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Trust and incentives in academic research and the position of universities within innovation systems

Hugo Horta[1]

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Abstract
Academic research has evolved tremendously over the last century. The middle of the twentieth century saw the development of research and the strengthening of trust both within academia and between academics and external actors. Since the later part of the twentieth century, however, the development of academic research has been characterised by reduced trust in universities and academics. It is argued that the lowering degrees of trust in universities and science are reflected in the current incentives in academia, often driven by governmental funding agencies, and the result of the altered position of universities within innovation systems. Universities are still important contributors to knowledge production, but they have slowly become more peripheral within innovation systems. Rather than setting their own research directions, they face strong incentives to do research primarily to serve others. This requires them to interact with organisations with which they have little in common and with which they find it difficult to communicate. The academic research pendulum seems to have swung too much towards knowledge transfer and application, with problematic outcomes. These developments indicate that it is necessary to reassess the purposes and potential benefits of academic research to restore trust in universities and increase the integrity and usefulness of research.

Keywords Academic research · Trust · Incentives · Innovation systems · Knowledge transfer

Introduction

Academic knowledge production is at an all-time high. If one measures the evolution of academic knowledge production by the number of publications indexed in specialised datasets such as the Clarivate Web of Science or Scopus, one observes an upward trend that seems unlikely to reverse any time soon (Barrios González et al., 2021). There is barely a single country in the world that has not seen its publication numbers rise in the last decades. Collaborative research is also on the rise. The proportion of single-authored publications

✉ Hugo Horta
horta@hku.hk

[1] Social Contexts and Policies of Education, Faculty of Education, University of Hong Kong, Hong Kong, Hong Kong SAR, China

has declined worldwide, while national and international collaboration through co-authorship has increased (Kwiek, 2021). Although research intensity and resources differ between countries, the number of researchers involved in knowledge production is generally increasing and, in most countries, more funding is being allocated to research activities (Wang et al., 2018). These trends have accelerated the production and accumulation of academic knowledge, opening up new possibilities for using this knowledge to tackle global challenges, develop new products and services, and promote social and economic development. Incentives related to knowledge production have played a central role in these trends.

Incentives are related to values, norms, or instruments that motivate organisations and individuals to work in particular ways. For individuals, incentives may be intrinsic or extrinsic (or most commonly a mix of both) and may include a range of compensatory, moral, and coercive rewards (see Dalkir, 2011; Laffont & Martimort, 2002). Intrinsic incentives in academia relate to self-motivated curiosity, creativity, and autonomy to pursue scholarly interests. An example of intrinsic incentives in academia relates to the "sacred spark" hypothesis, whereas academics have a predetermined inner drive to conduct and publish research without necessarily having any other incentive to do so (Cole & Cole, 1973). To some extent, these intrinsic incentives emerge from socialisation processes, which are internalised as part of becoming an academic during doctoral studies (Schneijderberg & Teichler, 2018). Academics' work environment (e.g., type of university) often defines their competitive horizons, which provides a type of extrinsic incentive that shapes their academic work (Valimaa & Hoffman, 2007). These extrinsic incentives are based on internal performativity standards and academic career progression, which often result from internal transformations that the universities have undergone or are experiencing. These incentives are also partly situated and informed by broader disciplinary or field cultures. Sometimes they are not aligned with scholars' intrinsic motivations and create tensions, of which the teaching–research nexus and publish-or-perish dynamics are examples, which may force academics to make difficult choices (Hoffman et al., 2016). While they are situated within the organisational structure of universities, these external incentives are also influenced by other external incentives in the academic capitalist framework derived from government policies and funding regimes, which impact universities, academic work, and research focuses alike. In particular, research focuses are influenced by research and impact assessments linked to funding (Buckle et al., 2020). The role of extrinsic incentives is arguably Janus-headed: while such incentives have promoted an increase in publication numbers and co-authorship, they have also fostered an environment and behaviours that are considered by many researchers to be pernicious to academic systems, research, and the knowledge resulting from research (see Yokoyama, 2006). Incentives mould the behaviours of all those engaging in social actions, including academic researchers (as research is a social action framed within a specific social environment, e.g., that of the research team, laboratory, and university; Latour & Woolgar, 1979). Therefore, the work of academic researchers and the results of their work reflect their interpretation of and subsequent adaptation to incentives (Brew & Lucas, 2009), but also reflect university research cultures and prioritisation of academic outputs (Xu et al., 2021).

One of the most common criticisms of the current set of incentives in academia pertains to the introduction of outdated corporate-minded ideals to academic settings, leading to an overemphasis on measurement-based evaluation (e.g., Deem et al., 2008). New public management and managerialist practices were introduced to universities following broad reforms of state systems and public functioning in the late twentieth century, which aimed to transform inefficient, cumbersome, and expensive structures and activities into more efficient, streamlined, and productive systems (Boyne et al., 2003). These broad reforms were

dictated by economic neo-liberal ideologies and affected the public apparatus as a whole, not only higher education. The main focus of the higher education and science reforms was to ensure that public expenditure on higher education, including funding for academic research, was allocated in the most efficient way possible and provided value for money (Olssen, 2016). Various single and composite indicators of research performance were introduced to evaluate research, such as the number of publications produced, the number of citations received, and journal impact factors (Kyvik & Aksnes, 2015). These indicators of research performance also valued English language publications to the detriment of other languages and tended to be dismissive of other forms of knowledge production that may take different forms and shapes (Dahler-Larsen, 2018). Today, these indicators determine the allocation of resources within frameworks of national and institutional incentives, expectations, and targets, and are themselves continuously assessed, updated, and adapted (Langfeldt et al., 2015). Incentives built around and supported by these indicators also push academic researchers to internationalise their research output by publishing in international peer-reviewed indexed journals (overwhelmingly written in English), ideally in collaboration with peers from other countries, and to flesh out the potential contributions of their research to policy and practice (Chubb & Watermeyer, 2017). In many countries, these changes have brought about tension between the focus on international topics and the need to address national or local challenges, because the two are not always compatible (Xu et al., 2021). This culture of performance-based measurement has influenced the behaviours of universities and researchers and promoted fierce competition, which has exacerbated inequalities and vulnerabilities in academic environments (Oleksiyenko & Tierney, 2018). A climate of performativity has become the norm in academic research settings, shaping academic work and creating fields of judgement based on the relative performance of academic researchers (Ball, 2003). This emphasis on measurable performance determines academics' career success — not only in terms of their reputation within the scholarly community but also in terms of their ability to acquire tenure and promotions within their universities, except perhaps for those that specialise in teaching or focus on teaching careers (Hammarfelt & Rushforth, 2017).

Performance-based incentives rely on concrete measures of research output and outcomes; therefore, academic researchers have been forced to accelerate their research processes to provide deliverables and justify research investments (Levin & Aliyeva, 2015). Despite the increase in published research, Young (2015) argued that this practice has resulted in a lack of palpable research breakthroughs. The anachronistic relationship between the increase in the number of scientific publications and technological advances is reinforced by growing evidence suggesting that scientific progress and technological development have plateaued in recent decades (Bloom et al., 2020; Huebner, 2005; Modis, 2022; Strumsky et al., 2010). The focus of incentives on research performance metrics, particularly concerning recruitment, tenure, and promotion decisions, has arguably led to the emergence of a "publish or perish" culture, in which academic researchers have little choice but to publish specific types of research in specific journals and within specific timeframes (Levin & Aliyeva, 2015). As a consequence, the freedom of academic researchers has been curtailed and survival has become their main objective instead of scientific discovery (Rzhetsky et al., 2015). At best, survival and scientific discovery become combined goals (Horta & Li, 2022).[1] The notion of publication production "pipelines" has become

[1] Some authors have argued that this is also true for grant applications because research funding evaluators tend to favour safer rather than riskier and more innovative grant applications (Gallo et al., 2018).

the norm in academic research settings (Edgar & Geare, 2013). Top-down managerialist forms of organisation that focus on performativity may also reduce academic autonomy among researchers and foster more conservative research agendas (Horta & Santos, 2020). Even more problematic is the increase in cases of scientific fraud, "salami-slice" publication tactics, and studies that overstate the importance and impact of their findings to obtain greater visibility.[2] These trends are blamed by some researchers on the current incentive system in academia (see Tonta & Akbulut, 2020; Edwards & Roy, 2017; Higginson and Munafo, 2016).

Many studies criticise this set of incentives and note its harmful effects on academic research (see Lorenz, 2012 and studies referred above). Some of these studies focus on how researchers use gamification strategies to adapt to these incentives. Others ask who gains and who loses as a result of the incentives, and who resists and who complies with them. Other studies explore how these incentives and related evaluative structures may distort academic work and knowledge itself (e.g., Seeber et al., 2019; Leisyte, 2016). Some of these studies argue that current research incentives and the policy and structural changes that promote them are driven not only by the need to foster knowledge dynamics but also by the desire to streamline investment and increase efficiency and productivity. A few of the above studies also highlight a decline in governments' trust in the research work done by universities and academics. For example, Woelert and Yates argue that performance-based measurement in Australian higher education is indicative of low levels of governmental trust in the "intrinsic capacity of universities and academics to do their work efficiently and effectively" (2015: 175).

This raises the question of how this incentive system and related lack of trust in academic research came to be. To make a novel contribution to the debate on this question, this paper moves away from topics frequently analysed in the higher education literature, such as the effects of new public management and managerialism on academic research. Although this literature is acknowledged, this paper takes a different path, using a broad range of insights from higher education studies, science and technology studies, and studies in other relevant fields to argue that the current incentive system and associated lack of trust in academic research are affected by three main issues. First, after governments supported the central role of academic research from the nineteenth century to the mid-late twentieth century, the role of universities in innovation systems has become more peripheral in the late twentieth century and early twenty-first century. The positioning of universities within innovation systems is largely derived from public policies and incentives. Although universities contribute to the development of science, technology, and innovation, governments are increasingly showing less trust in universities. The level of governmental trust in universities shapes and is being shaped by a number of incentives. Second, the relationships between and expectations of universities and other non-academic actors are changing, as they are increasingly required to interact amidst divergent cultures, norms, and objectives. Third, the research goals of universities are increasingly set by others.

It is important to acknowledge that some issues are generalised in this paper to advance its arguments; however, these arguments may become more nuanced and sometimes incongruous if national contexts, types of higher education institutions, and fields of knowledge

[2] Therefore, it is not surprising that an increasing number of predatory journals are emerging because many academics must publish their research to ensure their survival in the uncertain academic environment of their institution where publication numbers may be more relevant than any actual advancement of knowledge (Merktan et al., 2021).

and disciplines, among other features or characteristics are considered. This purposive generalisation of the arguments is largely intended to attempt an interpretation of the understandings that policymakers seemed to have had when they designed and implemented policies and models with a lasting impact on academic research and innovation systems. In addition, this generalisation may reflect the tendency of an argument to lean towards a particular vision of academic research that is more appropriate for some fields of knowledge because innovation tends to be associated with Science, Technology, Engineering, Mathematics and Medicine (STEMM). Singh and Aggarwal (2022) defined innovation as "the operationalisation of creative potential with a commercial and/or social motive by implementing new adaptive solutions that create value, harness new technology or invention, and contribute to competitive advantage and economic growth" (177). This broad definition of innovation is probably more appropriate and preferred currently, but it is important to consider that the definitions of innovation that have guided innovation policy and systems in the past decades have been narrower in scope and purpose (see Singh & Aggarwal, 2022; Granstrand & Holgersson, 2020; Lemanowicz, 2015).

The paper is organised as follows. The following section situates academic research within the development of innovation system models. It identifies initial innovation models that promoted the development of academic research and demonstrates the important role played by universities within these models. It then shows how major changes occurred when a new innovation model took primacy, leading academic research to assume a more peripheral and service-oriented role and reducing trust between actors, particularly between governments and universities concerning academic research. The next section then analyses how the shift from the first innovation model to the second affected the relationship between governments and universities with regard to trust and associated incentives pertaining to academic research. The final section briefly concludes the paper.

The repositioning of universities towards a peripherical centrality in innovation systems

The initial centrality of universities to innovation

Universities have historically been centres of culture, training, reflection, and attempts to advance knowledge, although they have not always been founded on proper scientific methods or focused on contributing to economic development (Amaral & Carvalho, 2020). The rationalism and empiricism that emerged during the Enlightenment and the relevance of the scientific method helped to reform universities of the Middle Ages, leading to the emergence of scientific knowledge as it is known today (Dupré, 2008). von Humboldt's university model emerged out of this reform where university activities were organised around the relationship between research and teaching practices, but also where philosophy could be united with empirical science, which could then be united with general upbringing and universal enlightenment (Bertilsson, 1992). von Humboldt's university model, which would later influence the design of some research universities in the United States (US), was focused on contributing to the development of the state. Governments sponsored the consolidation of von Humboldt's model, and its contribution to the rise of the German economy during the nineteenth century has been well documented (e.g., Pierenkemper & Tilly, 2004). This early success was one of the key reasons for the adoption of the model by some universities during the nineteenth century and the early twentieth century. This drew

the attention of several governments, which realised the usefulness of academic research in innovation systems, even if innovations in this period were centred around a few scientific and economic areas of interest (Ashby, 1967). von Humboldt's university model inspired several systematic reforms at the institutional level because the model was associated with the idea that the knowledge created by universities (i.e., research) could be applied to technological development. This application of knowledge emphasised more basic research than applied research, as basic knowledge in most disciplines was relatively weak at the time (Lenoir, 1998). Other university models also attempted similar reforms in the middle to late nineteenth century, such as the land-grant universities in the US, which were established with an agricultural focus and a strong sense of application, but with a weak scientific knowledge base (Carlsson et al., 2009). Nevertheless, most of the innovations during this period were driven by inventors working outside academia and not by universities or academics (Mowery, 2009). In addition, knowledge transfer from new academic knowledge was mostly localised to a few scientific fields and industrial sectors (such as the chemical industry in Germany; see Rosenberg, 2010). Interestingly and somewhat forgotten, already at that time reputable academics such as Max Weber expressed concern that government- and industry-directed funding for research and development (R&D) activities was already affecting the autonomy of universities and the academic freedom of researchers, with subsequent impacts on their academic work (Albritton, 2006). While external organisations had started to influence academics' work in the nineteenth century, this change was somewhat reversed in a relatively laissez-faire fashion during the mid-twentieth century when the US government increased academic research funding.

Universities and the linear innovation model: increasing the centrality of universities

The biggest change in academic research in the twentieth century may have been the creation of the US research university, due to awareness of the importance of academic research to the Second World War effort (Sarewitz, 2016). Policymakers realised that universities could be powerhouses for knowledge creation, which could directly promote technological advancement and therefore contribute critically to nations' technological competitiveness and social and economic development (Vest, 2007). The procurement of targeted research as part of the war effort and massive projects that were of strategic importance to winning the Second World War allowed policymakers to understand the potential knowledge offered by universities to foster a faster process from knowledge creation to knowledge dissemination and application not only for the military but also for civilian purposes (Geiger, 2017). These policymakers understood that universities could play an even greater role in national innovation systems. The focus for policymakers then became obvious: improving the knowledge production capability of universities and finding ways to transfer "useful" knowledge from academia to other sectors and organisations (Rhodes, 2001). This is not to say that before the Second World War there was no knowledge transfer from academia; indeed, and as described above, that was the precise purpose of land-grant universities in the US. In Germany, knowledge transfer between academia and industry was already occurring in the late nineteenth century (see also Lyons et al., 2018). However, this transfer was not centred on universities, as targeted research based on governmental directives and economic strategic plans took place mainly in large government laboratories. After the Second World War, universities increasingly assumed this role, while state

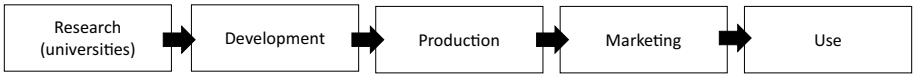

Fig. 1 Linear model of innovation (based on Kline and Rosenberg, 1986)

laboratories gradually lost their place and prominence in knowledge transfer activities (Cox et al., 2001).[3]

The academic research setting did not change much at first. The innovation model initially adopted was linear (Fig. 1), in which universities produced essentially basic research, based on the premise that scientific advancement is a pre-condition for social and economic development (Stokes, 1997). This line of thinking emerged in US science policy but soon influenced the world (except Warsaw Pact countries, due to their differing ideologies). Vannevar Bush's essay "Science – The Endless Frontier" was extremely influential in situating the university within the linear model of innovation and maintained the status quo for academic research until the late 1970s (Bush, 1945). This status quo was not only maintained but also defended. According to Bush (1945), academic researchers should have the freedom to pursue their research goals, and this freedom will allow scientific breakthroughs. He added that the rigidity of controls enforced by government policy constrain the ability of academic researchers to be creative and originate ideas to be used in technological innovations. This argument is attuned with the ideas of philosophers of science such as Michael Polanyi, who argues that scientific autonomy and independence are essential because academic researchers have the greatest expertise and therefore know best how to direct their efforts. Arguing along similar lines to Bush, Polanyi also emphasises that external attempts to interfere with the work of academic researchers will bring scientific progress to a standstill (Polanyi, 1962). Bush (1945) called for the government to increase public funding for academic research to provide the necessary resources and conditions for scientific discovery to come to fruition.

The fundamental belief that underpinned the linear model of innovation was that given sufficient resources, self-governing academic researchers, pursuing their own interests or working together with their disciplinary communities, could generate a pool of basic knowledge that other actors could then use for decision-making or technological development (Godin, 2006). Increased public funding was expected to increase the knowledge pool and therefore benefit all involved. The success of this model was measured by increasing numbers of publications and citations (i.e., reflecting the expansion of the knowledge pool).

In practice, strong public investment in academic research further developed and differentiated universities and shaped higher education systems. It created research infrastructures, increased the highly qualified human capital focused on research at universities, and fomented an investment dynamism that, as expected by the science policymakers backing the model, also prompted the business sector to invest more in research and other learning activities to promote their own innovation efforts (Conceição et al., 2004). Naturally, this model was appealing to academic researchers because it coupled substantial funding with relatively minimal external oversight; knowledge production and use were separated; and high levels of trust were afforded to academic researchers (Douglas, 2009). At this stage, the model of collegiality trusted by academic researchers was still dominant, research was mostly governed and managed by academics, and the relationship between governments

[3] In the Soviet Union, the development path was different, partly due to ideological factors.

and universities was mostly bidirectional and trusting. The maintenance of this relationship was critical because the need to maintain balance was understood in the period before and during the Second World War. On the one hand, universities became more willing to transfer their academic findings to non-academic actors because academics could work on specific government and industry issues. Thus, they could enter new areas (especially STEMM areas) requiring expensive laboratory equipment and provide key inputs for business-driven innovations. On the other hand, several instances of academic tension and resistance emerged, such as the argument that industry actors were intruding on academic research areas (Arora et al., 2020).

Problems with the linear innovation model were identified in the middle to late 1970s. Oil shocks, energy crises, and the end of the Bretton Woods system marked the decline of the post-war economic boom in the US and Europe, which was accompanied by some disenchantment with the outcomes of human capital theories because the initially overly optimistic large public investment in knowledge was not providing the expected returns (Blaug, 1976). However, investment in human capital remained crucial, and endogenous growth theories further expounded that this investment was needed to guarantee sustainable social and economic development in increasingly globally competitive economies (Arrow, 1962). One of the problems with the linear model of innovation was that producing more research did not necessarily lead to better outcomes and could even amplify problems or make decision-making more difficult (see Woodhouse & Sarewitz, 2007). However, long-standing endogenous growth theories, as in Bush's initial thinking (1945), continued to emphasise the critical benefits of increasing the basic knowledge pool as a reservoir from which industry, government, and society can draw; this is still an important part of the rationale for continued investment in academic research and publication today (Romer, 1986, 1990). It became more apparent that policymakers were pushing for the production of more research to enlarge the knowledge pool as much and as quickly as possible through sets of incentives. Researchers' inner motivation to do research, namely the "sacred spark" hypothesis proposed by Cole and Cole (1973), was found to be a less important driver of scientific research production than extrinsic motivations, in line with the "accumulative advantage" hypothesis proposed by Merton (1968). This is not to say that the "sacred spark" was of no import, but extrinsic motivations derived from external incentives were found by research conducted at the time to be more powerful than intrinsic motivations (Allision & Steward, 1974).[4] This understanding paved the way for the rise of performance-based funding and competitive funding schemes in academia, especially when coupled with the ideal of awarding resources based on merit (Bucchi, 2015).

Universities and the interactive innovation model: moving towards the periphery

However, the biggest problem with the linear model of innovation related to the utility of the knowledge produced. There was a growing realisation that potential users of knowledge had difficulties accessing the expanding pool of knowledge, and that more communication between academia and other sectors was needed. In the same way, a narrower and

[4] Recent research has shown that the relationship between intrinsic and extrinsic motivations and incentives is more complex than suggested by studies in the 1970s. Intrinsic motivations and incentives have been shown to enable scientists to be more productive in research (Horodnic & Zait, 2015). Rijnsoever and Hessels (2021) also found that both intrinsic and extrinsic motivations play an influential role in academics' participation in scholarly activities and the commercialization of research findings.

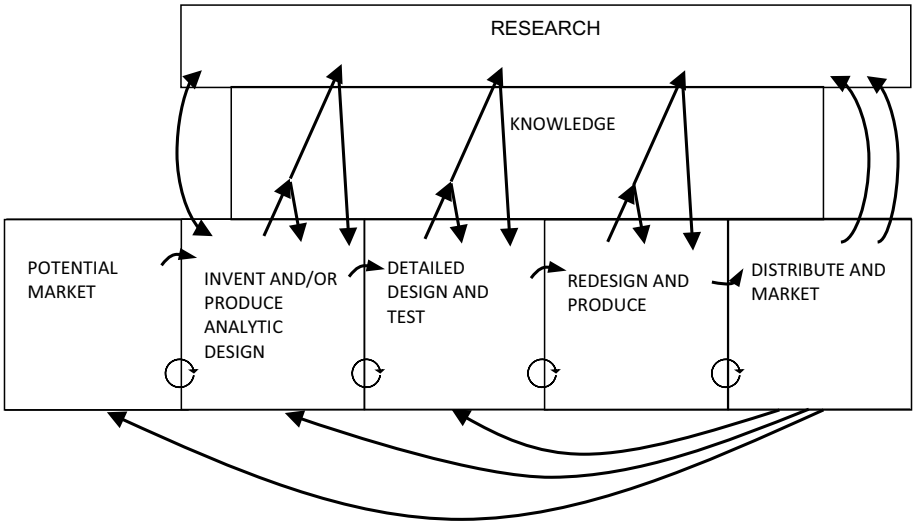

Fig. 2 Interactive model of innovation (based on Kline and Rosenberg, 1986)

more application-oriented focus was understood to be necessary to make knowledge more available and relevant to non-academic stakeholders (Sarewitz, 2016). In other words, there was a need for academics to interact more with others to facilitate knowledge transfer. This led to the emergence of the interactive model of innovation (Fig. 2), also called the chain-linked model by Kline and Rosenberg (1986), which remains dominant today, despite some variations (e.g., Caraça et al., 2009). This model, which changed the relationship between science and innovation and has greatly influenced academic research, is based on two premises. First, because innovation is non-linear and highly uncertain, a close interplay is needed between academic research and innovation. Second, technological development does not necessarily start with academic research; although the latter can lead to radical applications, it also benefits from innovations in a constant feedback loop that will at some point connect to the needs of users (Kline & Rosenberg, 1986). These two premises are essential. The first emphasises both knowledge production and transferability in academia, rather than knowledge production alone. The second premise views the centre of knowledge processes and outcomes to be not academia but the users of knowledge, such as industry and other end users.[5] Together, these premises imply a major disruption in academic research, including the loss of its previously assured centrality.

Governmental and international comparative benchmarks for universities to determine their global positioning, including university global rankings (mostly based on STEMM-favoured publication and citation metrics), are likely to help reinforce the importance of university-driven scientific inputs within innovation policy, but probably do not support

[5] Naturally, these premises impacted some fields of science, higher education institutions, and countries than others. A substantial amount of academic research has little or no relationship to industry or academic utility (Klavans & Boyack, 2017). Partly derived from this innovation model, the increased political and institutional pressure for research to have practical applications with a greater impact, such as favouring users' application of academic knowledge, has affected academic freedoms, environments, and work (Martin-Sardesai et al., 2016).

the knowledge centrality of universities within innovation systems (e.g., Lo & Tang, 2020). Academic research continues to have an important role in innovation systems but may be drifting to a more peripherical space. The diminished centrality of academic research to innovation in recent decades can be seen clearly from the results of an analysis of knowledge input indicators sourced from the Main Science and Technology Indicators dataset operated by the Organization for Economic Co-operation and Development (OECD).[6] Using two central indicators for assessing knowledge inputs in science (i.e., funding and researchers) from 1981 until 2019 in OECD countries, the percentage of gross R&D expenditure in the business sector was 68% compared with 16% in the higher education sector. This difference between these two sectors has increased in recent years. The percentage of gross R&D expenditure in the business sector was 65% and 71% in 1981 and 2019, respectively, while the equivalent figures for the higher education sector were 15% and 16% in 1981 and 2019, respectively. As a percentage of the national total, the proportions of researchers in the business and higher education sectors are 60% and 28%, respectively.[7]

Universities and academic researchers continue to be trusted to help enlarge the knowledge pool, and they continue to be funded mostly by national governments to do so. During the period 1981–2019, the business sector funded no more than 6% on average of the higher education sector's expenditure on research and development in OECD member states. Although academic research is now minimally funded by the business sector, it is required by public policies to focus more on and become more involved in innovation processes (e.g., by encouraging universities to become more entrepreneurial and transform themselves to serve society better; see Clark, 2001). Universities have also been instructed to focus on changing their research to introduce new organisational forms and activities aimed not only at knowledge production but also at making research findings available and transferable to new organisations and new audiences (Sam and Sijde, 2014).

Because these demands were mostly exogenous to the realm of academic research, these new arrangements required new incentives. With the government sector often playing the role of moderator and policy driver, new forms of engagement with organisations that have different modes of working, thinking, and acting were also required. This has naturally led to a myriad of trust issues that has affected the relationships between academics, universities, governments, and companies, which the literature on industry–university collaborations characterises and elaborates on extensively (e.g., Hemmert et al., 2014). A recent systematic review of the literature on industry–university collaborations revealed a low level of trust between universities and industry in research collaborations, reinforcing previous findings that indicate that organisations from the business sector have difficulties relating to academia, and vice versa (Bruneel et al., 2010).[8] The problem lies not only in the fact

[6] The OECD Main Science and Technology Indicators dataset is available from https://stats.oecd.org/. The data were accessed on October 28, 2021.

[7] It is not useful to compare the outputs between higher education and the business sector in this analysis because they are not directly comparable. One sector focuses on producing scientific publications while the other sector focuses on producing or offering new products and services. The number of publications (essentially produced by universities) and the number of patents (essentially produced by the business sector) have increased, but this is an expected result due to growing inputs from funding and researchers (Arora et al., 2020).

[8] The relationship between universities of applied sciences and non-academic actors may imply a greater level of trust and interaction between them than in the relationship between comprehensive universities and non-academic actors because the mission of the former is more oriented towards facilitating collaboration and knowledge transfer to the business sector, not-for-profit sectors, and governments (Po et al., 2016).

that most academics see the knowledge they produce primarily as a public good, whereas industry sees it as a private good; there are several further sources of misalignment, such as academics' lack of focus on the relevance of research to industry and the different temporal horizons of the two sectors. Such divergences also include different types of barriers to collaboration: motivational (e.g., the perceived lack of career benefits for academics of collaborating with industry and academics' scepticism about industry funding and entrepreneurship), capability-related (e.g., time pressure, social capital distance, and skill distance), governance-related (e.g., communication problems and knowledge and bureaucratic restrictions), and contextual (e.g., poorly designed incentives for collaboration and a lack of understanding of industry–university collaboration) (Nsanzumuhire & Groot, 2020). Above all, many academics, despite differences according to disciplinary field and personal interest, tend to be sceptical about and mistrustful of these collaborations (Azman et al., 2019). However, because the benefits of knowledge are centred on the users, it is likely that universities are generally seen as untrustworthy by society — and thus also by governments — for failing to make the knowledge they produce accessible or relevant enough to those who can use it (McKelvey, 2006). Considering the role of governments in these relations, their influence also needs to be considered. University-based research tends to be much more dependent on government policies and funding (and therefore more subject to the government's influence) than industry-based research, some of which is globally distributed rather than nationally focused or nation-dependent (Rahm et al., 2000).

With its new position in the interactive model of innovation, academic research faced substantial transformations. Universities started to include new organisational forms such as patent offices as part of boundary spanning efforts[9] and provided incentives for academics to register patents, even though revenue is gained from such patents only in exceptional cases (Conceição et al., 2006). These practices were further promoted by the implementation of the Bayh–Dole Act in the US in the 1980s, which made publicly funded academic research available for commercialisation; universities were incentivised to further register patents themselves, partly to demonstrate that they had a knowledge portfolio that could be used by companies for technological development (Mowery et al., 2001). Aarrevaara et al. (2022) considered the Bayh–Dole Act as a turning point, which led policymakers to understand how university-created knowledge could be a semi-public good rather than a public good. The idea, which had a global impact, was to increase trust in universities to fulfil their new social mandate by serving users that needed their knowledge, thus assuring that their knowledge was applicable. However, Eisenberg and Cook-Deegan (2018) argued that in this process, boundary spanning organisations within universities, rather than academic researchers, began to dictate the narrative and positioning of universities concerning knowledge application and transferability.

In this context, new modes of knowledge production typical of industrial and business research, given their focus on real-world challenges and applicability, were also highlighted in academic research settings (Fisher & Klein, 2003; Gibbons et al., 1994). This was knowledge production to be carried out in transdisciplinary arrangements, organised around transitory and flat structures (such as fit-for-purpose research teams who gathered to research a given challenge). Its quality was controlled by diverse actors, making it more accountable

[9] Universities have established technology transfer offices, collaborative research centres, and university–industry Incubators in an attempt to mitigate the cognitive and cultural distance between academic and non-academic groups while promoting the physical and social proximity within these shared spaces (see Villani et al., 2017).

and reflexive. The extent to which these attributes are effective, desirable, and politically motivated are insightfully discussed by Hessels and Lente (2008). This was quite a change from the discipline-based challenges proposed by individual researchers or by the scientific community, the frameworks of which highlighted the substantial homogeneity of academic researchers and processes, with their quality assessed by peers and therefore less social accountability. The attempts to combine mode 1 and mode 2 to some extent represented a cultural and social shock to the existing ethos and culture of scientific research, but they also signalled a preference for applied research over basic research, which concerned several researchers and academic communities (Quaglione et al., 2015). Concurrently, triple helix, quadruple helix, and, more recently, quintuple helix models of innovation[10] highlighted the increasing interactions between universities and other social actors, underlining the blurring of their organisational boundaries. They also revealed, whether directly or indirectly, that the control and direction of research processes were becoming increasingly dispersed among different social actors, thus minimising the ability of academic researchers to set their own research goals. These trends have been particularly evident in recent decades, when user and open innovation models have been increasingly regarded as relevant and impactful (Harhoff & Lakhani, 2016).

In sum, changes in the innovation model moved the university from a central position, focused mostly on knowledge production (from the standpoint of academic research), to a more peripheral place. It was still important and relevant to the innovation process, but it now served other social actors that took centre stage. This change meant that the focus was no longer simply on producing knowledge but also on attempting to transfer it in the best possible way to non-academic organisations. This required engagement with parties outside the academic scientific realm who had different ways of working, thinking, and acting, which soon resulted in a decline in trust and consequent attempts to manage this lack of trust. It also meant that universities transformed their structures, procedures, values, and norms to make themselves more engaged with and responsive to external demands, as their new positioning in innovation models demanded. This, together with concurrent economic globalisation trends not discussed in this paper, promoted some scientific fields over others, but also advanced the commercialisation and marketisation of academic knowledge products in a dynamic of academic capitalism (Slaughter & Leslie, 1997). Meeting the demands of others required networking and interactions based on innovation purposes, and the new organisational models, which were influenced by economic neoliberalism and new public management, created regimes of uncertainty, inequality, and over-competition, as mentioned in the introduction to this paper. In contrast with the linear model of innovation, in which universities were able to set their own goals, the current interactive model of innovation is one wherein goals are set for universities by others or are heavily influenced by others (Barringer & Slaughter, 2016; Mok & Jiang, 2020). Current incentives and related issues of trust can be understood through this change.

[10] The innovation helix framework assesses the interactions between different sectors in their research collaboration activities. The triple innovation helix framework emerged in the late 1990s to include universities, government, and business (industry) in research collaborations (Leydesdorff & Etzkowitz, 1998). In the late 2000s, the quadruple and quintuple helix innovation models were developed by adding two more helixes to the innovation model: that is, civil society (i.e., culture- and media-based public) and the natural environment (Carayannis et al., 2012).

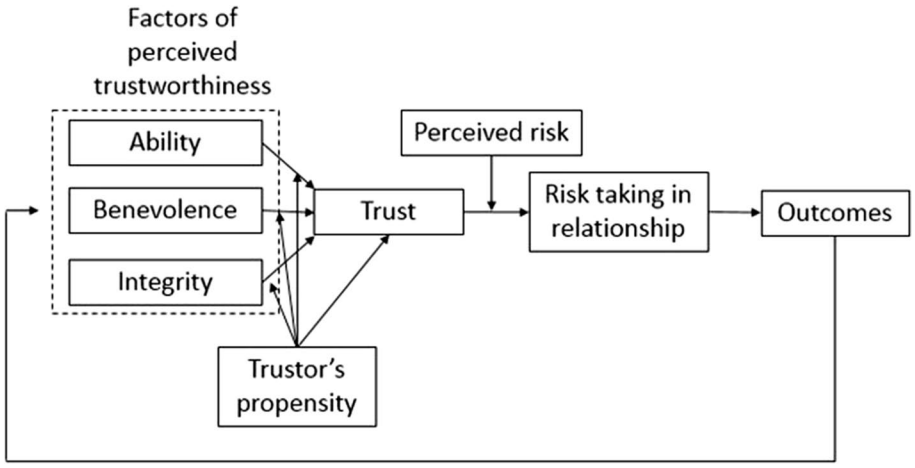

Fig. 3 Model of trust developed by Mayer et al. (1995)

Trust and incentives: the relationship between the state and universities in the two innovation models

Analysing the relationship between the state and universities can provide further insights into trust and incentives in academic research settings. Universities tend to be overwhelmingly dependent on public research funding, and most incentives in academia are designed and driven by public policies (Conceição et al., 2004). The changing trust relations between the state and universities in the two innovation models can be conceptually analysed using the model of trust developed by Mayer et al. (1995). It is useful to apply this model to the relationship between the state (the funder of academic research within the scope of innovation models) and universities (which produce knowledge resulting from academic research) for two reasons: the first is that this relationship presupposes interdependence, and the second is that the need for trust tends to arise from a situation of risk, such as the investment of one party (the state) in an activity that the other party (the university) is expected to perform (Schoorman et al., 2007).

The components of the model of trust developed by Mayer et al. (1995) are illustrated in Fig. 3. "Trustor's propensity" refers to the extent that in a given innovation model, the trustor, which in this case is the state, has the propensity to trust universities to fulfil their mandate on a given task. This propensity to trust the state is informed by three factors of the perceived trustworthiness of the trustee (i.e., the university). The first factor is ability, which refers to the sets of competencies, expertise, and other characteristics that make a party capable of carrying out a particular task within a given domain (such as universities' ability to do research). The second factor, benevolence, refers to the extent to which the trustee has an attachment to and positive orientation towards the trustor, following its directives. The third factor, integrity, is a set of principles that the trustee adheres to and that the trustor finds acceptable. These three factors tend to be interrelated but may vary independently. They are to a very large extent perception based. Overall, they establish the level of trust that the trustor has in the trustee. They need to be understood as situated on a continuum, with high levels of perceived ability, benevolence, and integrity at one extreme and low levels at the other. The level of trust informs the perception of risk

Table 1 Trust relations between the state and universities regarding academic research, using the model of trust developed by Mayer et al. (1995)

Model of innovation/trust model components	Linear model of innovation (up to the mid- to late 1970s)	Interactive model of innovation (from the early 1980s to the present)
Trustor's propensity (government)	High: funds universities to do research; minimum oversight	Low to medium: funds researchers to do research and engage in knowledge transfer; tries to maximise a priori the chance of a positive impact of the investment made; funding associated with incentives promoting the delivery of concrete research outputs (e.g., papers) in specific venues (e.g., internationally peer-reviewed journals)
Ability (universities)	Government trusts in universities' ability to do research: self-governance of academic research is promoted and defended by the government	Government feels the need to create and increase incentives (including evaluations) to promote quality research production; pushes universities to be more accountable and is sceptical of universities' ability in knowledge transfer and industry–university collaborations; universities develop efforts to show that they can produce and transfer knowledge effectively
Benevolence (universities)	Attachment to scientific field and university. Somewhat detached from assuming direct responsibility for national social and economic development	Multiple attachments to global and national communities, and universities; more or less apparent direct attachment to national social and economic development
Integrity (universities)	Focus on scientific principles that are respected by the government, as being of general interest to knowledge advancement	Focus on standard and universal scientific principles, but governments raise the bar to emphasise publication in specific research outputs and publications in specific type of journals; international publications more valued; changing knowledge producing modes and creation of boundary spanning organisations at universities; governments not completely convinced that universities are as dedicated as they can be to knowledge transfer
Trust (of government in universities)	High	Low

Table 1 (continued)

Model of innovation/trust model components	Linear model of innovation (up to the mid- to late 1970s)	Interactive model of innovation (from the early 1980s to the present)
Risk taking (perceived by the government)	Low, as there is trust in universities' ability to enlarge the knowledge pool, and the increasing public funding is contributing to it	Medium to high: Governments attempt to mitigate risk levels by relying on "objective" indicators that measure scientific activities; establishment of managerialism to make the process more efficient (as in corporations); favouring competition for research funding; promote evaluation regimes and quality assessments of research and its impact; fosters and follows the results of rankings and benchmarks
Outcomes (that loop into the trust relation)	The knowledge pool increases, but there are evident deficiencies in knowledge transfer and engagement with non-academic organisations. Not sufficient to sustain the technological competitiveness of a country or region	Increasing knowledge pool but little evidence of scientific breakthroughs; increasing scientific fraud and lowering of trust in academic science; publish-or-perish dynamics; adaptation and strategies of academic researchers to comply with incentives for career purposes rather than scientific advancement. Primacy of academic capitalism and furthering of potential inequalities between and within universities

in the relationship and the understanding of the uncertainty of risk taking. Trust triggers risk taking in a relationship, with the latter becoming the outcome of trust. Risk taking in a relationship is based on the perceived risk associated with a trusting behaviour (such as the empowerment of a university), but the form of risk taking is dependent on the context and situation (e.g., the state may trust universities with teaching but not with research). The outcomes of this trust–risk taking inform the trustor's propensity to trust and the perceived trustworthiness of the trustee in future interactions.

Table 1 provides a summary of the trust relations between the state and universities regarding academic research within the context of the two models of innovation. It indicates the decreasing trust of the state in universities' ability to conduct research perceived to be of value to the innovation system. The analysis also shows that the current model of innovation and the current situation in which universities are working are not conducive to scientific breakthroughs. Instead, the outcomes point to increasing problems with academic research, which will eventually lead to future tensions and further reduce trust between parties and in science, and the fact that the current incentives in academia are not having the effects desired by policymakers. A third innovation model or a restructuring of incentives in academic research may be needed, and this may require a balancing act between the nature of academic research in the linear model of innovation and that in the current interactive model of innovation.

Conclusion

Universities may have become victims of their own success. They have become integral parts of innovation systems because of progress in academic research and the understanding of policymakers and other social actors that academic research can make a key contribution to social, economic, and technological development. In the linear model of innovation, the status quo of universities and academic research remained relatively unchanged and was even boosted by unprecedented public funding directed to academic research to enlarge the knowledge pool. These changes were made possible partly by technological advancements and other external factors but mainly by support from academia, even if scientific advancements were not as effective as they could eventually be. However, the establishment of the interactive model of innovation brought a repositioning of academic research within innovation systems. They brought a new set of incentives and changes to knowledge production processes in academia that included triple, quadruple, and quintuple helix arrangements as well as changing knowledge production modes. Others concerned knowledge transfer activities, which many academics and universities were not particularly confident about, interested in, or able to perform effectively.

Additionally, trust issues are a recurring issue in research collaborations between organisations that diverge in terms of their *ethos*, ways of doing things, thinking, and goals. Direct or indirect incentives to promote knowledge transfer have also become a pervasive element of academic research; academics are now, even at the start of research projects, asked to describe the ways in which their research will be impactful. This is not aligned with the notion of serendipity in science or the fact that many innovations leading to products used today were conceived without foreseen applications (Gillies, 2015). This misalignment indicates that academic research is to a large extent no longer governed by academics and that the idea of science that is dominant today overemphasises application and impact because of its focus on users and on lay university governors (often from or

linked to the business sector). These conditions, along with incentives that promote the mass production of papers, are not conducive to scientific breakthroughs (Rzhetsky et al., 2015), and scientific progress and technological advancements seemed to be diminishing or stalled (e.g., Modis, 2022; Bloom et al., 2020; Strumsky et al., 2010).

Since the twentieth century, there has been a pendulum swing from doing research for its own sake without much consideration of its applicability to focusing on specific types of research that require the articulation of potential impact and application. Because of the incentive system and probably more for career survival and progression than to meet societal demands, many academics follow a publish or perish imperative, adapting to standardised evaluation formats and performativity drivers (Seeber et al., 2019). This has resulted in an increase in scientific fraud as much as in scientific advancement, in turn reducing trust in academic research and in academics. This is not a desirable situation. It is probably time — for the sake of regaining trust and to enable academic research to play a more beneficial role — for the pendulum to find a balance between the extremes represented by the linear and interactive models of innovation.

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Declarations

Conflict of interest The author declares no competing interests.

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