An Analysis of DPIs Value-Generating Ability

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Authors:

Dr. Stephen Brien, Vikram Sinha, Sandeep Radhakrishnan

ARTHA GLOBAL

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1. Introduction

Few technological reforms have been as ambitious in scale and scope as 50-in-5. A country-led initiative launched in 2023, it aims to support 50 countries in designing and deploying digital public infrastructure (DPI)[1] components by 2028. The purpose – building resilient and innovative economies that ensure the well-being of all. In this, it has the imprimatur of the global development ecosystem, from the United Nations (UN) to the World Bank; the UN's Digital Compact, adopted at the UN Summit of the Future in September 2024, called out DPI's potential for increasing economic opportunities (United Nations, 2024). These are displays of immense faith in DPI's transformative potential. Has that faith been earned?

On the administration and public service delivery front – and by extension, for development purposes – it has, by most measures. This extends well beyond the much-cited examples of India, Brazil and Estonia, whose success in deploying and using DPI-based identity, payments and data exchange systems, among others, has transformed their financial transaction patterns, government-citizen interfaces and social protection delivery. Malawi, for instance, had grappled with the problem of providing identity to its population – approximately 80% of which is rural – until 2017. By 2018, the National Registration and Identification System's National ID had covered 97% of the rural population, saving USD 20 million in annual payments to 'ghost' social benefits beneficiaries and enabling a host of citizen-oriented services (UNDP, 2022). Togo's Novissi cash transfer system expanded financial access and enabled transfers of nearly USD 24 million to 820,000 vulnerable beneficiaries during the COVID-19 pandemic (UNDP & Dalberg, 2023).

The economic effects on private sector activity – an explicit promise of the DPI approach with its emphasis on enabling innovation – are more difficult to parse. There is anecdotal evidence of its potential and burgeoning success on this front: the promise that India's Agristack holds for transforming the country's agricultural economy and catalysing private sector innovation in farmer services, from credit and insurance to market access, for instance, or the robust payments and fintech ecosystem coalescing around Brazil's Pix payments system. However, systematic evidence-building efforts are in their infancy.

Additionally, DPI at scale is still a relatively nascent and evolving phenomenon; few countries have deployed full DPI stacks[2] to unlock their combinatorial impact. The bulk of empirical work on DPI's effects, therefore, focuses on assessing the supply-side factors mediating deployment and the extent of adoption (Srivastava, Swami & Sharma, 2025). While these are useful

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[1] DPI has several overlapping definitions that emphasise various elements. For instance, the 2023 G20 consensus on DPI focuses on its technical characteristics and development potential, describing it as "a set of shared digital systems which are secure and interoperable, built on open standards and specifications to deliver and provide equitable access to public and/or private services at societal scale and are governed by enabling rules to drive development, inclusion, innovation, trust, and competition and respect human rights and fundamental freedoms." The Centre for Digital Public Infrastructure, on the other hand, talks about DPI's broad, systemic approach "to solving socio-economic problems at scale by combining minimalist technology interventions, public-private governance, and vibrant market innovation."

[2] A DPI stack comprises a number of integrated systems or platforms with core functionalities that can be foundational in nature – identify, payments, consented and secure data sharing, search and discovery – as well as, increasingly, speaking to specific sectoral use cases.

indicators, they are at best a halfway house to assessing private sector economic impact, current and future.

1.a. Why innovation classification matters

This lack of clear evidence of the nature of private sector impact is unsurprising. While DPI departs in some details from traditional conceptions of physical infrastructure, it shares a common core – chief among them the fact that in addition to enabling crucial public and private functions, infrastructure also enables long-term dynamic effects (Eaves et al, 2025). These positive externalities and downstream economic impact have been notoriously difficult to capture.

This distinction is crucial. Solow's productivity paradox points to the frequent disjunction between technological innovation and productivity growth (Brynjolfsson, 1993). Bridging this gap requires building pathways for innovational complementarities (Bresnahan and Trajtenberg, 1995). This includes innovation in management and production processes, workflow management and so on (Brynjolfsson et al, 2018). Our empirical assessment of DPI growth gains bears this out, pointing to the importance of ecosystem orchestration and institutional redesign in unlocking its potential (Brien et al, 2025).

DPI thus exhibits this classic pattern of transformative technologies in their early deployment: widespread visibility coupled with limited measurable productivity gains. This "DPI productivity paradox" mirrors what Paul David (1990) documented with computers — technologies that appeared everywhere except in the productivity statistics for nearly two decades. This apparent disconnect between adoption and impact reflects DPI's position in the innovation cycle. While most implementations are less than a decade old, the complementary innovations that unlock transformative impacts — new business models, organizational restructuring, skill development — typically emerge over 10 to 30-year horizons.

Given this, focusing on DPI's immediate financial savings and gains can at best give us a linear extrapolation of future growth. This runs the risk of being substantially off the mark on the upside if, as they promise, DPI instantiations are able to catalyse downstream effects. The penalties for such inaccuracy could be harsh. Properly categorising technological innovations helps predict their economic trajectory, distinguishing between service delivery improvements that enhance existing systems and general-purpose technologies that create new economic paradigms. This distinction shapes policy decisions and investment priorities.

1.b. Thesis and methodology

This paper is an attempt to address this and model how to think about these effects. To do so, we step back from the question of empirically quantifying DPI's economic impact and adopt a broader approach aimed at assessing DPI's medium-to-long term economic potential for the private sector. We build upon Eaves et al's (2025) framework for measuring DPI's public value. Discarding the first value category linked to public sector functionality, we link the dynamic (direct private sector gains from enhancing or reworking workflows and processes to capitalise on new efficiencies unlocked by DPI) and market-shaping (structural market transformation) value categories to innovation literature, assessing them as DPI's potential for complementary innovation and combinatorial innovation, respectively. This ties in well with the innovation typology work done by Garcia and Calatone (2002), who categorise innovations by their impact on technology and markets. The authors neatly place general-purpose technologies (GPTs) in the upper-most echelon of innovations ('radical innovations') since they cause both technological and market discontinuities at multiple levels. At the other end of the spectrum lie 'incremental innovations', which merely create market discontinuities at the firm level. Our assessment will examine the type and extent of discontinuities that have occurred as a result of DPI and therefore categorise DPI accordingly.

Any such assessment must deal with the fact that innovation is iterative – a feedback loop between technological innovation and market introduction via adoption and diffusion (Garcia and Calatone, 2002). This is not a steady process. Initial adoption is followed by a pause as market ecosystems build absorption and utilisation capacities, and then subsequent waves of complementary and combinatorial innovation (Helpman and Trajtenberg, 1996)[3]. DPI's dynamic economic potential, therefore, stems from its ability to catalyse this process of diffusion and further innovation; this is the primary lens we use.

Given DPI's recent vintage, a comparative analysis allows for teasing out its potential trajectory in a way that assessing it in isolation would not. We've taken two reference points – software-as-a-service (SaaS) representing incremental innovation and general-purpose technologies (GPTs) standing in for radical, transformative innovation. The paper begins with unpacking DPI's value proposition, then establishes the value creation framework and uses it for the comparative assessment. It ends by positioning DPI between service delivery innovations and radical innovations, arguing it represents "really new innovation" (Garcia and Calatone, 2002) — an institutional rather than technological breakthrough.

2. Understanding Digital Public Infrastructure

Digital Public Infrastructure represents a novel approach to building national digital ecosystems through open, interoperable systems. These systems manifest in the core areas of identity, payments, and data exchange. Countries with mature DPI ecosystems are liable to advance to sectoral systems in areas such as healthcare, agriculture and education – the choice is shaped by the country's economic structure and political economy compulsions and constraints – once the core systems are in place. Unlike proprietary platforms, DPI creates shared digital rails that both government and private sectors can build upon.

While the concept of DPI has gained real traction in public discourse in recent years, most notably with the successful rollouts of Aadhaar, Pix and the United Payments Interface (UPI), the technology was first deployed as far back as 2001 with X-Road in Estonia. As ICTs proliferated towards the end of the 1990s and the start of the 2000s, the public sector began to experiment with its use cases. While certain measurable improvements emerged (namely,

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[3] While this argument has been made in the context of General Purpose Technologies (GPTs), it is equally applicable to other technological innovations that fall below the GPT threshold but have sufficient market-shaping potential.

efficiency gains), the progress achieved was not without its downsides. Perhaps the most notable of these downsides from a public sector perspective had to do with the issues of vendor lock-in and information silos within government. Vendor lock-in occurs when an institution uses the products and services of one private technology provider and becomes trapped within the product and service ecosystem of that provider. Information silos, meanwhile, significantly reduce the policy and public service delivery potential of the administrative data trove sitting with governments, and increase transaction friction for end users.

In response, DPI has evolved into modular, interoperable architectures that work together to enable digital services across an economy. Each core layer — identity, payments, data exchange — provides foundational capabilities that multiple applications can leverage, creating network effects and reducing duplication.

2.a. Defining DPI's characteristics

A set of specific characteristics informs DPI's foundational capabilities – interoperability, modularity/reusability, extensibility, and security and privacy. Taken together, they enable the key architectural benefit that makes DPI more effective than previous-generation siloed systems and underwrites its potential for long-term economic value creation: the ability to generate, access, validate, disseminate and use data in standard formats across systems and actors with minimal friction.

- **Interoperability:** The DPI builder or controlling authority publishes standards and specifications that all ecosystem actors must adhere to in order to interact with the DPI system or layer an application or solution on it. This ensures that all components of a DPI stack, as well as other systems and platforms, are able to communicate seamlessly.
- **Modularity/Reusability:** Conventional government systems operate as integrated end-to-end solutions. This stems partly from technological limitations in previous waves of government digitisation, and partly from existing procurement ecosystems that are dominated by vendors who have spent decades building stables of proprietary, closed-loop systems. DPI systems, in contrast, comprise single-purpose components operating on common standards and protocols to ensure that they can be combined in 'plug and play' fashion. By breaking down a system into discrete functions, each delivered by a specific component or module, the DPI approach ensures that these systems are adaptable and flexible, with new functionalities added as needed. It also allows for these modules to be reused and reconfigured to architect systems in other contexts for other purposes.
- **Extensibility:** Extensibility denotes the capacity of DPI systems to act as foundational but minimal frameworks, capable of scaling in functionality over time. This allows both public and private actors to tailor the infrastructure to diverse use cases, sectors, and user needs. It enables DPI to serve long-term, evolving societal outcomes rather than being locked into static service definitions.
- **Security and Privacy:** Robust security frameworks and privacy-by-design principles are integral to DPI. These include user consent via granular consent mechanisms, data minimisation via ensuring that each system and subcomponent 'knows' only as much as

it needs to fulfill a given function, auditability to ensure transparency and foster trust, and encryption to secure against unauthorised access. Embedding this approach in DPI systems reduces trust frictions between counterparties and regulators. Agents are more willing to transact, share data, or open accounts when privacy protections and auditable provenance are present. Secure, auditable rails also lower enforcement costs and legal uncertainty, which is important when services scale across borders or sectors.

2.b. How DPI characteristics enable value creation

By analysing a wide range of global cases illustrating value creation across foundational DPI – digital identity, digital payments, and data-sharing systems – Brien et al (2025) illustrated how DPI enables and amplifies this economic value creation. We distill these insights into four interconnected mechanisms that address fundamental market failures and inefficiencies. Each pathway—from reducing search costs to enabling new business models—operates at different levels of the economy while reinforcing the others through network effects.

- **Reduced transaction friction:** Interoperability enables reduced friction in transactions, as users can send money to peers' or merchants' bank accounts regardless of whether they belong to the same banking ecosystem. The adoption of by millions of micro and small-scale businesses in India is almost solely due to the fact that they can accept payments from any bank account (BharatPe, 2025).
- **Improved cash flows and liquidity:** Interoperability can also be linked to increased cash flows and access to liquidity due to the fact that different firms and agencies can seamlessly communicate with each other and access real-time information, allowing for the faster disbursal of funds. This is evidenced by the credit line feature that is now available on UPI, where users can access instant, small-ticket borrowing with a 45-day repayment window (Verma, 2025).
- **Formalisation of the informal economy:** Scalability can enable formalisation i.e., reaching previously excluded sections of the population. With the rapid adoption of both Aadhaar and UPI in India, there was a concurrent rise in the number of bank accounts opened. This enabled previously unbanked sections (many of whom were engaged in a micro or small business practice) to enter the formal economy, allowing them to access financial services. This goes hand-in-hand with an improvement in cash flows and access to liquidity.
- **Innovation ecosystem catalysis:** Modularity can drive this, allowing developers to access existing digital blocks due to open protocols and build on them for different use cases since the blocks themselves are minimalist and adaptable by nature. Open Banking was mandated by the UK government in 2018, wherein the country's nine largest banks were required to openly share transaction data with licensed startups (Manthorpe, 2018). This led to the emergence of a number of fintech companies that accessed the data through open APIs to then build products and services on top of them. As of 2025, 1 in 5 banking customers in the UK uses open banking products and services, and nearly 8% of all quick payments in the UK are done through open banking applications (Open Banking, 2025).

Two key elements of DPI's economic value creation impact emerge here. The first is that in terms of *scope*, private sector adoption of DPI – when the DPI is built and managed in keeping with the DPI approach – straddles both relevant categories of Eaves et al's (2025) economic impact framework. The outcomes can manifest as dynamic effects in the form of efficiency gains, as well as market-shaping effects via macro market discontinuities and new market creation.

In terms of *scale*, however, DPI's long-term impact is likely to be bounded by its core nature. As we have noted, it is essentially a reconceptualisation and repurposing of a number of technologies, such as microservices architecture. In addition, its value creation pathways and on-ground evidence make it clear that the innovation ecosystems it catalyses stop short of fundamentally altering factors and means of production. Taken together, these two elements point to DPI's economic impact being broad in scope, but its scale being limited to service and product delivery innovation rather than production innovation.

These boundaries are defined by DPI's economic value generation paradigm: it enables both efficiency gains and macro market discontinuities primarily via its institutional innovation, not through introducing deeply catalytic technological innovation to the market. Interoperability, modularity, extensibility and privacy by design are defined by deliberate governance design choices that lead to specific configurations of existing technologies. The same technologies, when deployed under other different governance and institutional frameworks that do not prioritise public good, whole-of-government and open innovation outcomes, will lead to drastically different outcomes. This is, after all, not a hypothetical; the government and market systems that preceded DPI were the result of precisely those different choices. These choices exist on a spectrum, not in a binary state. Within the growing pool of DPI deployments across countries, different institutional and governance pathways can lead to different outcomes as well, as Brien et al (2025) find.

2.c. Current evidence of impact

Real-world deployments demonstrate DPI's capacity to transform service delivery and financial inclusion at a national scale. These implementations provide empirical evidence of both the opportunities and challenges in building digital public infrastructure. While they are insufficient on their own to indicate the longer-term macro potential for economic impact, they provide proof of concept.

Estonia provides a fine example. At the turn of the millennium, IT specialists in Estonia piloted a project in which three government databases were interconnected to bypass the need to acquire permissions manually in order to access the data. The pilot was able to demonstrate how cross-departmental data could be accessed faster and how this drives up efficiency. The pilot also showed that faster access did not come at the expense of reduced security, as all data was encrypted and digital permissions were still required to access the data. However, given that Estonia had already rolled out eIDs in the country, verification of access requests was not a hurdle (Veldre, 2016). The pilot demonstration was successful and was eventually scaled up to become the X-Road initiative – the first DPI to be built. Since its implementation, an estimated 3,000 e-services have been offered over the platform, which has helped Estonia save over 1,345 years of working time annually. X-Road has also been implemented in more than 20 countries around the world, reaching a total of 558 million end users globally (Lars, 2025).

India's DPI deployments are another instance of proven impact, with enterprises successfully integrating various DPI systems or components into their workflows. Perhaps the most prominent example is Aadhaar's use as a verifiable identity proof to open bank accounts, access credit services, insurance, etc. This has brought electronic Know Your Customer (eKYC) costs down from roughly $12 per individual to less than $0.06 (Kawale, 2024). UPI, meanwhile, has opened up avenues for private sector players like Google, PhonePe, etc. to offer financial services to businesses and customers through applications that utilise the underlying payments infrastructure layer (Verma, 2025).

3. The innovation classification framework

Garcia and Calatone's (2002) innovation typology provides a structured approach to categorising innovations based on their capacity to create technological and market discontinuities. After surveying innovation literature, they distil the various ways to assess an innovation's economic potential into three categories: radical, really new and incremental. Radical innovations create both technological and market paradigm shifts at the macro and micro levels, incremental innovations create either technological or market shifts at the micro level, and really new innovations cover all the ground in between.

There are multiple concepts here that are important for situating DPI appropriately within the three categories. The first is the core definition of innovation. This goes back to the Organisation for Economic Cooperation and Development's 1991 definition of technological innovation (Freeman, 1991), which has two elements. It holds that innovation is iterative – a new technology may undergo market diffusion, then become the foundation for further waves of innovation. And it holds that new technology does not equal innovation. It must be mediated by a host of development, production and marketing processes that transform it into a good or service that is made accessible to end users in the market via diffusion. The core product may undergo further improvements during the diffusion process. This entire chain of processes – starting with developing the core technology, moving on to taking it to market and ending with user adoption – constitutes innovation.

The second concept is the distinction between macro and micro discontinuities. Macro discontinuities reflect an innovation's ability to bring about a paradigm shift in science and technology or to wrench market structures at the global scale or in an industry in new directions. It is independent of individual firms' resources and skills. Micro discontinuities restrict the scope of an innovation's impact to individual firms' existing knowledge, capacity and capabilities on both the technology and non-technology fronts.

3.a. Economic implications of innovation types

Each innovation category – radical, really new and incremental – corresponds to distinct patterns of economic impact, from bounded efficiency gains to economy-wide transformation. Understanding these patterns helps calibrate expectations for DPI's potential contribution to economic growth and development. It also enables linking this framework to the economic impact categories in Eaves et al’s (2025) economic impact framework.

- **Radical innovation:** They bring new technologies to markets, and in doing so, create new industries and markets. Such innovations do not arise from addressing existing demand; instead, they are new enough to markets, producers and consumers to create new, hitherto unknown demand. This kind of macro discontinuity will always result in micro discontinuities as well, given the inevitable impact of such disruption on individual firms. Its effects, therefore, span both the dynamic and market-shaping categories of the economic impact framework.
- **Really new innovation:** Such innovations also create discontinuities at both the macro and micro levels. Unlike radical innovations, however, they bring about these paradigm shifts in only one of the technological or marketing categories at the macro level. At the micro level, they can bring about such shifts in either or both categories. Given this, the effects of the innovation can manifest as entirely new product types that cater to existing demand, as existing technology repurposed to create new markets, or as introducing new technology to existing products in order to improve them. Depending on the specific configuration, these effects can fall into either the dynamic or the market-shaping categories of the economic impact framework.
- **Incremental innovation:** While the previous categories can be difficult to distinguish between and can often lead to innovations being mistakenly assessed, incremental innovations are relatively straightforward – improving existing technologies and products in existing markets as a way to gain competitive advantage in mature ecosystems. Such effects fall within the dynamic category of the economic impact framework.

4. Comparative innovation analysis

To position DPI accurately, we compare it against two innovation categories: incremental innovation, represented by SaaS, and radical innovation, represented by GPTs such as electricity and information and communications technology (ICT) (the personal computer and the internet). While AI may emerge as the next GPT and is a closer technological analogue, its infancy makes historical GPTs more reliable benchmarks.

4.a. The incremental benchmark: Software-as-a-service

Incremental innovations can catalyse innovation and improvements at the firm level via multiple pathways. SaaS is an instance of a service delivery innovation; it alters how software services and products are delivered without fundamentally altering production or creating new industries. It reduces friction and improves efficiency and convenience, but remains bounded in transformative scope, operating within established economic paradigms and market structures.

In the initial part of its rise and spread, starting in the early 2000s, its market impact stemmed primarily from shifting the software industry from a one-time purchase to a subscription model. With the advent of microservices in the next decade, the breadth of improvements to the software delivery model increased, accompanied by a commensurate increase in impact. This was a natural evolution for SaaS, allowing for agility and on-the-fly evolution and innovation in a live service environment, crucial for enterprise software.

Among service delivery innovations, SaaS offers the closest parallel to DPI's digital architecture and deployment model. Both leverage microservices architecture, cloud infrastructure and APIs, making SaaS the most instructive benchmark for understanding DPI's innovation type and economic potential. However, starting from this common grounding, SaaS and DPI diverge at several points as well. Those differences tell a story.

4.a.i. SaaS evolution

Determining the innovation and economic value generated by software is a tricky proposition. The measurement challenge begins with its ubiquity. This pervasiveness is two-sided. Software is core to the business and operations of nearly every sector across agriculture, manufacturing and services. Equally, it is the product of contributions from well beyond the software industry. Focusing on just the software industry, therefore, undershoots the value it creates by a significant margin. The evolution of digital markets creates another layer of complications. Zero-price digital products and services embodied through software don't have traditional financial models; firms' incentive in such cases is not profit creation but acquisition of data and customers (Kira, Sinha & Srinivasan, 2021).

By the mid-1990s, the shifts in consumption and production brought about by the rise and diffusion of software and information technology more broadly had made entire segments of the global economy hard to measure. The rise of cloud computing and SaaS in the late 1990s and early 2000s, with accounting and financial management tool NetSuite and Salesforce's customer relationship management system, further shifted the market. SaaS was a replacement for Application Service Provisioning (ASP), a delivery model that contained within itself hosting, maintenance, and support services. The key difference is that SaaS is a standardised product, whereas with ASPs, each customer uses their own instance of the software (Mäkilä et. al., 2010).

While it took time for enterprises and other customers to become comfortable with software as a service, the evolution of microservices-based SaaS a decade later helped the enterprise application industry make a strong, persistent reply in the wake of the 2008 global financial crisis. It isn't a coincidence that many of the next generation of SaaS companies that would go on to hold strong market positions went public around this time. (Bandulet, 2017).

Despite this, most SaaS providers over the following decade had low to negative profitability. The disruption flowed from a strong service delivery innovation push. Simply having the vendor host the enterprise software on its servers instead of having it deployed at the client's premises doesn't make it SaaS. Software as a service entails being on-demand self-service; possessing multi-tenant resource pooling; and agility in responding to changing demands and requirements, among other characteristics (Mell & Grance, 2011). The upshot is that it isn't possible to simply modify packaged software to function as SaaS. This is a ground-up exercise. The software must be specifically coded to run with a low resource cost, have a multi-tenant architecture, and enable patches and upgrades in a live environment (Bandulet, 2017). This was not an easy pivot for packaged software companies to make.

4.a.ii. SaaS characteristics

Mäkilä et. al. (2010) collate a variety of definitions of SaaS and arrive at a basic set of characteristics from them. We reviewed the listed definitions and suggest the following set of characteristics:

- **Centralised hosting and management:** The application is deployed from a centralised, provider-managed data centre. All infrastructure, updates, and maintenance are handled by the vendor, not the customer, and users access it remotely via the Internet, intranet, LAN, or VPN.
- **Remote, on-demand access:** SaaS allows for time and location-independent use via online connectivity, where customers rent, subscribe to, or are granted access to software rather than installing and owning it.
- **Subscription or usage-based pricing:** SaaS operates on a recurring fee model (monthly, per-use, or per-user) rather than perpetual licenses. This model typically bundles infrastructure, hosting, support, and software access into a single, predictable charge.
- **Multi-tenancy and shared resources:** A single application instance allows multiple independent customers to use it concurrently. This approach fosters economies of scale and facilitates continuous updates and upgrades.
- **Continuous updates and innovation:** The model facilitates consistent delivery of new features and efficiency enhancements. Customers automatically gain from vendor-driven improvements, eliminating the need for further investment in hardware or upgrades.

4.a.iii. SaaS economic impact

The biggest obstacle to measuring SaaS's economic impact – rather than the economic performance of SaaS firms themselves, which is relatively well-documented – is the reductiveness of the idea of software. The advent of SaaS in the early 2000s magnified this issue; its economic potential rested only partly upon the core product. Much of SaaS's value over the past two decades has come from the efficiencies it has unlocked through service delivery innovation, incorporating elements of infrastructure as a service and platform as a service. These have, in turn, unlocked innovations across client firms' operational heads, from capacity and capabilities to workflows and budgeting. The cumulative impact outstrips the efficiencies enabled by the previous generation software licensing model to an extent that client firms still haven't fully internalised. Gomez, Cram, and Lawrence (2022) found that non-software companies that were primary software customers – with SaaS now making up the bulk of the enterprise software market – consistently experienced positive forecast errors and greater-than-expected returns.

This evolution, powered by SaaS, is part of the broader 'dematerialisation' of the economy. Cloud computing, broadly, and SaaS, more specifically, enabled firms to move away from their reliance on in-house servers and other hardware. The pay-as-you-go model reduced the upfront expense of software licenses while adding the strategic flexibility of being able to scale up rapidly when needed. The paradigm shift from software as a product to SaaS extended to labour costs, physical space requirements and other operational expenses. The resulting cost reductions, efficiencies and agility have enhanced the revenue growth and resilience of firms (Hooton, 2019).

While this seems the natural outcome for firms utilising SaaS – it is, by definition, meant to outsource computing and associated infrastructure, after all – realising its economic potential is not quite so simple. It depends to a significant extent on a firm's absorptive capacity. This plays a crucial role in knowledge economies and has underwritten the shift from closed innovation models to open innovation models (Loukis, Janssen & Mintchev, 2019). It refers to a firm's ability to acquire external knowledge, internalise it, combine it with internal knowledge, and utilise it effectively.

A firm with adequate absorptive capacity has the potential to unlock the full suite of complementary innovations that lead to direct efficiencies and savings. Such innovations go well beyond simply downsizing IT staff and reducing hardware overheads. They point to deep rethinking and reorganising of internal labour management, workflows, and market opportunity assessments, among other core functions. For instance, the role of ICT staff in a firm utilising SaaS often shifts from technical to business-oriented. As mediators between the technology creators – the SaaS vendor – and the firm's business and marketing staff that are its end users, they now have the potential to steer the firm towards deploying technology towards assessing and responding to market demand more effectively (Loukis, Janssen & Mintchev, 2019). This labour restructuring goes both ways. Integrating technology into workflows and maximising its market relevance becomes decentralised – no longer just the preserve of ICT staff but dependent on business staff inputs as well. All of this must be underwritten by a reimagining of internal processes.

Malladi and Krishnan (2012) test this out with an empirical study looking at data from 243 US firms and find that it holds true: firms that restructure and innovate on these fronts are more likely to realise efficiencies and savings. However, there is less evidence for SaaS enabling the kind of combinatorial innovation that leads to macro market discontinuity and long-term non-linear economic and productivity growth. The efficiencies, scalability and agility that SaaS enables have led to more incremental gains on this front. It has allowed firms to address more niche market segments and reduce go-to-market timelines, as well as contribute to product innovation. These fall within the ambit of producing new products and services in the same mould as existing offerings, or improving the latter. Little points to the ultimate expressions of combinatorial innovation's potential such as new market creation.

Quantifying these gains is difficult, as we have noted. The complexities involved have led to diverging estimates that use different methodologies and often measure different components. Additionally, the permeability of software categories means that it is difficult to differentiate between cloud computing, broadly speaking, which includes other offerings such as AI and SaaS. We should therefore look at cloud computing economic impact estimates as no more than broad signposts. On the lower end, Hooton (2019) used U.S. Bureau of Economic Analysis data to chart cloud economy growth from 2002 to 2007, through until 2012. Based on this growth rate, he extrapolated that the cloud economy contributed approximately $214 billion or 1.1 per cent to US GDP in 2017, nearly tripling in size since 2002. A 2024 study looked at global markets, finding that the cloud economy had contributed over $1 trillion to global GDP in 2023. The North American (US and Canada) component of this was $457 billion; this is in the general ballpark of Hooton's estimates if the line were extended through 2017 until 2023.

4.b. The radical benchmark: General-purpose technologies

General-purpose technologies are innovations that have a profound and lasting impact on multiple sectors of the economy, leading to widespread and transformative changes. These technologies are characterised by their adaptability, ubiquity, and ability to catalyse innovation and economic growth across various industries. GPTs such as steam power, electricity, and ICT have historically driven significant economic and societal change, often leading to industry-wide restructuring.

The steam engine, invented in the 1700s, revolutionised economies during the Industrial Revolution through its adaptability, ubiquity, and transformative capacity. It found applications in manufacturing, agriculture, and transportation, boosting efficiency and productivity. The electricity revolution in the late 19th and early 20th centuries had a profound economic impact, driving sustained periods of growth and enabling the development of new industries. Electricity demonstrated flexibility and adaptability by powering machines, tools, and assembly lines across various sectors.

The ICT revolution transformed how information is transmitted and shared, leading to increased efficiency, reduced transaction costs, and new business models. Taken together, personal computers and the internet have reshaped industries, created new jobs, and driven innovation across various sectors, including communication, data processing, and automation. The internet, in particular, has been a catalyst for significant economic growth, enabling e-commerce, remote work, and the development of new digital industries.

These GPTs exemplify how transformative technologies can drive long-term economic growth, productivity increases, and the development of new industries, ultimately reshaping economies and societies.

4.b.i. Defining GPT characteristics

The literature proposes many different ways of characterising GPTs. We propose to draw on the work of Bresnehan (2012) and consider three characteristics of general-purpose technologies that contribute to their economic impact. They are: adaptable (flexible and iterative), ubiquitous (pervasive and self-reinforcing), and transformative (synergistic and catalytic). It is the combination of these qualities that has underpinned their substantial social and economic impact.

- **Adaptable**

  GPTs emerge and evolve through a process of combining and recombining existing technologies in novel ways (Brian, 2009). For example, the steam engine combined elements like pistons, cylinders, and valves that had previously been used separately. GPTs are dynamic technologies that continuously improve through recombination and refinement. They are highly flexible and can be adapted to different uses and industries, allowing for widespread adoption and significant influence across various sectors of the economy. This versatility, coupled with their strong capacity for technological advancement, enables GPTs to evolve and become more efficient over time. As they integrate with other technologies and complementary innovations, GPTs create an expanding network of linked technologies that drive successive waves of innovation, sustaining long-term economic growth and boosting productivity across multiple applications.

- **Ubiquitous**

  GPTs are pervasive and have applications in a broad range of industries and sectors. This widespread applicability allows them to transform various aspects of the economy, including production, distribution, communication, and consumption. Furthermore, GPTs often exhibit powerful network effects, where the value of the technology increases as more people or organisations adopt it. This self-reinforcing cycle promotes rapid uptake and diffusion of the technology, amplifying its economic impact. The combination of pervasiveness and network effects allows GPTs to drive innovation, productivity growth, and structural change across multiple domains.

- **Transformative**

  GPTs do not evolve in isolation but as part of a complex, interconnected ecosystem. They form an expanding network of technologies that are deeply interlinked and co-evolve over time. Advances in one technology can spur progress in others, creating a dynamic ecosystem where innovations in different domains reinforce and amplify each other, leading to widespread and sustained economic impact. New technologies arise not from scratch but through the novel recombination of existing components, methods, and ideas. The more diverse and malleable the set of available building blocks, the greater the scope for combinatorial innovation. The wider the accessibility and interoperability of these building blocks, the larger the pool of potential innovators who can engage in this recombinant process.

4.b.ii. Economic impact of GPTs

GPTs' economic impact is characterized by their ability to boost productivity across multiple applications, create synergies with other technologies, and generate significant spill-over effects. These technologies spur advancements in related fields and create entirely new industries. The powerful network effects associated with GPTs promote rapid uptake and diffusion, amplifying their economic impact. The economic impact of GPTs is far-reaching and unfolds over multiple decades as they become more widely adopted and integrated into different sectors of the economy. They have the power to reshape entire industries, drive productivity growth, foster innovation, and create widespread ripple effects that span generations.

The adaptability, ubiquity, and transformative capacity of GPTs underpin their ability to drive long-term economic growth, productivity improvements, and structural changes across various sectors. It is the powerful combination of these characteristics that distinguishes GPTs from other innovations and enables them to have such a profound and lasting impact on the economy and society.

The steam engine, for instance, revolutionised economies during the Industrial Revolution. Its adaptability allowed it to be used in various industries, including manufacturing, agriculture, and transportation. The widespread adoption of the steam engine boosted efficiency, increased output, and lowered costs, ultimately driving significant economic growth and development. The electricity revolution enabled the development of new industries and technologies. Its pervasive nature transformed production processes, improved efficiency, and facilitated the creation of new products and services across the economy. The network effects associated with electricity led to the rapid adoption and expansion of the infrastructure, further amplifying its economic impact.

Similarly, the ICT revolution has significantly transformed the economy by revolutionising information transmission and sharing. These technologies have increased efficiency, reduced transaction costs, and enabled the emergence of new business models. The internet, in particular, has been a catalyst for rapid economic growth, facilitating the rise of e-commerce, remote work, and digital industries. Computers and IT have reshaped the economy through their adaptability, ubiquity, and transformative capacity. Their evolution has driven productivity growth and innovation across various industries, transforming business operations, communication, and entertainment. The integration of computers with other technologies, such as the Internet of Things (IoT) and automation, has further enhanced efficiency and cost savings.

GPTs have been crucial drivers of economic growth, productivity, and innovation throughout history. However, their economic benefits may not be immediately apparent. For instance, the steam engine initially faced challenges and negative productivity growth during its early transition phase. Similarly, the effects of electricity unfolded over decades due to the gradual nature of infrastructure development and expansion. Nonetheless, the adaptability, ubiquity, and transformative capacity of GPTs have enabled them to reshape entire economies and societies, creating new opportunities and laying the foundation for modern industrial and digital economies.

5. DPI's position in the innovation spectrum

Systematic comparison reveals DPI exceeds service delivery innovations through its open architecture and economy-wide scope, yet falls short of GPT status due to limited production transformation. This positions DPI as a "really new innovation" with distinctive democratizing characteristics.

5.a. Exceeding incremental innovation (vs SaaS)

DPI can be seen as an evolution of proprietary software, at least in the context of the public sector. Yet, its development is not solely in response to the issues associated with proprietary products and services. The success of X-Road, followed by India's Aadhaar and UPI, forced the private sector to take notice and begin experimenting with potential commercial use cases. This was made possible by DPI's open, public infrastructure model; this creates fundamentally different value propositions than proprietary software. The architectural differences enable economy-wide network effects and democratic access that transcend the bounded efficiency gains typical of incremental innovations, such as SaaS that deliver service delivery improvements. Furthermore, suitable policy choices have a significant impact on the growth trajectory of DPI. The zero-MDR policy in India, for example, essentially eliminated transaction costs for merchants, driving up mass adoption of UPI (Singh, 2025). In Estonia, policies that emphasise cybersecurity, interoperability, and open data access have enabled the country's X-Road platform, e-governance, and i-Voting systems to become models for trust and efficiency in public service delivery.

Given the key characteristics of DPI and SaaS as we have described them, we can now compare the two technologies to understand where the key convergences and divergences lie. In this analysis, we will approach the comparison from two separate points of view, i.e. in the first instance using the characteristics of DPI as the baseline, and in the second instance using the characteristics of SaaS as the baseline. Doing so helps avoid any inherent bias toward either of the technologies and allows for a more critical evaluation.

5.a.i. DPI's architectural advantages over SaaS

The primary point of divergence between DPI and SaaS is the open nature of the former compared to the proprietary nature of the latter. This makes vendor lock-in with SaaS likely – and in turn, vendor lock-in limits interoperability since each firm develops solutions with remote APIs and, in some cases, organisation-specific programming languages. While SaaS enterprise software packages do allow some amount of interoperability via exposed APIs, this is most often of the permissioned and limited kind, and may be limited to the vendor's own stable of products.

DPI Baseline

- **Interoperability:** DPI is built on open protocols and APIs to enable seamless communication between different systems, which in turn helps prevent monopolies and ensures tech neutrality. SaaS, on the other hand, is typically based on proprietary standards, but most modern SaaS providers expose certain APIs for the purposes of integration. The key risk with SaaS ecosystems is that they can become walled gardens (e.g., Salesforce, Microsoft 365).

- **Extensibility:** DPIs are built as a minimal, foundational layer that can scale across any number of use cases or users. Extensibility is systemic and intended to support entire economies and societies. With SaaS, however, extensibility is mainly achieved through add-ons, plugins, or APIs within the scope of the vendor's product. They are designed to scale efficiently, but nonetheless limited to the domain of the application (e.g., CRM, HR, finance).

- **Modularity:** DPIs are composed of reusable building blocks (identity, payments, data exchange) that are decoupled and interoperable. This allows innovators to combine and reuse blocks for new services, avoiding duplication of effort and resources. SaaS is typically a single cohesive application; modularity is offered via feature sets or integration with other SaaS tools. Modularity is more ecosystem-driven (e.g., Slack integrating with Google Drive) rather than being a core architectural principle.

- **Security and privacy by design:** Privacy features are embedded into the architecture of DPIs, i.e. verifiable credentials, multi-factor authentication, consent frameworks, etc. The aim is to build societal trust and auditability. The security of SaaS is managed centrally by the provider, such as encryption, authentication, compliance certifications (e.g., GDPR, SOC2) and so on. Privacy often depends on vendor policies; not always 'by design', but as regulatory compliance.

SaaS Baseline

- **Centralised hosting and management:** SaaS is hosted and fully managed by the vendor in centralised data centres. Users access it remotely without the need for local installation. With DPI, the hosting varies as it can be centralised (e.g Aadhaar) or federated (e.g. Estonia's X-Road).

- **Remote, on-demand access:** Users subscribe/rent SaaS via the internet or networks, and as such, access is time and location-independent. DPI is similar in that it is also designed for ubiquitous access (e.g. UPI payments via mobile), but access is meant to be universal and inclusive, not restricted to paying customers.

- **Subscription or usage-based pricing:** SaaS utilises a recurring revenue model (subscription, per-use, per-user), thereby bundling software, hosting, and updates into a single charge. DPI, however, is funded as public infrastructure (state budgets, donor funding, or hybrid models). Access is typically free or low-cost to users, with costs usually being subsidised by governing authorities.

- **Multi-tenancy and shared resources:** In the case of SaaS, one software instance supports many independent customers securely, reducing costs for the firm. DPI, on the other hand, is built on shared rails (identity, payments, data exchange) that serve both public and private actors simultaneously.

- **Continuous updates and maintenance:** Vendors push updates automatically for SaaS, ensuring that users are always on the latest version. With DPI, updates are governed by public processes (legal frameworks, security audits). Changes require a broad consensus to preserve trust and interoperability. This is, however, context-dependent. Governance structures vary from region to region, which in turn determines the level of consensus needed to make changes. Smaller changes or updates may be achieved with minimal buy-in, but more significant changes may need to go through a legal/electoral process.

5.a.ii. DPI surpasses incremental innovation limits

SaaS is proprietary software with limited means for customisation, which in turn limits its adaptability across additional use cases. It is perhaps of no surprise then that companies like Salesforce and Microsoft, often recognised as amongst the most valuable SaaS companies in the world, deliver products that primarily cater to corporate productivity. DPI, on the other hand, does not suffer from such limitations.

Given these convergences and divergences, we argue that DPI as a technology is superior to SaaS not only in the context of public services but also for private sector use cases. A study by Nagle (2015) demonstrates that firms adopting open source software (OSS) experience measurable productivity gains (Nagle, 2017). Using U.S. firm-level panel data and an instrumental variables approach, the study finds that even a small increase in OSS adoption (1%) leads to a statistically significant rise in productivity (0.002–0.008%), particularly for firms with strong complementary capabilities, such as in-house technical expertise. These gains arise from cost savings on license-free software, reuse of high-quality code, faster development cycles, access to collaborative improvements through developer communities, and knowledge spillovers from the open ecosystem. Collectively, these mechanisms enable a more efficient and innovative software development process, improving firm-level economic performance.

DPI amplifies these benefits at a societal scale. Much like OSS reduces the cost and friction of building software, DPI lowers the cost and friction of delivering services across domains such as financial inclusion, healthcare, and governance. Platforms such as MOSIP provide modular, reusable digital ‘building blocks’ that both public and private actors can freely access. By offering these open and interoperable foundational layers, DPI allows a wide range of downstream innovations without requiring each actor to build the underlying infrastructure from scratch. In this sense, DPI institutionalises the logic of open source software, creating shared digital rails that catalyse innovation across entire economies.

The open nature of DPI also aligns with Romer's (1990) endogenous growth theory, which emphasises that innovation is driven by the non-rival, spillover nature of knowledge. Open, interoperable digital systems function as public goods, amplifying innovation across sectors, whereas proprietary systems impose friction, limit spillovers, and often lead to redundant development efforts. Supporting this, Wright et al (2023) find a positive relationship between a country's OSS participation (measured via GitHub contributions) and the formation of innovative startups. This effect is particularly pronounced in countries with lower GDP per capita, suggesting that open systems help compensate for traditional resource constraints.

These insights directly translate to DPI. Open participation, a core feature of DPI, enables wider engagement in digital and economic ecosystems. For example, UPI allows any entrepreneur to build payment-enabled services, while ONDC enables small businesses to access national e-commerce networks without platform lock-in. DPI also reduces resource dependence: Aadhaar facilitates KYC verification for rural populations without physical documentation, and Account Aggregator frameworks allow small borrowers to securely share financial data to access credit. Furthermore, DPI fosters knowledge spillovers and ecosystem formation; its open APIs allow MSMEs, fintechs, and health startups to leverage infrastructure for broader social and economic impact. In essence, DPI functions not as a discrete product but as a general-purpose platform that reduces barriers to entry, encourages local adaptation, and unlocks commercial value at scale.

Thus, while both SaaS and DPI enable service delivery innovation, the scope is different for each. DPI's public, interoperable design allows these benefits to extend across an entire economy, giving it a broader potential to generate economic value compared to proprietary SaaS solutions, which are typically locked within single vendors and markets.

5.b. Falling short of GPT status

Beyond raw numbers, DPI has captured imaginations with an attractive narrative: that developing nations can bypass decades of digital infrastructure building through digital protocols. This has catapulted it from a technical idea to a global policy agenda. Emerging economies, led by India and Brazil, have been at the forefront: Aadhaar, UPI, and Pix are now seen as reference models for digital identity and payments worldwide. Multilateral forums such as the G20, World Bank, and UN have embraced DPI as a new platform for inclusion, service delivery, and innovation. This prominence has sparked a broader debate: can DPI also serve as a growth enabler, allowing developing countries to "leapfrog" in economic terms?

The tentative hope is yes, based on early proxies such as scale of DPI-enabled inclusion in economic activity and measurable evidence spanning both categories of the economic impact framework – from private sector efficiency gains and market disruptions in the dynamic category in areas such as banking and credit to potential structural transformation in the market-shaping category, such as in the power and energy sector (Foundation for Interoperability in Digital Economy, 2025). However, there is a ceiling to this impact compared to the deeply transformative market-shaping effects GPTs have.

5.b.i. Limited production transformation

It is tempting to assess DPI by borrowing intuitions from how economists study production technologies such as ICT — tools that directly increase output per worker. But DPI operates through institutional and network channels, not production ones. It is infrastructure for coordination and exchange, not for physical production. This fundamentally changes how its contribution to growth should be measured and valued.

Traditional growth accounting stemming from Solow's model decomposes output growth into labour, capital, and a residual (TFP). Technologies like electricity and ICT showed up either as capital deepening (more machines deployed per worker) or as embodied technological progress (new generations of equipment that incorporated efficiency improvements).

- **Physical capital augmentation**: Workers operated tangible machinery that multiplied their individual output capacity
- **Production function shifts**: The same workforce could now access fundamentally higher production possibilities
- **Embodied technical progress**: Innovation was literally purchased—buying a 1920 motor meant buying 20 years of engineering advances
- **Measurable capital deepening**: Balance sheets and GDP statistics could directly track technology adoption through equipment investment

This logic doesn't fit DPI. It is best understood as a techno-institutional layer – a set of digital rules and shared protocols that lower the costs of transacting. By making it faster and cheaper to prove identity, move money, or share data, it reduces frictions in compliance, settlement, and enforcement. Its economic contribution, therefore, comes not from producing more with the same inputs, but from enabling more people and firms to participate in markets on fairer terms. In this sense, DPI's effects are structural and cumulative rather than instantaneous or output-enhancing.

- **Institutional infrastructure:** Creates shared trust mechanisms that substitute for personal relationships and physical documentation
- **Transaction cost reduction:** Eliminates the time, paperwork, and intermediaries that previously made small transactions uneconomical
- **Participation expansion:** Transforms "unbankable" populations into viable customers by changing the economics of serving them
- **Network effects:** Each new user makes the system more valuable for all existing users, unlike machines that deliver fixed output

5.b.ii. DPI's bounded transformation scope

As we have seen, DPI's economic effects unfold across both categories of the economic impact framework, each operating on different timescales with varying degrees of certainty. The first category — immediate efficiency gains stemming from new private sector use cases — is concrete, measurable, and already visible across deployments worldwide. The second category — market shaping effects — emerges as adoption deepens and network effects compound.

Much of the impact here remains largely speculative but potentially significant. When DPI rails achieve critical mass, they become platforms for entrepreneurial innovation. India's UPI and Brazil's Pix demonstrate how open payment infrastructure can spawn entire fintech ecosystems, though quantifying these effects remains challenging. DPI platforms like ONDC and Account Aggregators could go further, reshaping entire sectors by democratising access to markets and data. These represent the most speculative but potentially transformative applications, where DPI moves from reducing friction to enabling fundamentally new economic arrangements. The degree to which DPI can bring about such structural transformation is an open question, with the contours of an answer likely to emerge only in the medium term.

That answer will be highly contingent on institutional design. The same infrastructure that enables broad-based innovation under open governance can concentrate power under closed systems. The gap between DPI's transformative potential and likely reality depends critically on implementation choices that remain unsettled across most deployments. For instance:

- Contingent on governance choices (open vs. closed)
- Dependent on complementary reforms
- Winner-take-all dynamics vs. broad-based gains
- Risk of platform capture negating benefits

However, DPI’s impact stemming from service delivery innovation rather than deep technological and production-altering innovation bounds its impact relative to GPTs. A 2024 BIS study examining 101 economies between 2014 and 2019 finds that a one percentage point increase in digital payment use is associated with a 0.10 percentage point rise in GDP-per-capita growth over two years (Aguilar et al., 2024). The relationship is statistically significant but modest, and the authors note that it operates primarily through inclusion and formalisation rather than productivity.

When controlling for broader digitalisation and governance quality, the study finds no robust link between digital payments and total factor productivity (TFP) growth. The growth effects arise instead on the extensive margin through broader participation via financial inclusion, credit access, and reductions in informality, rather than through higher output per worker.

This pattern illustrates DPI’s distinctive contribution: it expands who can participate in markets and how efficiently they transact, even if those gains do not immediately appear as higher productivity. These findings reinforce the view that DPI’s early impacts are institutional and redistributive before they become transformative. Its economic effects accumulate through lowered transaction frictions, widened participation, and, eventually, new forms of innovation built on trusted digital rails.

6. Conclusion

DPI was developed to address certain core challenges in the public sector. It has since demonstrated profound spillover effects, enabling several pathways for private enterprises to increase efficiency, create new business models and catalyse new markets. The technology that underpins DPI and allows it to have such spillover effects is not novel, but its impact has been profound in specific contexts. Its key differentiator lies not in technological breakthrough but in governance models that transform how digital infrastructure is conceived, deployed, and accessed. This institutional approach explains both its rapid adoption in developing nations and measured productivity impacts. It is also the reason why the digital public infrastructure phenomenon is increasingly known as the DPI approach – which contains the entire package of technology, institutional architecture and governance design – and not merely DPI, which would imply that the core technological artefacts were the differentiator.

Its success as a tool to enable key public sector goals can be attributed, in the main, to this institutional architecture ensuring that DPI instances are open and interoperable. 'Openness' has been an element of the technological landscape since the very beginning of the information technology revolution and has competed for supremacy in the market. Its lack of prevalence comes down to its inability to succeed in the public sector. However, while proprietary innovation in the software field successfully wooed public sector clients the world over, it quickly became evident that its proposition came with too many limitations. Thus, the public sector started experimenting with open source tools before the advent of DPI – its spiritual successor in some ways.

6.a. The core finding

The existing literature on DPI has analysed its impact from several different points of view; however, little work has been done so far from the private enterprise perspective. This paper aimed to fill that gap by offering a lens through which to address questions of impact (realised and unrealised; direct and indirect) of DPI in the private sector. In mature DPI ecosystems such as India, Estonia, and Brazil, there are several examples of the private sector building on top of the foundational technological layers of identity, payments, and data-sharing to create products and services that can create macro and micro market discontinuities. This is enabled by governance innovation that transposes the logic underlying public provision of hard infrastructure – long understood as a modern state's responsibility and prerogative due to the societal and economic benefits generated – to the digital economy. In fact, without the appropriate governance choices being taken, it is unlikely that DPI will produce the kind of transformative results described in this paper. A conducive policy environment, combined with pervasive and sophisticated digital infrastructure, along with talented human resources, can enable DPI to realise its highest potential. The aforementioned mature ecosystems all have these characteristics to varying degrees, and as such serve as relative paragons of a DPI enabling ecosystem. DPI's value-generating ability exists on a scale, and its precise positioning is a direct consequence of how it is governed. Suppose the principle of openness is not embraced to the preferred degree; in that case, its impact will be no greater than that of SaaS, which has been the main technology used in the public sector for several years. This will be a mere continuation of the digital economy's trajectory thus far, with proprietary private platform models restricting spillover effects and establishing market barriers for competition that have proved difficult to overcome. Therefore, our paper seeks to inform choices related to the public provisioning of digital infrastructure, especially in relation to choices dealing with questions of approach and governance models.

We have linked the DPI economic impact framework developed by Eaves et. al. (2025) to Garcia and Calatone (2002)'s innovation typology framework. By doing so, we have situated DPI in the latter as a 'really new' innovation. We have also analysed DPI in the context of SaaS and GPTs – situated in the innovation typology framework as 'incremental innovation' and 'radical innovation' respectively – to arrive at DPI's economic value creation potential. GPTs, given their transformational qualities, sit logically at the upper boundary of value generation, while SaaS, albeit pervasive, sits at the lower boundary. SaaS in particular serves as a useful analogue through which to understand DPI, given that SaaS products and services have permeated the public and private sectors globally. SaaS is also the ideological and institutional counterpart to DPI, owing to its proprietary nature as against DPI's open nature. Our comparative analysis between DPI and SaaS shows that the two technologies converge and diverge on specific characteristics that inform our ability to position DPI between SaaS and GPTs, albeit closer to the former than the latter. The key characteristic at play is 'openness'. The work of Frank Nagle has investigated open source technologies and their impact on innovation, and their findings serve as the theoretical underpinning for our argument that DPI sits above SaaS in our scale of the three technologies. This is primarily due to the fact that openness fosters innovation in a way that proprietary technologies do not.

Real-world examples in India, Brazil, and Estonia show how technological features such as interoperability and modularity, which are essential to DPI, have allowed commercial actors to build products and scale extensively in a short period of time. Additionally, examples from the UK and Sri Lanka show the combinatorial potential of DPI, enabling innovations that transcend the predictable applications in identity verification and financial services.

6.b. Why institutional innovation matters

Recognizing DPI's institutional nature clarifies both its unique value and the choices required to realise its potential. Firstly, it gives us a lens through which to view DPI, even if the framing is broad. Given its nascency, much of the literature that has focused on DPI has offered little in terms of categorisation in relation to other technologies. Rectifying this contributes to addressing an issue that is increasingly in policy and research focus: determining DPI's economic impact and economic value creation potential.

Secondly, our analysis serves as a useful indicator for public and private investment choices. Economic growth is reliant upon societal access to public goods. This is not limited to traditional services such as healthcare and education; it also includes access to research and innovation. For countries that are examining various pathways to inclusive growth, understanding the potential that DPI offers as a means for spurring growth will enable better decision-making.

Thirdly, our paper makes the case for a DPI that conforms to its key characteristics as described in earlier sections. Much of the value-generating potential comes from a supportive and conducive environment, which includes the research and innovation ecosystem and the policy landscape. There are variations in how DPI is governed and the environment in which it operates, and these variations have implications for its ability to create value.

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