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# ABSTRACT

## Industrialization under Medieval Conditions? Global Development after COVID-19

Industrialization is vital for inclusive and sustainable global development. The two engines of industrialization – innovation and trade – are in danger of being compromised by the COVID-19 pandemic, under conditions increasingly reminiscent of the medieval world. It comes at a time when innovation had already been stagnating under guild-like corporate concentration and dominance, and the multilateral trade system had been buckling under pressure from a return to mercantilist ideas. The COVID-19 pandemic may cause a permanent reduction in innovation and entrepreneurship and may even bring the 4th industrial revolution (4IR) to a premature end. Hence the post-COVID-19 world may be left with trade as the only engine for industrialization for the foreseeable future. If the global community fails to fix the multilateral trade system, the world may start to resemble the Middle Ages in other, even worse, aspects.

**JEL Classification:** F01, F13, L26, L52, O25, O30

**Keywords:** COVID-19, innovation, trade, development, industrialization, industrial policy

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# 1 Introduction

Industrialization has, most spectacularly since the late 18th century, driven global development. The manufacturing and trade of goods, using increasingly sophisticated technology and labor, have resulted in considerable gains in productivity, consumption, incomes, and general welfare, and remains essential for development (Naudé & Szirmai, 2012; Haraguchi et al., 2017). The rise of manufacturing has been due to the interdependent effects of innovation and trade. Innovation brought new production methods into being, while trade opened up broader markets, allowed specialization and scale economies, and incentivized and spread innovation (Grossman & Helpman, 2015; Thierer, 2016). In short, trade and innovation have been the two engines of industrialization over the past three centuries.

The COVID-19 pandemic, which broke out at the end of 2019, created severe health and economic crises. For instance, the pandemic resulted in more than a million confirmed deaths by October 2020. It places the pandemic amongst the top 6 pandemics since the 14th century (Jorda et al., 2020). As an economic crisis, COVID-19 is amongst the worst since the Second World War, with global GDP likely to shrink at least by 6,2 percent in 2020 (World Bank, 2020). The repercussions of these health and economic crises on industrialization could be substantial. If we want to understand how the COVID-19 pandemic will affect industrialization, and if we want to know how best policymakers should adjust their industrial policies after the pandemic, we need to know how the pandemic will impact on innovation and trade, its two engines.

Impacts will play out over both the short and the long-term. Six months into the pandemic, it is clear that the short-term effects were, as was expected, dramatically negative. It is evident in a sharp decline in new business startups, an increase in actual and expected firm failures (Bartik et al., 2020; Bosio et al., 2020; Fairlie, 2020), and a steep decline in trade (CCSA, 2020). If it was only a once-off, transient shock, one would expect the world to return to pre-2020 trends soon and move on, with a resumption of pre-COVID-19 industrial policies. However, if the COVID-19 shock is longer-lasting, or will have more long-term, persistent consequences, such impacts will have more severe implications for industrialization. The questions therefore are, what are the likely long-term, lasting impacts of the crisis, and how can these be mitigated?

In the remainder of this paper, an attempt to give a preliminary answer to these will be made. In section 2, the long-term consequences for innovation are explored. Section 3 deals with long-term impacts on trade. In section 4, the long-term implications for innovation

and trade are evaluated through the perspective of the already worrying decline in innovation and science that characterized the world before the outbreak of COVID-19. Section 5 concludes that the world circa 2020 has a growing number of features in common with the medieval world, which has been further exposed by the COVID-19 pandemic. These include an increasing market concentration, dominance and defensive innovation by large superstar and zombie firms - reminiscent of medieval industrial Guilds and Feudal overlords; a return of Mercantilist notions to center stage as far as trade is concerned; and a rise in anti-science sentiment. The challenges for industrial policy under such sub-optimal Medieval-like conditions are discussed.

# 2 New Industrial Guilds?

If we consider previous crises, such as the 2008-2010 global financial crisis, or the 1930s Great Depression, we see long-lasting impacts on innovation and related measures such as entrepreneurship (Shiller, 2020). For instance, evidence indicates the Great Depression harmed technological entrepreneurship and innovation in the USA for more than seventy years (Babina et al., 2020). And entrepreneurship in the USA, as measured, for instance, in the annual number of startups or the establishment opening rate, has not yet recovered to pre-2009 levels following the global financial crisis (Naudé, 2020b).

There are several reasons to be concerned that the COVID-19 crisis will, indeed, as previous crises, be followed by long-lasting reductions in innovation. One mechanism is through increasing inequality. Previous pandemics have been associated with rising inequality (Furceri et al., 2020), and that this is also likely to be the case with COVID-19. For example, Palomino et al. (2020) expect income inequality in European countries to rise by between 2 and 21 percent. This is bad news for innovation because inequality, after certain levels, tends to reduce innovation (Doucouliagos, 2017).

Another mechanism through which the COVID-19 crisis can cause a reduction in innovation is through further increasing market concentration and "superstar" firm dominance, as well as having as an unintended side-effect the prolongation of so-called "zombie firms" (McGowan et al., 2017). Even before the pandemic broke out, a growing literature documented the decline in innovation associated with superstar market-dominance and zombie firms, including through "defensive" innovation (Akcigit & Ates, 2019; Dinopoulos & Syropoulos, 2007; Song et al., 2015).

The COVID-19 pandemic can deeper entrench market dominance through the further shift towards online trade and automation as accelerated by the pandemic (Bloom & Prettner, 2020), by rising government spending on bailouts (The Economist, 2020a,b), and the long-term impacts of the likely permanent reduction in startups / new firm entry (Fairlie, 2020; Sedlacek & Sterk, 2020; OECD, 2020). As put by *The Economist* (The Economist, 2020a), the "splurge" by governments to rescue large corporations could lead over the long term to "a vast and lasting expansion of the state together with dramatically higher public debt is likely to lead to a lumbering, less dynamic kind of capitalism."

The fact is that the world is already experiencing a very undynamic form of capitalism, labeled as "platform capitalism" (Srnicek, 2016) as well as a stagnating type of capitalism, characterized by "declining business dynamism" (Decker et al., 2017). The growing list of scholars and authors diagnosing contemporary capitalism to be in - possibly terminal - crisis includes Collier (2018) and Milanovic (2020). To this list can be added growing concerns about the robustness and future of democracy, as *Freedom House*[1] warns that "a shift in the global order is challenging long-standing democracies. . . . With many citizens expressing doubts that democracy still serves their interests."

The high and rising levels of market concentration, declining new firm entry, defensive innovation, zombie firms, return of big government, and democracy in retreat can perhaps remind one of the conditions that pertained under industrial guilds and feudal overlords during the Middle Ages. It is worth recalling that after Germany's unification in the 1870s and subsequent industrial revolution, the reform of its system of industrial guilds was imperative, as it was standing in the way of adopting new industrial innovations[2] (Ogilvie, 1996, 2004).

# 3 A Return to Mercantilism?

As far as trade is concerned, the World Trade Organization (WTO)[3] has shown that the growth trend in world merchandise trends permanently slowed down after the 2009 global financial crisis - see Figure 1. Whether it will do so again after the COVID-19 pandemic is in my view still an open question, although Razin (2020) makes a good case that the COVID-

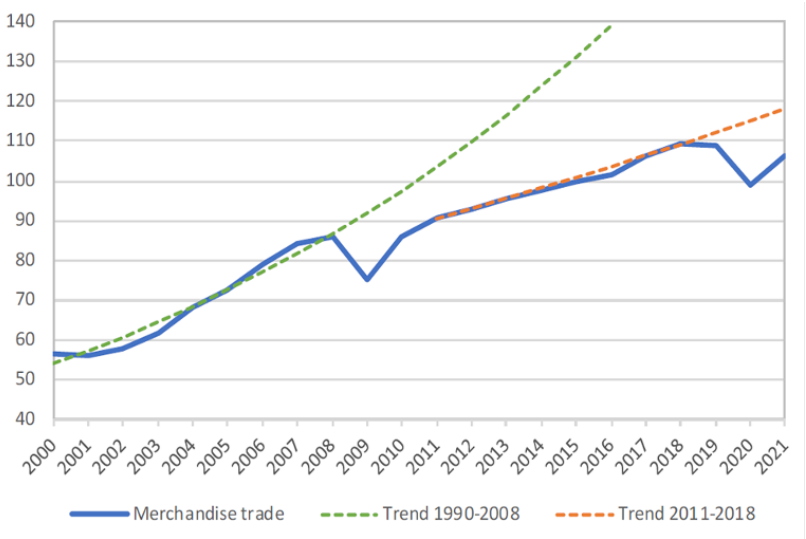
[1] See `https://freedomhouse.org/report/freedom-world/2019/democracy-retreat`.

[2] Ogilvie (1996, pp.286-287) describes how the guilds constrained innovation by reference to the case of how "the Remscheid scythe smith's guild successfully resisted the introduction of water-driven scythe hammers in the 18th century" – See also the discussion in Naudé & Nagler (2018).

[3] See `https://www.wto.org/english/news_e/pres20_e/pr862_e.htm`

19 pandemic will "add further momentum" to de-globalization that had already started a decade ago. How strong this further momentum will be, will partly depend on the nature of the contraction in global GDP. So, for instance, it seems that merchandise trade was less affected during the COVID-19 crisis than during the global financial crisis.[4] The WTO has pointed out that "the volume of world merchandise trade is only expected to decline around twice as much as world GDP at market exchange rates, rather than six times as much during the 2009 collapse." Indeed, according to the RWI/ISL Container-Throughput Index[5] , by July 2020, trade had recovered to before 2020 levels, and "cargo handling in Chinese ports again reached an all-time high" in July 2020.

Figure 1: *World Merchandise Trade, 2000 - 2021*




*Data source*: World Trade Organization, at `https://www.wto.org/english/news_e/pres20_e/pr862_e.htm`.

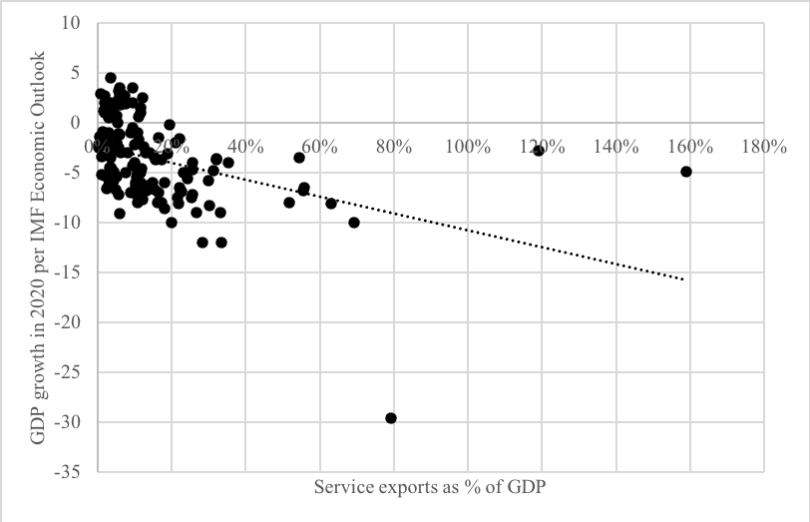
Trade has been, at least over the short-term so far, more resilient during COVID-19 than during the global financial crisis. A possible reason is that during the global financial crisis expenditure shifted away from tradeable to non-tradable and non-durable goods (Eaton et al., 2016). In contrast, during the 2020 COVID-19 crisis, there has not been a similar relative shift in expenditures towards services, because services sectors, including travel, tourism, and hospitality services, were effectively locked down, whereas, in contrast, production and distribution of physical goods could continue with relatively fewer restrictions, given that they require less face-to-face interaction (Avdiu & Nayyar, 2020).

[4]The glaring difference in trade in medical supplies: more than 90 countries restricted exports of medical supplies such as personal protective equipment (PPE), ventilators and respirators amongst others (Desta, 2020).

[5]See `https://www.isl.org/en/containerindex`

Thus, during COVID-19, we have seen a relative expenditure shift towards tradeable, manufactured goods away from services, thus benefiting countries and regions with manufacturing industries more. Preliminary data available tend to support this, in those countries where services trade was more critical suffered significantly more in terms of GDP contractions – see Figure 2.

Figure 2: *Countries more dependent on Service Exports tend to suffer more significant declines in GDP growth*




*Data source*: Author's calculations based on data from the World Bank Development Indicators online and the IMF World Economic Outlook, April 2020.

Hence countries with more substantial manufacturing sectors and other goods-producing sectors such as agriculture and mining were thus more resilient during the pandemic. This experience is likely to reinforce the well-founded notion that what a country produces and exports matters and that diversification of production and trade is welfare-enhancing and protect against external shocks and volatility (Cadot et al., 2013; Hidalgo et al., 2007).

With industrialization, in particular manufacturing, still mattering and indeed having been showed to be essential for volatility reduction and resilience during the COVID-19 pandemic, one should be gravely concerned for the anti-trade (and anti-globalization) backlash that has become evident in recent years (Macgregor-Bowles & Bowles, 2017; Dür et al., 2020; Razin, 2020). In particular, just as COVID-19 illustrated the importance of open trade, the ability of countries to industrialize through trade is being thwarted by the rise of economic nationalism (Born et al., 2019) and the increased marginalization of the WTO (Bagwell et al., 2016). In the latter regard, Jean (2020, p.137) refers to the violation of the WTO's Agreement on Subsidies and Countervailing Measures (SCM) by many countries in an attempt to support

their domestic industries during the crisis and concludes pessimistically that "the pandemic and the ensuing structural changes can only add to the feeling that WTO rules have been conceived in a context that differs substantially from the one we are living in, increasing the risk of a loss of legitimacy. The rules-based trading system is threatened with irrelevance, and the inability of the WTO to play an active role in coordinating responses since the outbreak of the crisis does not help to assuage these concerns."

Economic nationalism and the jettisoning of the rule-based trading system, all fueled by anti-globalization sentiment, is sending the world back into what could perhaps be described as a return to Mercantilism (Barro, 2019). It is reflected in China's neo-Mercantilism (Yu, 2019), the growing popularity of the so-called "Beijing Consensus" amongst developing countries (Halper, 2010), the USA-China trade war[6] (Chong & Li, 2019), and even the Brexit (Born et al., 2019). If not precisely medieval, we are experiencing a distinctly 19th-century approach[7] to trade and geopolitical rivalry (Dent, 2020).

This Mercantilism will not only be detrimental for industrialization by restricting the benefits of trade but ultimately damaging for global health outcomes and the ability of the world to respond to current and future pandemics. Macgregor-Bowles & Bowles (2017) note at least four pathways through which Mercantilism and the rise of anti-globalization could lead to a deterioration in global health, namely through promoting protectionism, increasing xenophobia, rising military spending (which crowds out aid and health budgets), and by exacerbating climate change. Besides, Mercantilism tends to spill over into other terrains – including health. During the COVID-19 pandemic, the mercantilist-inspired USA-China trade war concretely spilled over into the health sphere, as reflected in the politicization of the WHO, which caused Fidler (2020) to warn that "The manner in which China and the United States politicized COVID-19 for geopolitical purposes bodes ill for international health cooperation."

[6]With reference to the USA-China trade war US President Trump has notoriously stated on Twitter that "Trade wars are good, and easy to win." They are neither. See `https://www.theatlantic.com/ideas/archive/2019/08/trade-wars-are-not-good-or-easy-win/595546/`

[7]Or, as Rampell (2018) writes in the Washington Post "Trump's trade policy is stuck in the '80s - the 1680s." As the above paragraphs makes clear with reference to China's neo-Mercantilism, the Beijing Consensus and the Brexit, it is not only in the USA where regressive trade policies are holding sway.

# 4 Is the 4IR Facing a Premature Demise?

That the world is increasingly characterized by conditions which remind of previous centuries, such as the rise of new "Guilds" and neo-Mercantilism, is accentuated by the fact that even before the COVID-pandemic broke out, the world was being characterized by stagnating innovation and a rising anti-science sentiment. This significantly weakens the prospects of industrialization, particularly so as this pre-existing condition may be exacerbated by the COVID-19 pandemic - as the previous two sections argued. In this section, I will consider in more detail the pre-existing condition of stagnating innovation and anti-science sentiment, to try and understand whether industrialization may be viable after the pandemic, and if so, what this means for the so-called 4th Industrial Revolution (4IR).

That the world was suffering from stagnating innovation before catching the COVID-19 pandemic is perhaps surprising to some, but generally uncontroversial. Gordon (2012, 2016) and Cowen (2010, 2016, 2017) contains essential expositions of the "Great Stagnation" and Ridley (2020) describes the extent and reasons of the "innovation famine". Naudé & Nagler (2018) document the long-term decline in Germany's innovation, showing its current industrial structure and big corporations were inherited mainly from its very innovative late-19th century.

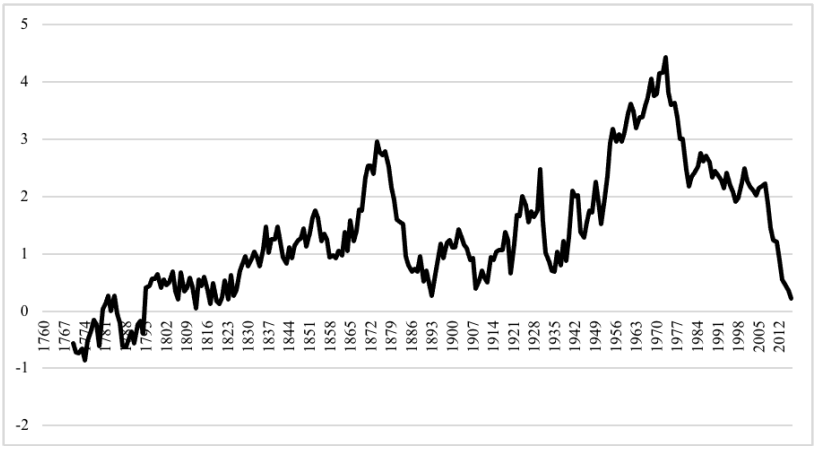
Bloom et al. (2020) ascribe the decline in innovation to the possibility that "ideas are getting harder to find" concluding that the USA must double its research effort every 13 years to counter the effect of ideas getting harder to find. Erixon & Weigl (2016, pp.10-11) ascribes the decline in innovation instead to defensive corporate strategies, which is reflected in a lack of corporate renewal, pointing out that "In Germany's DAX 30 index of leading companies, only two were founded after the 1970s. In France's CAC 40 index there is only one. In Sweden, the 50 biggest companies were created before the start of World War I in 1914 and the remaining 20 were founded prior to 1970. If you compile a list of Europe's 100 most valuable companies, none were actually created in the past 40 years."

In section 2 the consequences of defensive innovation by market-dominating superstar and zombie firms were described. It was argued that the COVID-19 pandemic might consolidate and even strengthen the market power of incumbent firms and depress further the entry of new firms, thereby further undermining the potential for corporate renewal. Moreover, large incumbent firms will be even more likely not only to engage in defensive innovations such as creating patent thickets or buying up new ventures but moreover utilize these expressly to limit the diffusion and spread of new knowledge (how innovation and trade historically

contributed to industrialization) – which will further make new ideas harder to find. After all, as Akcigit & Ates (2019, p.3) "when knowledge diffusion slows down, market leaders are shielded from being copied, which helps establish stronger market power."

Innovation, an engine of industrialization, is therefore becoming less and less effective in fulfilling this role. Whereas the 1st and 2nd Industrial Revolutions were characterized by large gains in labor productivity growth and subsequent wage increases, labor productivity growth in the West has stagnated since the 1970s and decoupled from wage growth (Brynjolfsson & McAfee, 2016). The decline in labor productivity growth since the 1970s has been notable in many Western economies – see Gordon (2018). It is perhaps most dramatically seen that labor productivity growth in Great Britain has declined by 2016 to its lowest rate in more than 200 years – see Figure 3.

Figure 3: *Labor Productivity Growth (GDP per hour worked) in Great Britain, 1770-2016 (10-year moving average)*




*Data source*: Author's calculations based on A Millennium of Macroeconomic Data by the Bank of England, available at `https://www.bankofengland.co.uk/statistics/research-datasets`.

As a result of the declining labor productivity growth rate, potential GDP growth has declined in affected economies, for instance, from 2,1 percent in 1998 to 1,0 percent in 2015 in the OECD (McGowan et al., 2017). There is another implication of the decline in innovation and labor productivity that is relevant to the discussion on industrialization post-COVID-19. That is that the so-called 4th Industrial Revolution (4IR), which has, in recent years become a leitmotiv in virtually all countries' industrial policies, may after the pandemic face a premature demise. There are several reasons for this, which I will discuss in the remainder of this section.

First, mention has already been made that all previous real industrial revolutions were

accompanied by rising labor productivity growth. The 4IR is conspicuous by the absence of wide-spread labor productivity growth and the absence of mass technological unemployment, as was expected by some (Gries & Naudé, 2020). There are of course some firms - the minority - that benefit in terms of productivity from 4IR technologies, but as Andrews et al. (2016) note, the laggards are far more prevalent. It could of course also be the case that there are implementation lags and that the productivity gains are still in the future (Brynjolfsson et al., 2017) - see for instance the example in Juhász et al. (2020) of the diffusion of mechanized cotton spinning in France during the 1st Industrial Revolution. The problem is, that if this is the case for 4IR technologies, then the COVID-19 pandemic, and the declining innovation, rising concentration and de-globalization that it is accompanied with, will only serve to further delay the diffusion of technologies.

Second, many of the critical technologies espoused as 4IR technologies, such as Artificial Intelligence (AI), advanced computing, connectivity (the Internet of Things), 3D-printing, and renewable energies, have not (yet) lived up to their promise. To start with, consider that innovation in renewable energy has been characterised by a decline in patenting, start-ups and venture capital since around 2010 and that still less than a fifth of US electricity is generated by renewables (Popp et al., 2020). Globally only 11% of primary energy needs are met by renewable energies.[8] And 3D-printing (additive manufacturing), a technology from the 1980s, has so far failed to ignite a global revolution in localized small-scale niche manufacturing, remaining essentially restricted to create (very usefully) molds and models (Tserovski et al., 2019). As Kleer & Piller (2019, p.23) recently pointed out "Wide adoption of this technology is predicted but not yet achieved" - they refer to a Delphi study on the future of additive manufacturing finding " large uncertainties and little consensus among the participating experts."

Perhaps one of the most hyped technologies of the 4IR is AI. Thus, it is notable that AI has been of relatively little value in fighting the pandemic (Naudé, 2020a). Instead, as Rotman (2020) remarked, "our most effective response to the outbreak has been mass quarantines, a public health technique borrowed from the Middle Ages." Moreover, instead of revolutionizing manufacturing as some are touting[9] AI to do, AI is not diffusing fast, nor is its technical potential yet attained. AI remains expensive, mostly out of reach of small businesses, who do not have access to large enough data-sets to train AI models, as well as not safe enough, and increasingly burdened in its implementation by (expensive) regulations (Naudé, 2019; Far-

[8]From Our World in Data: `https://ourworldindata.org/renewable-energy`

[9]See for instance this article in MIT Technology Review : `https://www.technologyreview.com/2020/09/29/1008933/how-ai-will-revolutionize-manufacturing/`

boodi et al., 2019). Moreover, whereas many had pinned their hope on the 4IR to promote green industrialization, it is increasingly evident that AI, at least in its current form based on Machine Learning (ML), comes at a substantial environmental cost. Schwartz et al. (2019) report that "Training a large, deep-learning model can generate the same carbon footprint as the lifetime of five American cars, including gas."

Like AI remaining limited in adding real value to manufacturing on a broad and sustainable scale, so too do we yet have to see the potential of the Internet of Things (IoT), 3D-printing (a 1980s technology), and renewable energy to be realized. In their book *The Internet of Things Myth*, Hatton & Webb (2020) make the point that "Unlike the home environment where Wi-Fi is universal, there is no standard for connecting distributed IoT devices. There have been a number of pretenders to the throne, but no single technology has yet emerged around which the whole IoT ecosystem can converge. Neither does there seem to be a single viable candidate, despite what the proponents of 5G might claim." And despite digital technologies, our transportation systems are hardly significantly better than the 1950s. Preston & Waterson (2015) remark that "Railways were being rolled out rapidly from the 1830s, while the commercial breakthroughs in petrol and diesel engines date to 1876 and 1892 respectively. Even the jet engine that made mass aviation possible can be traced back to Frank Whittle's first patent in 1932 [...] Despite decades of futuristic predictions, modern transport wouldn't look all that different to someone from the 1950s". Given the lack of fundamental progress in transportation, it remains the case, very much as in earlier ages, that "trade logistics are the most important non-tariff factor in predicting international trade" (Abrego et al., 2019).

Despite the promise of the 4IR, productivity growth in the advanced economies shows no sign of revolutionary change, as it did in all of the previous industrial revolutions. Moreover, one could very plausibly argue that the technologies associated with the 4IR, such as connectivity and mobile computing, enabled the rise of social media with its downsides, including violations of data privacy, which has now led to a tech backlash (Hendrickson & Galston, 2019; Feldstein, 2019). We read more in the news about voter manipulation, fake news, growing cybercrime, and the pernicious effects on society of echo chambers, filter bubbles (like Medieval walled castles), and exploitation on online labor platforms, as well as of the regulatory battles of governments against digital platform giants, than of improved productivity or rising wages and new, sustainable manufacturing processes spreading (Chen, 2019; Coyle, 2017; Moore & Tambini, 2018). The COVID-19 pandemic has brought to the fore concerns about digital technologies being misused for disinformation and misinforma-

tion[10] (Brennen et al., 2020; Naudé & Vinuesa, 2020) and strengthening the surveillance state (Harari, 2020).

A third reason why the 4IR may suffer a premature demise is that on top of the increasing doubts about the impact of 4IR technologies, and the recognition of the downsides of these technologies, the world is taking a worrying anti-science turn (Dawkins, 2017; Levine, 2017). Hotez (2020) describes the rise of anti-science movements in the USA in climate change, air pollution, and biomedical sciences, including vaccines. Saad (2020) considers the rise of anti-science as partly the result of several "idea pathogens" under which he includes postmodernism, radical feminism, and transgender activism. These idea pathogens and the anti-science beliefs they result in are often somewhat ironically fostered and nurtured on university campuses.[11]

Erixon & Weigl (2016) expressed concern that innovation and entrepreneurship are being further strangled by the anti-science culture emerging in many universities where science is increasingly taking a second place in favor of precautionary, risk-avoidance behavior in the extreme. This stifles free speech, essential for progress in science and innovation. In their words (p.38) "There are ever-growing demands for 'safe spaces' where students would be allowed to shield themselves from academic teaching and thinking they do not like." Such safe spaces are not necessarily inspired only by risk aversion or excessive precaution-taking, but also, as Goldberg (2018, p.218) points out, "as an effort to control certain battles spaces in the culture war." It would thus seem that also in our beliefs and sense-making systems, that the current age is exhibiting Medieval characteristics, where idea pathogens and culture wars combine to restrict the flow of scientific knowledge and spread dis-and misinformation.

This anti-science turn is of concern for industrialization post-COVID-19, not only in that it limits free speech and the flow of knowledge and the freedom to experiment and dissent, essential for innovation, but that it takes place when progress in, and funding of, science is under pressure. Weinstein (2012) has expressed concern that in fundamental physics, the field responsible for virtually all of the technologies underpinning earlier industrial revolutions, from the steam engine to electricity, electronics, and nuclear power, has been stagnating since the 1970s. And Funk (2019) has noted the decline in venture capital funding going into

[10]To try and counter some of the misinformation and disinformation being spread about the pandemic, the Infodemic Observatory evaluates around 4.7 million 'tweets' per day on for their reliability - see `https://tinyurl.com/y5bfush6`.

[11]Consider, as an example, the following statement that was made at a "de-platforming" protest on a US university campus, as reported by Sullivan (2018) "Science has always been used to legitimize racism, sexism, classism, transphobia, ableism, and homophobia, all veiled as rational and fact, and supported by the government and state. In this world today, there is little that is true 'fact'."

non-digital science-based technologies such as semiconductors, fiber optic communications, mobile communications, and medical instruments. For instance, and very pertinently in light of the COVID-19 pandemic, venture capital funding going into medical instrument technologies declined by over 50% between 2003 and 2017.

The causes of anti-science sentiment, stalled progress in fundamental physicals, and declining investment in (non-digital) science-based technologies are myriad and complex; however it is likely that the over-regulation of these areas, and the growing amount of "permissions" that need to be obtained to be innovative in various scientific fields and bring these innovations to markets, (as opposed to digital services) are playing a contributing role (Erixon & Weigl, 2016; Thierer, 2016). Fixing the engine of innovation for industrialization post-COVID-19 may require a more "permissionless" and permissive environment for entrepreneurial innovation, as well as better understanding "crisis innovation," as Gross & Sampat (2020) argues with reference to the Second World War.

# 5 Concluding Remarks

Industrialization, in particular through the manufacturing sector, remains a vital economic transformation trajectory for inclusive and sustainable global development. The two engines of industrialization – innovation and trade – are in danger of being (further) compromised by the COVID-19 pandemic.

Moreover, innovation and trade are being compromised at a time when both innovation and trade had already been under pressure. Innovation had been stagnating due to, amongst others, the evolution of global capitalism, that had seen the rise of platform capitalism and concentration in and dominance of markets by large superstar firms and zombie firms, many of them aged, and engaging in defensive innovation - in a manner reminiscent of the medieval guilds and feudal overlords. Trade had been under pressure due to rising economic nationalism and trade wars, with the rules-based multilateral trading system losing credibility – signaling an increasing application of mercantilist views and ushering in a period of de-globalization.

The COVID-19 pandemic may cause a long-term reduction in innovation and entrepreneurship, as section 2 of this paper argued. This will delay and even bring to a premature end the 4th industrial revolution (4IR). The technologies of the 4IR were of limited help against the pandemic so far - apart from allowing some to work remotely and to share information

fast.[12] Hence, doubts are arising as to whether the promises of and expectations of other key 4IR technologies, such as the IoT or 3D-printing and renewable energy and advances in transport, would ever materialize, at least to the extent that it would meaningfully impact on manufacturing.

So far, as the world economy recovers from the pandemic, it is evident that the 4IR has been the only industrial revolution that has been accompanied by a stagnation in general labor productivity. As was shown as an example in section 4 of this paper, labor productivity growth in the UK was in 2016 at its lowest level in 200 years. Of even more concern, not only did the technologies of the 4IR not help so much against COVID-19 or to drive labor productivity and potential GDP growth, but these technologies have also contributed to creating new problems such as surveillance states, disinformation, and misinformation about the pandemic, rising cybercrime, amongst others. More than ever, Peter Thiel's comment that "we wanted flying cars instead we got 140 characters" reflects the disappointment of an age that expected sustainable global development from a new industrial revolution driven by "brilliant" technologies and open and fair trade. It appears that instead of a 4th industrial revolution, we got to wear masks and raise the proverbial bridges across our moats. With innovation and trade, the engines of industrialization, in jeopardy, what are the options?

It would seem, at least over the foreseeable future, that sub-optimal policy-making will be the inevitable resort of governments and multilateral agencies. The question may be, what is easiest to fix: innovation or trade? If only one can be fixed, at least industrialization may be able to fly on one engine. For example, if the stagnation in innovation is too complicated to solve soon given the dominance of the new industrial "guilds" and challenges in physics, then the second-best option may be to assure that existing technologies and know-how at least flow with increasing speed throughout the world to allow for convergence. This would require trade openness and globalization to be furthered, not retarded. And *vice versa*, in a mercantilist world, with trade disabled as an engine of industrialization, the second-best may be to nurture innovation and entrepreneurship, which will require the opening up of domestic economies to competition and new entrepreneurs, and the promotion of permissionless innovation.

In my view, it is perhaps too difficult to fix the innovation system in time. We do need the technologies of the 4IR and do need the 4IR to turn out more than a promise; however, fixing the regulatory, funding, scientific and entrepreneurial constraints on innovation will run into

[12]See also the analyses on the limited contribution made by smartphone contact-tracing apps against the pandemic by Barber & Knight (2020) and the editorial in *Nature Biotechnology* at `https://doi.org/10.1038/s41587-020-0610-4`.

formidable obstacles. Following COVID-19, decision-makers may retreat into a safer, less risky, and less uncertain world than the current. The aging demographic in much of the advanced economies are likely to give this further impetus.

This will leave trade as the only engine for industrialization in the near future. Fortunately, the rules-based multilateral trading system is not yet irredeemably damaged despite de-globalization and the return of Mercantilism. There is still a (very) small possibility that the global trade system may be reformed, even if in a direction that will better help developing countries to raise their welfare through industrialization based on imitation, rather than innovation. If the world fails to get trade fixed, it will likely also start to resemble the Middle Ages in other, even worse, aspects.

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