't speak about their successes, only their failure" (Lewis 2015, 112).

As well as accepting the inevitability of failures, the United States may also be more accepting of outsized success. The widely lamented increase in US inequality in recent years is partly due to its global leadership in technological innovation, which has spawned vast wealth accruing to the owners of Microsoft, Amazon, Facebook, and Google. They may be the modern version of the Gilded Age's "robber barons" who profited enormously from the rapid industrialization of the late 19th century with innovations in oil, railroads, steel, and banking that enriched Rockefeller, Vanderbilt, Carnegie, and Morgan even as they also lifted millions out of poverty. As Schumpeter observed, "Innovation offers the carrot of spectacular reward or the stick of destitution" (quoted in Ridley 2020, 1).

Despite its envious track record, some Americans fret that "the United States is no longer the global innovation leader" (Atkinson and Ezell 2012, 9).[18] However, such concerns are based on statistics showing the US lags in some traditional measures of inputs such as R&D and the number of scientists. These concerns seem exaggerated in view of the dominance of US tech companies such as Apple, Amazon, Google, and Facebook. Nor does the pace of US innovation seem to be slowing. The United States today remains at the forefront of technological innovation in four areas, according to the World Economic Forum's Klaus Schwab (2016, 75): technological innovation in energy (especially fracking), advanced and digital manufacturing, the life sciences, and information technology.

Government policies and innovation insecurity

Most governments around the world pretend to want to mimic the US prowess at innovation that produced its technology juggernauts. The difficulty of replicating American innovation is reminiscent of the scene in *Henry II* when Glendower claims, "I can call spirits from the vastly deep," and Hotspur answers, "Why, so can I, or so can any man; but will they come when you do call for them?"[19] Many nations have adopted policies calling on the spirits of innovation, but rarely have they responded.

Almost every country obsesses about finding the elusive formula for boosting innovation. As a result, insecurity and envy about innovation exists almost everywhere: "In Australia, people say they wish they had the British education system and the American innovation system. You're in Britain and they say, we wish we had the American education system and the German innovation system. You're in Germany, and they say, we wish we had the Australian innovation system and the Japanese education system. Every country in the world is suddenly paranoid they have lost their advantage to someone else" (quoted

in Foege 2013, 134). While this formulation reflects a widespread neurosis about innovation, the problem is that innovation is not a system that can be manufactured from parts on an assembly line.

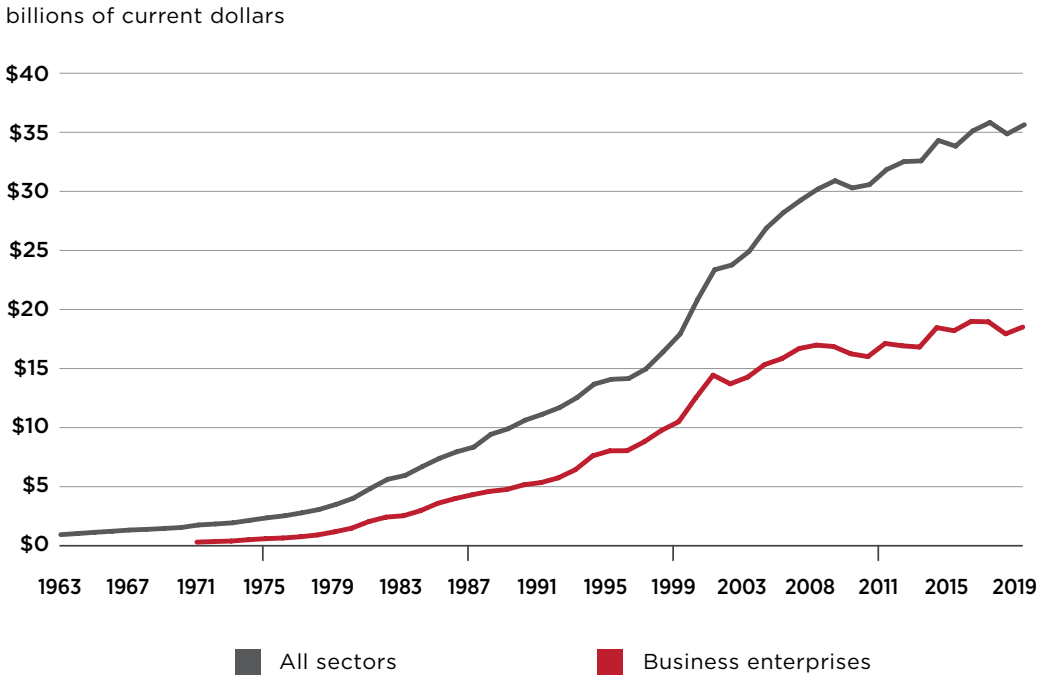
The priority policy-makers attach to boosting innovation dates to the 1970s when the initial burst of postwar growth slowed markedly. The initial reflex of policy-makers in many countries was to implement "structural adjustment programs systematically [which] assisted sluggish industries with scant growth potential rather than dynamic, innovative ones. The net result may have been to deepen the productivity slump rather than ending it" (Levinson 2016, 130). Realizing their policy error, nations soon embraced a paradigm of encouraging innovative industries. However, this resulted in programs targeting the assumed inputs into innovation such as higher education, research, science, infrastructure, and entrepreneurship, in the belief that governments could control the determinants of long-term growth as assuredly as they had come to believe they controlled the short-term course of the economy (Levinson 2016, 9). Policy-making had come full circle: In the 1930s people turned to governments to save them from the presumed instability of the market, but starting in the 1970s policy-makers turned to entrepreneurs to save them from chronically slow growth (Greenspan and Wooldridge 2018, 327).

Soon, however, it became apparent that stimulating innovation was vastly more complicated than steering the short-term course of the economy with monetary and fiscal policy. The difficulty is that innovation is not solely the product of economic factors. Furthermore, most studies reach the same conclusion as a PricewaterhouseCoopers report on innovation that "no single strategy or approach works for all countries" (2010, 4). Finding the right policy mix for their particular circumstances has proved elusive for most countries.

Canada spends large amounts on research and development, even using the narrow definition of most statistical agencies that excludes outlays for exploration and development of oil and gas. The increase in recent years has been dominated by government outlays for R&D (see Chart 1). The problem, as emphasized by the Council of Canadian Academies, is "the stubborn tendency to equate R&D and business innovation continues to inhibit a deeper understanding of innovation" (2013, 25).

One telling example of how policy easily but mistakenly equates innovation with R&D was the 2001 Speech from the Throne. The government reiterated Canada's goal "should be no less than to be recognized as one of the most innovative countries in the world" (quoted in Tang 2003, 201). However, to achieve this ambitious goal, the government immediately fell back on a narrow focus on R&D, proposing a policy "for Canada to become one of the top five countries for research and development performance by 2010" (ibid.). The policy obsession with specific inputs into innovation persists partly because they provide civil servants with metrics that measure government at-

FIGURE 1: GDE ON RESEARCH AND DEVELOPMENT



Source: Statistics Canada Table 27-10-0273-01

tempts to foster innovation; when overall innovation fails to respond, the government can claim it took concrete action and blame the failure on some other part of the innovation process.

The unrelenting focus on R&D spawned billions of government outlays for basic and applied research, talent development, research infrastructure, and subsidies to "innovative" industries. The result is a consensus that "Canadian research is now considered to be world-class in most fields" (Council of Canadian Academies 2013, 10). However, one of the problems with subsidizing R&D is that it "rewards spending on R&D, rather than improving the rewards to productively deploying that investment" (Poschmann 2013). Germany, Sweden, and Finland outperform Canada in innovation metrics without almost any tax incentives (Khan 2016).

A plethora of government-sponsored studies has tried to analyse the reasons for Canada's persistent innovation gap (as measured by MFP) with other countries and the policies that would narrow this gap. These studies show we generously fund education, including lavish Canada Research Chair positions in academia starting in 2000 that have yet to pay off in their expressed

goal of raising productivity. Canada has above-average infrastructure after two decades of more investment in capital projects. We have extensive programs targeting specific technologies and individual companies. Despite ticking all these boxes, innovation continues to lag. Canada's experience duplicates that of Sweden and Finland, which rank high in many statistical measures of innovation but not in productivity or GDP per capita (Sharpe 2003, 397). This reflects the futility of fixating on innovation inputs and not results, which flunks one of the foundational tests of whether something is innovative, which is, does it serve a market?

> *Germany, Sweden, and Finland outperform Canada in innovation metrics without almost any tax incentives.*

There is a growing recognition of the ineffectiveness of Canada's emphasis on the supply-side of innovation. When the Harper government launched yet another round of studies and consultations to improve innovation in 2014, one commentator observed, "Unfortunately, the government has already tinkered with most of the key levers at its disposal. It has pumped more money into direct research and development grants for smaller companies, invested in venture capital, overhauled the National Research Council, and tightened the rules of its flagship R&D tax credit" (McKenna 2014). As a result, "it has been said many times that Canada excels at research, but falls short in the commercialization of that research" (Carson 2014, 280).

A 2019 IRPP study noted, "Canada has many of the right conditions for innovation: a well-educated workforce, strong research institutions, openness to skilled immigration, an active venture capital scene, generous R&D tax credits and access to the large US market." The IRPP paper concluded that Canadians do not exploit this potential because they "are less inclined to scale up and commercialize their new products and processes. Instead, they sell their intellectual property (IP) to foreign entities" (Gallini and Hollis 2019, 1; although it goes on to say selling to foreign firms may enhance our innovative capacity here by preventing an exodus of talent). The discouraging result is Canada has become one of Holman's so-called "Ivory Tower" nations, using his finding "that certain countries that spend much on research can't turn their science into business" (quoted in Zakaria 2011b, 201).

Another perennial favourite of government innovation policy in Canada and elsewhere is the idea of shifting the industry mix toward higher value-added

and supposedly more innovation-based sectors. These ideas regularly circulate in Canada, especially the notion that we should move up the value-added chain from producing natural resources to processing them into finished manufactured goods. However, studies show that "the amount of productivity growth generated from an industry-mix strategy is quite limited" (Atkinson and Ezell 2012, 221). For Canada, this reflects that profit margins and value-added is higher for natural resources than for manufactured goods, where fierce international competition has squeezed profit margins (Cross 2013).

Other countries have also found that a government-directed shift to higher value-added industries does not lead to more innovation or faster economic growth. Atkinson and Ezell point out that China's goal of raising the share of high value-added industries from 4 percent to 15 percent of GDP, assuming those industries had twice the productivity of other industries, would yield a one-time productivity boost of just 1.4 percent. Boosting productivity in a large industry (such as Walmart did for retailing) has a much greater impact; for example, raising productivity in retailing and banking in India to just 30 percent of the US level would raise its GDP by more than 10 percent (Atkinson and Ezell 2012, 329). By exclusively focusing on export-based sectors, Japan missed the greater opportunity to boost productivity in its domestic sectors, which ultimately limited its long-term growth. Countries that target exports are one-trick ponies, lifting growth for a brief period but then languishing at their technological frontier.

The import substitution model of growth in many Latin American countries was even worse than Asia's targeting of exports, holding back an entire continent's progress. For example, Brazil's policy of raising tariffs on foreign computers and components to seed a domestic IT industry served only to raise the price of capital goods that could have boosted productivity in a number of other industries (Atkinson and Ezell 2012, 222). After years of such failed policies aimed at specific industries, emerging nations increasingly focus on innovation economics that "reformulates the traditional economic growth model so that knowledge, technology, entrepreneurship, and innovation are central goals" rather than the allocative efficiency of markets (ibid., 296).

Cultural beliefs and practices matter more than targeted policies

The results for Canada's innovation policy have been disappointing because innovation comes from cultural beliefs and attitudes to entrepreneurship and not specific inputs on the supply side. *Paradox Lost*, a report on Canada's capacities in science, technology, innovation, and productivity, blames a lack of demand for innovation from business firms. Assured of a reasonable level of profitability by a good labour supply, a low exchange rate, and ready access to the US market, too many Canadian businesses settle for a "low-innovation equilibrium" (Council of Canadian Academies 2013, 29).

However, the conclusions of the *Paradox Lost* report ignore the role of broader cultural attitudes to business, entrepreneurs, and creative destruction. George Gilder argues that such an oversight results from the "belief that wealth subsists not in ideas, attitudes, moral codes, and mental disciplines but in identifiable and static things that can be seized and redistributed is the materialist superstition. … It confounds every bureaucrat who imagines he can buy the fruits of research and development. The cost of capturing technology is mastery of the knowledge embodied in the underlying science. The means of entrepreneurs' production are not land, labor, or capital but minds and hearts" (2013, 190).

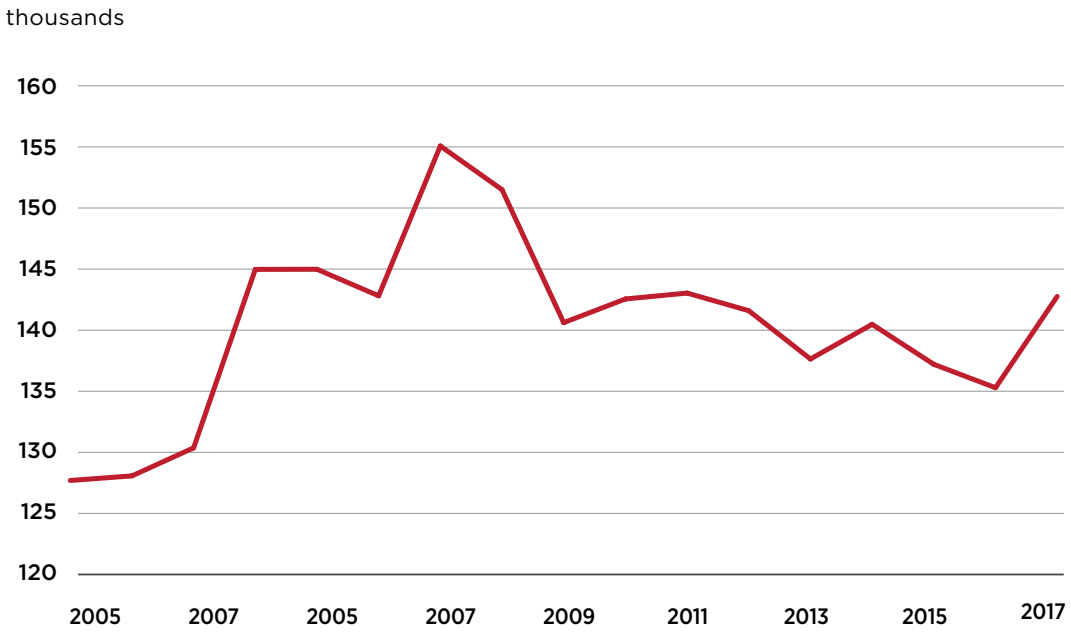
While Mazzucato is over-confident about the ability of policy-makers to correct their innovation policies, she identifies one of their fundamental problems as a hubris that just tinkering with rules and regulations is enough to unleash a tsunami of innovation perpetually lying just below the surface of every country. She writes:

> The assumptions that all the State has to do is to "nudge" the private sector in the right direction; that tax credits will work because business is eager to invest in innovation; that removing obstacles and regulations is necessary; that small firms—simply due to their size—are more flexible and entrepreneurial and should be given direct and indirect support; that the core problem in Europe is simply one of "commercialization"—are all myths. They are myths about where entrepreneurship and innovation come from. They have prevented policies from being as effective as they could be in stimulating the kinds of innovation businesses would not have attempted on their own. (Mazzucato 2013, 22)

Without policies that cultivate a culture that welcomes, nourishes, and rewards entrepreneurship, isolated government attempts at "innovation policy" are doomed to failure. As Drucker observes, "A policy that promotes high tech and high tech alone – and that is otherwise is as hostile to entrepreneurship as France, West Germany, and even England are – will not even produce high tech. All it can come up with is another expensive flop, another supersonic *Concorde*; a little *gloire*, oceans of red ink, but neither jobs nor technological leadership" (1985, 255).

Drucker's is a perfect description of why the current federal government's attitude to innovation has failed. It pays lip service to encouraging industries that fit its ideology (such as high tech and green energy) or its political needs (such as aerospace and SNC-Lavalin), while being unremittingly hostile to industries such as oil and gas, pipelines, pharmacology, and most small businesses (as shown by its abortive attempt to change small business taxation in 2018). The government is then perplexed by the unrelenting weakness of business investment and business startups in Canada.

FIGURE 2: BUSINESS DYNAMICS MEASURE NUMBER OF ENTRANTS, PRIVATE SECTOR



Sources: Statistics Canada Table 33-10-0164-01

A useful measure of a society's taste for entrepreneurship is the number of new firms (Prescott and Ohanian 2014). This helps document a government's success in cultivating an entrepreneurial culture where people want to start a business and can do so quickly and efficiently. The number of firms matters because innovation is much greater for the economy as a whole than within individual firms. This is because "change in the economy is driven more by the entry and exit of firms than by the adaptation of individual companies" (Beinhocker 2006, 333). The difficulty of identifying individual companies as innovative was driven home by the example of Enron, an energy company that collapsed in an accounting scandal in 2001. *Fortune* magazine had named Enron "America's Most Innovative Company" for six straight years, until it became apparent that much of its success was due to fraudulent accounting and not innovation in energy markets (Ariely 2008, 196).

Canada's track record in creating new firms is unimpressive. After a brief spurt at the height of the resource boom in 2007-2008, the number of new firms starting business has been on a downward trend for a decade, according to Statistics Canada (Chart 2). A brief rebound in 2017 barely raised the number of startups above its low during the depths of the recession in 2009 and well below its pre-recession highs.

At some point, innovation is rooted in a society's culture and values. It is not surprising that the formation of new businesses lagged in France after polls in 2005 showed that three-quarters of French youths between ages 15 and 30 aspired to work for the civil service after graduating (Smith 2004, 51). People need the drive to change things, the talent to do it, and a receptivity to newness (Phelps 2013, 20). Attitudes to innovation and entrepreneurial skills can be taught, "certainly at the university and college level, and eventually … in high schools," according to a former clerk of the Privy Council (Lynch 2014).

Canada's recent governments have ignored a more entrepreneurial culture as part of their innovation policy, one that lauds private sector innovations everywhere from breakthroughs in oil sands technology to successful brands such as Tim Horton's or the organizational prowess of Couche Tarde. Instead, our political leaders continue to praise the "heroic" efforts of Canada's bloated and pampered public sector, while offering at best grudging acknowledgement of private sector efforts and innovations. Being a member of the *Forbes* 400 list of the richest people should be celebrated here, as in the US, as "a monetary sign of entrepreneurial activity that made life better" (Tamny 2015, 60).

Canada's political leaders could learn from Arthur Brooks's (2012, 144) advice to the US president, which is to wake up every morning and ask, "What will I do today to get the government out of the way of entrepreneurs?" Leaders need not imitate Donald Trump's promotion of an entrepreneurial culture. Former UK Labour Party leader Tony Blair, speaking as prime minister to an audience of venture capitalists in 1999, declared, "I want this government to be the champion of entrepreneurs. We need society as a whole to applaud you – you are the front-line troops of Britain's new economy" (quoted in Della-Giusta and King 2006, 627). This was a remarkable statement from Blair because historically both the Conservative elite and the traditional Labour Party in Britain "showed a certain snobbery towards people who had an idea, developed it and went out and made money" (Della-Giusta and King 2006, 630).

Promoting entrepreneurship and innovation is not mindless cheerleading of the business sector. Just the opposite, the emphasis should be on results. Currently, Canada's innovation policy rewards making an effort at activities like R&D rather than the outcome. This misses the very point, established early in this paper, that innovation needs to be validated by success in the marketplace. Unlike students in today's education system, innovators should not get awards just for participation.

Risk-taking by definition produces some failures. The very process of trial and error that underpins much innovation explicitly acknowledges that "error is failure" (Ridley 2020, 317). An important part of cultural support of entrepreneurial innovation is its attitude to failure. After all, "we make discoveries,

breakthroughs, and inventions in part because we are free enough to take risks, and fail if necessary" (Lewis 2015, 49). The inventor Thomas Edison exemplified the entrepreneurial spirit when reflecting on his many attempts to invent the light bulb: "I have not failed 1,000 times. I have successfully discovered 1,000 ways to not make a light bulb" (quoted in Malmgren 2015, 27). Henry Ford made the same point: "Failure is only the opportunity to begin again more intelligently" (quoted in Ridley 2020, 80). Losing their fear of failure is one reason so many entrepreneurs are dyslexic, according to Cohn: "The one trait in a lot of dyslexic people I know is that by the time we got out of college, our ability to deal with failure was very highly developed" (Gladwell 2013, 123).

Tom Jenkins, in a book on Canadian failures, concludes, "There's a stigma in Canada around failure" (2017, 64). Canada would do well to adopt Taleb's suggestion of a National Entrepreneur Day to honour failed businesses and entrepreneurs. Taleb proposes a proclamation to accompany this day of celebrating entrepreneurs: "Most of you will fail, disrespected, impoverished, but we are grateful for the risks you are taking and the sacrifices you are making for the sake of the economic growth of the planet and pulling others out of poverty" (2012, 80).

> *Canada's innovation policy rewards making an effort at activities like R&D rather than the outcome.*

Since innovation is disruptive and entrenched interests use government to preserve the status quo, the implication is that, as a general rule, "the weaker the government, the better it is for innovation" (Mokyr 1990, 180). This is because "when rulers are weak, they are typically unable to halt technological progress, much as they may try" (Mokyr 1990, 181). Mokyr argues that Europe's weak states and decentralized federations encouraged its Industrial Revolution, while strong central governments in Asia hindered progress (2016, 164).

The ability of markets freed from regulation to deliver innovation was on full display when the US deregulated its aviation and telecommunication industries in the late 1970s. This spawned new products such as overnight package delivery, discount airlines, the mobile phone revolution, and specialty cable TV channels (Levinson 2016, 113). Deregulation is an example of how, in the

absence of government protection of established players, "an economy with free markets and no government or cartel intervention is like a teen-aged youth; it makes a lot of mistakes but nonetheless grows rapidly without special effort or encouragement" (Olson 1982, 177).

Instead of creating an environment favourable to innovation, Canada's extensive web of government laws, rules, and regulations inhibits innovation and instead encourages rent-seeking and protection from competition (Cross 2014). Tyler Cowen cites research that shows concentration ratios are correlated with government regulations of business: "As government regulates business more, this favors corporations large enough to have substantial legal and compliance departments. Regulation serves as a kind of fixed cost of doing business, discouraging market entry" (2019, 89). It is notable that the decade with the highest MFP growth in Canada since 1970 followed the signing of the *Free Trade Agreement* in 1989, which dismantled our extensive array of trade barriers with the US.

Economists have recently emphasized the dangers of a "rent-seeking" society "in which the tax lawyer and the political lobbyist have replaced the inventor and the engineer as the entrepreneur's main instruments towards higher profits" (Mokyr 1990, 181). Mokyr concludes, "Political maneuvering is a zero-sum game at best, whereas technological change is a positive-sum game" (ibid.). Canada is particularly prone to some wealthy families exerting power through lobbying and rent-seeking for favours from government and regulators. The case of the Irving family in New Brunswick is a classic example but others include Thompson, Bronfman, and Pelardeau.

Canada's sheltered banking system is a good example of an industry that has "always prized stability above innovation" (Meredith and Darroch 2017, 60). Sheltered from foreign competition by government regulation, this stability has meant Canada has avoided financial crises for over a century. While this is a source of national pride, people elsewhere see that "Canada retained a far more tightly regulated banking system than the US – and as a result lagged behind in terms of productivity" (Ferguson 2012, 51). This is consistent with other research that societies "that have experienced financial crises have tended to grow faster than countries that have not experienced crises" (Gorton 2012, 177).

The *Paradox Lost* report suggests Canada needs some "small catastrophes" to give Canadian firms the experience and the need in making risk decisions when their survival is at stake (Council of Canadian Academies 2013, 29). The coronavirus pandemic may not meet this definition of a crisis with positive effects for innovation, as it is having a more devastating effect on small firms than larger ones which will become more entrenched than ever with increased government support and less competition from the fewer surviving small firms.

Canada lacks one other key cultural trait necessary for an innovative society: a rebelliousness of spirit opposed to the established order. Instead, Canada's culture is built on "peace, order, and good government." This may avoid the internal upheavals seen in the US during its Civil War, the 1960s, and the polarizing political atmosphere since Trump's election in 2016, but it also results in fewer commercial innovations.

Canada's sheepish attitude was on full display during the recent pandemic. Our political leaders literally boasted about outsourcing their entire policy response to the medical community, including such basic considerations as who to allow in and out of Canada and what industries were allowed to re-open under what circumstances.[20] Quebec's deputy premier congratulated the population for its "docility" and "obedience" to the decrees of political leaders acting hand-in-hand with health officials. Such qualities are admirable in one's dog but do not form the basis of an entrepreneurial culture. David Brown offers a devastating critique of how following the rule of experts is the polar opposite of the entrepreneurial spirit: "We've become a society of rule-followers and permission-seekers. Despite our can-do self image, what we really want is to be told what to do. When the going gets tough, the tough get consent forms" (Clark 2008, 85).

The future of innovation

Technological change continues to spur the growth and exchange of ideas, which is a powerful force for more innovation when properly used. The proliferation of ideas and ways to combine them innovatively is increasing with the expansion of global communications on the Internet. Romer notes, "Every generation has underestimated the potential for finding new recipes and ideas. We consistently fail to grasp how many ideas remain to be discovered" (quoted in Naam 2013, 122). General purpose technologies such as electricity or the steam engine took decades to reach their full potential (*Economist* 2013, 23). Innovations fuelled by cheap processing power are just beginning, especially as the Internet and social media facilitate communications and networks. As these technologies mature, Milanovic foresees "the dissipation of rents accrued in the early stages of the technological revolution. As the revolution progresses, other people and companies catch up with the early innovators, rents are reduced or eliminated, and income inequality shrinks" (2016, 114).

The impact of communications and information technology is becoming more diffuse in other industries. Technology is evolving rapidly for fully autonomous vehicles (including trucks, drones, aircraft, and boats; Schwab 2016, 15), smart homes and cities, long-distance surgery and bioprinting, autonomous and 3D manufacturing, artificial intelligence, reduction of carbon emissions, and advanced virtual reality (Gingrich 2019, 107-108). One day

we will swallow a pill-sized nanocomputer to monitor our biochemistry and organ function (Carr 2014, 201) and take medication tailored to our DNA (Kelly 2016, 69).

However, the pace of innovation is not predictable. Innovation has been slower than the expected pace in areas such as self-driving vehicles, pharmaceuticals, robotics, artificial intelligence, and nanotechnology (Cowen 2010, 42-43). Besides the inherently unpredictable nature of innovation, this may also demonstrate how a number of processes today limit innovation.

Some of the inputs into disruptive innovation – imperfect as they are about innovation outcomes – have been declining for over a decade. The number of businesses being launched is falling; the average age of business is rising; job creation and destruction are down; and firms are consolidating. Before 2000, some of these trends reflected mom-and-pop retail stores being replaced by Walmart, but the trend has continued unabated after 2000, driven by "winner takes all" first movers in technology, which has increased corporate concentration (Greenspan and Wooldridge 2018, 396).

"Not even the Internet is an ideal network, any more than networks within a bureaucracy are good for innovation.

More generally, there are several indices of what Tyler Cowen calls "stultification." Canadians, like Americans, "are in fact working much harder than before to postpone change, or to avoid it altogether" (Cowen 2017, 1). We move less often between provinces; we change jobs less frequently; we start fewer new businesses; we more often marry people from our own class; we build moats around our work with occupational licences, let computer algorithms channel us to information sources that conform with our world view. People who innately resist change will not be innovative in the economy.

Nor is it automatic that information flows and networks will proliferate in today's world. They are not ensured by the Internet, urbanization, or globalization, with the latter two clearly threatened by the lockdown in major cities during the coronavirus pandemic. Not even the Internet is an ideal network, any more than networks within a bureaucracy are good for innovation. One drawback of the Web is that entering a search item into Google "triggers an instant auction that determines the order in which advertisements appear. This is especially true for the all-important first page of search results. What

matters here, the way power is exercised, is what is excluded – the vast number of relevant websites that we do not see" (Wajcman 2015, 179).

It may be surprising in a world with more connections than ever before that even tech companies are prone to internal network failures. However, evolutionary biologists say, "Human beings have a deep capacity for isolationism, for fragmenting into groups that diverge from each other. … People do their utmost to cut themselves off from the free flow of ideas, technologies and habits, limiting the impact of specialisation and change" (Ridley 2010, 72-73). So while the Internet gives us potential exposure to more new ideas, we can also choose to shut ourselves off in silos with like-minded people.

Also working to slow global innovation are an increase in corporate concentration, especially within the technology field itself, and the restrictions dictatorships such as China put on information flows. However, there is reason to believe that both these forces inhibiting innovation could be self-limiting.

Studies find that macroeconomic inefficiencies result when large corporate sectors are controlled by a few participants (Fogel et al. 2006, 555). The increase in concentration may be largely the result of the initial diffusion of Internet technology we are currently living through. The dominance of past technological giants such as Microsoft and IBM did not stop invasive new technologies from other industries quickly overtaking them, leaving their assets stranded, like France's Maginot Line was bypassed overnight by German tank columns in 1940.

In fact, the very dominance and profitability of several large tech firms today may itself undermine their ability to adapt and compete in the future. Schumpeter argued that one of the reasons capitalism was so dynamic is that successful businesses soon find themselves standing on ground that is "crumbling beneath their feet" (quoted in Greenspan and Wooldridge 2018, 397). Firms that control more market share and are insulated from competition by barriers to entry will feel less urgency to innovate. Studies have found that "corporate productivity, unlike urban productivity, didn't increase with size. In fact, the opposite happened: as the number of employees grew, the amount of profit per employee shrank" (Lehrer 2012, 209). This is because as firms grow, this limits "the very interactions that lead to new ideas. They erect walls and establish hierarchies. They keep people from relaxing and having insights. They stifle conversations, discourage dissent, and suffocate social networks" (ibid.). Large conglomerates become focused on the mechanics of management rather than innovative products (Greenspan and Wooldridge 2018, 320). Ridley calls a whole section of his book on innovation "Big Companies Are Bad at Innovation" because they are bureaucratic, vested in the status quo, and become inattentive to their customers (2020, 294).

Nations too will find that less competition undermines their ability to innovate and compete in the long run. Some countries have deliberately cut themselves off from the free flow of ideas. China today is the leading example of restricting the flow of information and ideas, which harms innovation. Henry Paulson, the former US treasury secretary, concludes in his book *Dealing with China*, "You can't run a successful business cut off from the world" (quoted in Dobson 2019, 47). China's blocking of online access to Google, Facebook, YouTube, and many other staples of the World Wide Web is called the "Great Firewall of China." Withdrawing from the free exchange of ideas is one reason that China's technological innovation has lagged. Outside of 3D printing and robots (WIPO 2015, 13), China's main forays into technology have been in security cameras, crowd analysis, and facial recognition technology (Gingrich 2019, 57). Canada's prime minister Justin Trudeau expressed admiration for China's authoritarian efficiency but ignored its lack of innovation, demonstrating his misunderstanding of Smithian versus Schumpeterian innovation.

China will one day have to acknowledge that restricting ideas puts a ceiling on its ability to innovate and grow. China's strict control of the flow of information, sclerotic centralization, fixation on stability, and cronyism are the very opposite of the approach to innovation advocated throughout this paper. Instead, this paper has emphasized the need "to encourage people to meet, exchange ideas, to have the freedom to explore things – and then new products, new technologies, new ideas will emerge from that process, rather than government trying to plan the outcome" (Ridley 2015c). Some of the most successful innovations at Google and Amazon were based on personalizing search engine or shopping results, while Facebook's model allows for personalized news and advertising (Ridley 2020, 211). It is difficult to see how a regime built on state control of individual actions and thoughts will master this vein of the personalization of products to the individual.

Conclusion

In his book *Capitalism, Socialism and Democracy*, Schumpeter argued the modern economy is characterized by long periods of relative stability interrupted by shocks that are followed by a period of stabilization: "Rather than cycles, we are led to think of a sequence of punctuated equilibria" (Becker et al. 2011, 18). Today the world is living through its biggest shock since the Second World War.

However, a period of upheaval can boost a nation's progress over the longer term. Mancur Olsen (1982) argues, "Countries whose economic foundations have suddenly been shaken tend to grow and innovate faster than more stable nations, as dramatic change becomes an issue of national survival" (see also Atkinson and Ezell 2012). For example, while the 1930s are viewed as a

time of widespread economic decline, numerous studies show it was a time of widespread innovation[21] and rapid growth in productivity (Gordon 2016, 547). The 1930s demonstrate that innovation can thrive even in a depressed economy, showing how today's turmoil can help lay the foundation for improved growth tomorrow.

The high-tech industry provides other examples of innovative businesses born in difficult circumstances. The 1974-1975 recession in the US was on a par with the severe 2008-2009 downturn, in part because both accompanied a financial crisis (unlike in Canada, which did not have a financial crisis in either period; see Cross 2016, 23). Nevertheless, Microsoft and Apple both started operations soon after the recession ended in 1975 and went on to dominate global technological innovation for decades. Similarly, the widely disparaged dot-com boom and bubble of the late 1990s helped transform Google and Amazon into today's behemoths (Sharma 2016, 220).

> *[The] dot-com boom and bubble of the late 1990s helped transform Google and Amazon into today's behemoths.*

The unique nature of the 2020 pandemic means entrepreneurs can help bring it to an end through new treatments of the coronavirus or vaccines that help immunize most people. Beyond medicine, innovation will have to play an even larger role for a full recovery of the economy from its government-mandated coma. The coronavirus pandemic overnight destroyed the business models of established firms and whole industries such as department stores, eat-in restaurants, and many modes of travelling. This opens up the landscape for new firms to flourish with innovative ways of delivering services such as at-home shopping, entertainment, and telework or entirely new ways of meeting the human need for face-to-face interaction. This is a classic opportunity for Schumpeter's creative destruction, where we have already seen much destruction and now wait for an offsetting creative response.

Canada can use this period of upheaval to renew and grow its economy. However, taking full advantage requires the cultivation of a more entrepreneurial mindset in our culture, a long-overdue shift. The current federal government has displayed its distrust and dislike of business by dragging its feet putting in place measures to support their survival and recovery even as it showered billions in income transfers on households.[22] The priority needs to be restoring earned incomes, partly to pay for the huge expansion of government

debts during the pandemic. The least expensive and possibly the most effective way of boosting incomes is to change the political rhetoric and societal attitudes so entrepreneurs, investors, and innovators know that government will actively welcome and encourage their efforts and not raise taxes and regulations to interfere with plans to renew and expand their businesses.

Implementing changes to bolster a more entrepreneurial culture will take time, but less than the decades already wasted on government efforts to boost innovation through changing the supply of inputs. Cultivating a more innovative and entrepreneurial culture is less ambitious than the regular calls for a shift to a "green economy" since it would add to, rather than subtract from, our standard of living. Encouraging innovation and entrepreneurship will have an immediate payoff, notably reassuring the business community that government regulations and taxes will be curbed and the attitude of political leaders will be more positive. Other changes to culture, notably attitudes to risk-taking and failure and educating students with the skills needed to be entrepreneurial, will take longer. However, their payoff can be measured in terms of higher growth that would be sustained for years.

About the author

Philip Cross is a Munk Senior Fellow at the Macdonald-Laurier Institute. Prior to joining MLI, Mr. Cross spent 36 years at Statistics Canada specializing in macroeconomics. He was appointed Chief Economic Analyst in 2008 and was responsible for ensuring quality and coherency of all major economic statistics. During his career, he also wrote the "Current Economic Conditions" section of the Canadian Economic Observer, which provides Statistics Canada's view of the economy. He is a frequent commentator on the economy and interpreter of Statistics Canada reports for the media and general public. He is also a member of the CD Howe Business Cycle Dating Committee.

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Endnotes

1 Despite their reputation for economic depression, the 1930s saw steady increases in corporate spending and hiring for research; outlays in the US rose from US$120 million in 1931 to US$175 million in 1938 and personnel from 30,000 to over 40,000, partly because hiring scientists, engineers, and technicians was so cheap. See Baumol (2002, 268).

2 Paul More, in his 1915 biography of Disraeli, observed the political dimension of this dichotomy: "Conservatism is in general the intuition of genius, whereas liberalism is the efficiency of talent." Quoted in Kirk (1953, 121).

3 Of these 39 important innovations, 26 occurred between 1920 and 1950, laying the foundation for the postwar surge of growth. See Gordon (2016, 556).

4 The first reference to the term "entrepreneur" was by Richard Cantillon in 1759 for someone who specialized in taking risks by buying output from workers for resale before consumers had expressed how much they are willing to pay (Casson et al. 2006, 3).

5 However, Say also admired Adam Smith enough to translate the *Wealth of Nations* into French.

6 The productivity approach to studying innovation need not be as straightforward as measuring inputs and outputs. The question remained whether MFP was exogenous or endogenous to the economic system: Did it appear as "manna from heaven" as in Solow's original formulation or was it the product of the market system as Romer postulated?

7 Although autos today would be recognizable to people from the early 20th century, reflecting that, as one trade journal admitted, "there has been no major innovation in car technology this [20th] century" (quoted in Engler and Mugyeny 2011, 133).

8 However, these same financial products were sold in Canada without the negative consequences as in the US, showing it was not just the product innovation that was at fault but also the taste for risk taking in both firms and regulators.

9 Gault (2003, 263) wrote, "That systematisation is the logical next step."

10 The GII is co-produced by Cornell University and the United Nation's World Intellectual Property Organization.

11 This has proved no more satisfactory than the System of National Accounts convention of using labour inputs to measure the output of public services, notably health care and education.

12 McCloskey (2016, 76) also calls it "innovism."

13 Even esteemed economists such as Paul Samuelson were led to believe high growth in the USSR was sustainable, predicting in 1967 its GNP would surpass the US by 1990 (O'Sullivan 2006, 256).

14 Another famous version of the same sentiment was Peter Thiel's quip that "We wanted flying cars, instead we got 140 characters" in a disparaging lament about Twitter (Gordon 2016, 566).

15 Some also argue that California's legal system encourages innovation, with Ridley (2020, 322) citing the legality of dual-share ownership while Licht and Siegel (2006, 523) point to more freedom for employees to share information with new employers.

16 Samuelson (1997, 120-121) writes, "The myth of management was (and is) that some sort of quasi-science could put capitalism's jarring process of experimentation, exertion, and excess behind us."

17 The powerlessness of government to anticipate, never mind control technology, is underscored by recalling how Bill Clinton in the aftermath of his election in 1992 had the "finest minds in the country assembled in Little Rock to discuss how to get the economy moving again. Having spent twelve years in the wilderness, the Democratic policy elite was plotting a return to greatness. There was talk about education and trade policy, hours of discussion and thousands of papers, much posturing and bloviating. In all the papers, Summers recalls, one term was conspicuously absent: the Internet" (Gross 2012, 26).

18 The authors even claim the lack of innovation in the US led to an over-reliance on finance, creating the Great Financial Crisis.

19 Quoted in David (1975, 37). *Henry II*, Part I (Act III, scene I).

20 Christian Leuprecht (2020, 8) observed how "the prime minister's daily press conference offers a reminder of the extent to which executive decision-making has, for all intents and purposes been delegated to an unrepresentative, narrow, unelected subset of subject matter experts."

21 Both Schmookler and Mensch count the peak of product innovations in 1935-1939, falling to zero by 1955-1959 (Field 2011, 108).

22 The priorities of the government were reflected in the take-up of support programs by households and businesses. Over 8 million households responded to the $2000-a-month Canada Emergency Response Benefit, far more than anticipated, while fewer than expected firms signed up for either the wage subsidy or rent relief, partly because firms themselves were asked to share either a financial or paperwork burden they could not afford (see Cross 2020).

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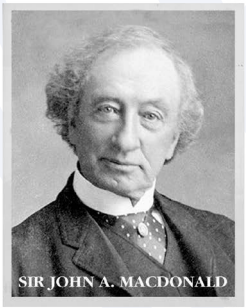
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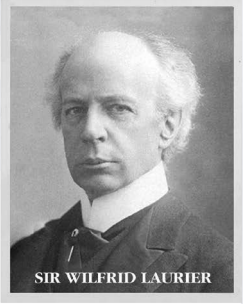
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