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In this article, the authors discuss using blockchain technology in the tax arena, suggesting that it provides the opportunity for increased transparency and reduced transaction costs while cautioning that the technology is new and that officials must be aware of potential problems such as a loss of privacy.

The term "blockchain" is on many people's lips, and for good reason: It is a potentially transformational technology that could have as much impact as the arrival of the internet in the 1990s. The ability to create a transparent and immutable record of transactions between parties that may not fully trust one another has obvious applications in the field of finance and financial regulation. Add in the ability to automate transactions using "smart contracts" and you have a recipe for slashing transactional costs and reducing the need for traditional intermediaries.

But what about taxation? There is a lot of discussion and innovation centered around using blockchain in financial markets, but tax risks falling behind.

On March 15 and 16, the Global Tax Policy Center at Vienna University of Economics and Business (WU GTPC), in partnership with New Economy Taxation, initiated a global program to study the impact of blockchain on taxation with a groundbreaking meeting of senior tax officials, legal experts, industry specialists, technologists, and academics. These initial discussions confirmed that blockchain has the potential to transform taxation too. For example, one use of blockchain proposes to embed tax compliance in the very processes businesses use to conduct transactions, practically eliminating compliance costs and removing many of the traditional opportunities for noncompliance. At the March meeting, we also discussed the need to develop mutual trust and understanding, as well as the importance of agreeing on similar terminology. The full agenda of the "Blockchain and Taxation" event is available online, and the focal points and key takeaways from the event are also received herein.

It is clear that a new approach to taxation based on the blockchain must be informed by an in-depth understanding of how the technology actually works, what problems it can solve, and what issues may be better addressed by other information technology solutions. The WU GTPC is now leading a multidisciplinary effort to identify and assess the plausible uses that take advantage of the blockchain's true potential to transform taxation, based on a rigorous analysis of the attributes of a fast-evolving technology and a deep understanding of the fabric of our tax systems. The initiative opens a long-term dialogue on the topic and provides tax authorities with a platform to ask critical questions and assess risks. It will also conduct an operational, regulatory, and legal evaluation of the issues pertaining to

blockchain applications by addressing the concerns posed by industry specialists and academia. One of the program's ultimate objectives is to allow tax authorities to develop the confidence and competence needed to integrate this technology into the design of future tax policies. The initiative will also help select early-adopter tax administrations map out the steps and begin implementing blockchain at both the regulatory and technical levels. In partnership with New Economy Taxation, WU GTPC intends to bring this global initiative to Asia on August 15 and to the United States in 2018. Austria, our home base, held a government-sponsored conference on May 6-7, 2017.

What Is a Blockchain?

The term "blockchain" has seen an unprecedented rise in popularity, with interest in the term jumping 70 percent in a single year, from June 2016 to June 2017.[1]

Since its emergence in 2008, blockchain in its original public/permissionless form and the private/permissioned alternatives offered by platforms such as Ethereum[2] have been steadily gaining recognition among technologists, government officials, academics, and the general public alike.[3] The technology promises to remove intermediaries from transactions and allow direct peer-to-peer exchange of value, thus slashing transaction costs. It also allows for recordkeeping on transparent, immutable ledgers accessible to everyone and immune to tampering, a system known as distributed ledger technology (DLT).[4] These properties resonate with government tax authorities' need to improve compliance and conduct more efficient operations both domestically and internationally.

In the not too distant past, the term "blockchain" would not have been found in any dictionary. Nor was it coined in the initial bitcoin white paper[5] released under the pseudonym Satoshi Nakamoto in the wake of the financial crisis of 2008. After the release of that paper, it was bitcoin that stole the limelight. Bitcoin, a virtual currency or cryptocurrency, uses the internet for the exchange of electronic cash[6] in direct, peer-to-peer transactions (that is, with no third-party intermediary) when trust is lacking, using cryptographic tools as a replacement for the validation function traditionally supplied by an independent authority. Because it allowed for the removal of an intermediary from transactions between unrelated parties, bitcoin quickly became a go-to means of trade within the underworld, where owners of the currency wished to remain anonymous.[7] As a result, the association of bitcoin with illicit, disreputable activities contaminated the entire construct of the nascent technology and diverted a lot of attention from its other elements.

It wasn't until the financial institutions themselves, institutions that the inventors of blockchain sought to undermine, started to examine the underlying technology, namely the blockchain, that its true genius was appreciated. Captivatingly simple and very complex at the same time, blockchain technology solves one of the most persistent challenges of distributed network systems — the consensus problem — by allowing unrelated decision-makers with conflicting strategies to agree on a common value. The blockchain is essentially a continuous log of transactions that is synchronically updated across the distributed network, so that all parties store, control, and access their copy of the database, but no control hub holds a master key. Transactions occurring on the network are bundled into blocks.

[1] Statistics supplied by Google Trends.

[2] Ethereum is an open-source platform that allows for the creation of both public/permissionless and private/permissioned networks.

[3] *See, e.g.*, Kibum Kim and Taewong Kang, "Does Technology Against Corruption Always Lead to Benefit? The Potential Risks and Challenges of the Blockchain Technology," OECD Global Anti-Corruption and Integrity Forum (2017); Dong He et al., "Fintech and Financial Services: Initial Considerations," IMF Staff Discussion Note (June 2017); PwC, 2017 Digital IQ Report; and "Land Grab: Governments May Be Big Backers of the Blockchain," *The Economist*, June 1, 2017.

[4] Many people mistakenly assume that distributed ledger technology is a synonym for blockchain. Although often used interchangeably, the blockchain is actually one application of DLT, just as bitcoin is one application of the blockchain.

[5] Satoshi Nakamoto, "Bitcoin: A Peer-to-Peer Electronic Cash System" (2008).

[6] Today, the birth of blockchain is likened by many to the emergence of the internet in 1990s. It has been called the internet 2.0 since it allows for the exchange of value in the virtual realm rather than traditional exchange of information only.

[7] Pseudonymity rather than full anonymity is ensured for bitcoin traders.

Each block contains new information as well as a validation, or hash, of the prior block and a time stamp. The new information must comply with a pre-defined set of rules and must be attested to by a majority of special participants known as miners. As a result, one single party cannot tamper with the database undetected, as inconsistencies will be identified elsewhere on the network.

It is in the core economic interest of all parties to maintain the robustness and reliability of the blockchain, as every addition of a block to the existing chain triggers an injection of the limited number of bitcoins onto the network. Miners then have to discover, or "mine," these bitcoins.[8] Bitcoin, therefore, is simply an incentive meant to guarantee the key parameters of the blockchain that attribute to its appeal: the decentralization and distribution of data, with the latter being kept on the transparent, permanent, and immutable ledgers.

> *Case Study — Maersk.*[9] Recently, IBM and the shipping giant Maersk ran a pilot, digitalizing an entire supply chain process using a blockchain technology as an alternative to the traditional paper-based record of shipment process. On average, they estimated that paperwork costs account for 15 to 20 percent of the total shipment costs. Especially in low-margin contexts, blockchain could present a compelling alternative for the industry as a whole. The process is being tested to identify critical intersections, such as ports, shippers, and customs, to determine where nodes should be located on the network. Should the scalability test yield successful results, IBM hopes to transfer to blockchain 10 million out of the 70 million containers shipped annually by the end of the year.
>
> As a next step, industry experts hope that the transparency produced by the blockchain's open distributed ledgers with permissioned access could potentially yield far-reaching benefits by connecting the flow of goods to the providers of the trade finance, which could create an advanced substitute for the existing system of sharing information using cloud technology.

Another essential feature of the blockchain is the codification of the validation process that allows a transaction to be executed along the pre-defined algorithm. This is known as a "smart contract," a misnomer since it is neither smart nor a contract in a strict legal sense, but rather a piece of self-executing code. On the blockchain, validation is embedded into a transaction by the miners enforcing adherence to the pre-defined rules in order to accept the transaction. For example, one common rule is not to allow more to be spent than is in the user's account. Another is to ensure that the user trying to spend has the rights to the account, represented by a password and a private encryption key. Smart contracts can be thought of as extensions of a foundational set of pre-defined rules to situation-specific rules. These situation-specific rules, which are also enforced by miners, allow the logic, validation, and workflow traditionally performed by third-party intermediaries to be programmed into the blockchain.

> *Case Study — Beneficial Ownership.* G-20 leaders identified enhanced transparency regarding the beneficial ownership of legal persons and their arrangements as an issue of a "high priority" for ensuring the integrity and transparency of the global financial system. The Extractive Industries Transparency Initiative (EITI) advocates that "beneficial ownership transparency can help improve the investment climate, reduce reputational and financial risks, prevent corruption and illicit financial

[8] Bitcoins have real monetary value, which has fluctuated dramatically since the emergence of the cryptocurrency. The value of the bitcoins is a result of the economic principle known as a network effect. In the words of David Perry:

> The network effect is a lovely piece of jargon that refers to the quite commonsense statement that networked products and services tend to have more value when more people use them. . . . Bitcoin creates value for the old investors and the new by splitting a finite currency supply in more ways. That's not trickery or theft, just good old fashioned supply and demand at work — a basic and ancient economic principle applied to the world's newest currency system.

See Perry, "Why Bitcoin Has Value," Bitcoin Magazine (Jan. 13, 2017).

[9] *See* Ian Allison, "Maersk and IBM Want 10 Million Shipping Containers on the Global Supply Blockchain by Year-End," *International Business Times*, Mar. 8, 2017.

flows, improve the rule of law, increase trust and accountability and enhance revenue collection."[10] In this context, the benefit of using distributed ledgers to increase transparency by providing the technology for the creation and maintenance of global beneficial ownership registries is clearly identifiable.

Case Study — Registers of Legal Organization (ROLO). With ensuring transparency, visibility, and trustworthiness being among the key challenges of the digital economy, a growing group of nations has proposed the development of online ROLO. The register would be based on international standards, which can be a trust anchor for the real-time identification of organisations and up-to-date trusted attributes about those organizations, to support a wide range of digital compliance and business requirements and reduce risks and costs. Blockchain and distributed ledger technologies are highly compatible with the requirements of ROLO. Formation of ROLO based on internationally agreed standards would ensure interoperability.

Blockchain as a whole and its component parts, distributed ledgers and smart contracts, are said to be formative technology in the sense that the technology is capable of replacing many traditional processes with faster and more efficient alternatives. There are undisputed benefits for the financial and insurance sectors as well as in blockchain's ability to streamline supply chains, but how can public services and tax administration benefit from blockchain? That is the focus of the next section of this article.

Case Study — Sweden. Sweden, one of the world's most digital societies, is taking another step forward in the use of technology by testing blockchain for land registry services. If implemented, land titles will be registered and recorded on distributed ledgers, producing transparent, immutable records. The benefits of transitioning to distributed ledgers include a substantial reduction in transaction costs and considerable time-saving opportunities. The shift would also help ease ownership determinations and mitigate real estate fraud. These issues are even more important in countries where the threat of land misadministration and risk of record-tampering are high, such as in Honduras or Georgia, which are also considering moving land records onto a blockchain. Land registries have (relatively) long been assumed to be a suitable environment for the implementation of blockchain technology, and Sweden would be a pioneer if it succeeds in establishing the first real-world example of the idea.

Case Study — Futurice. Finnish company Futurice, while initially attracted to blockchain technology by the hype surrounding it, has decided to test the open-source Ethereum platform to build an application that could actually be implemented and critically assess the promises and trade-offs of technology. They built a blockchain that recorded the time spent by employees developing blockchain-based applications on distributed ledgers, information that was passed on to the payroll department at the end of the month to calculate bonuses. Assessing the experiment, the company reported that transparency and openness were among the biggest advantages offered by the distributed ledgers, which created a fair system for everyone "very much like an invisible hand described by Adam Smith in the context of self-interested market economy."[11] However, the experiment also highlighted negative aspects, such as the questionable need for a technology-based solution when less risky alternatives are present, especially considering the susceptibility of smart

[10] Extractive Industries Transparency Initiative (EITI), "Ending Company Anonymity — A Key to Fighting Corruption" (2017).

[11] Teemu Turunen, "Building Payroll System in Ethereum Blockchain, What Did We Learn?" Futurice.com (blog) (Jan. 3, 2017).

contracts developed in Ethereum to cyberattacks. As a result, Futurice confirmed that open-source technology presented new opportunities for experimentation but warned against falling victim to the lure of popular hype and said actors need to clearly understand the associated risks and costs.

Blockchain, the Public Sector, and Tax

The principles underlying the operational mechanisms on which blockchain technology is based — including transparency, the decentralization of control over data, and the ability to program smart contracts to assume part of the function typically performed by a third, independent party — demonstrate the potential of technology to produce a transformative or even disruptive effect on the way we execute processes today. Apart from the obvious reductions in transaction costs, the added benefit of embedded compliance (that is, independent assurance that rules have been followed) is a benefit particularly suited to the tax domain.

Although large-scale adoption of the blockchain and smart contract technology is likely to occur across numerous sectors of business and society, one needs to carefully examine the related limitations and risks in any specific cases of implementation.

Distributed Ledger Technology

The public sector has already begun exploring the use of DLT. Examples include:

- *public assets and document registries*: land registry, birth certificates, marriage certificates, and company documentation;
- *electronic proof of identity*: benefits qualification and payments, passports, and immigration; and
- *customs and excise applications*: sharing of information about shipments and inspections across various departments.

Particularly in light of these successes, and benefiting from the lessons learned during the course of implementation, bringing DLT to the tax arena could produce numerous benefits. Some of the benefits and more specific potential uses of the technology in the tax sphere include:

- DLT could substantially reduce tax fraud. Increased transparency and the immutability of records could strengthen tax compliance while further discouraging tax avoidance and evasion.
- In conjunction with smart contracts, the ledger technology could enable real-time tax administration and compliance, allowing for both computation of tax due and immediate remittance of tax payments.
- Tax administrations could create a registry of advanced tax rulings and advance pricing arrangements and share the information with other tax authorities (subject to exchange of information regulations).
- Transfer pricing operations throughout multinational enterprises' accounting systems could be streamlined, tracked down to the transaction level, and provided to tax auditors anywhere in the network as an immutable, trustworthy record.
- Information relevant to the calculation of payroll is oftentimes fragmented and held by different departments. DLT could significantly improve and streamline the payroll calculation, including the calculation and payment of payroll taxes, by reducing the duplication of processes and preventing human error.

Smart Contracts

Smart contracts, the second main component of blockchain technology, are already being used to serve public sector goals. Examples include:

- *E-voting*: Each vote is executed by using a digital token and creates a traceable record, allowing confirmation of each vote's validity.
- *Public notary services*.
- *Transfer pricing*: MNEs' accounting systems can be autonomous and automated. This creates increased transparency and trust in the cross-border exchange of transfer pricing information and country-by-country reporting.
- *Distributed automated organizations* (DAOs): Run entirely by code on the blockchain, DAOs are new business models that promise to revolutionize the way companies are controlled and governed. DAOs are

based on direct shareholder participation, which is effected by casting a vote using digital tokens allocated to the financial supporters of the company. Although currently a purely business-world phenomenon, DAOs have the potential to become significant market players, largely affecting legal and regulatory frameworks surrounding corporate structures.

Smart contracts could be applied in many different tax-related contexts, including whenever a tax collection function is outsourced to a third party. Smart contracts can be coded to calculate, withhold, and remit tax directly to the revenue services, thus assuming the role of tax agents. Possible applications and related benefits include:

- *Payroll tax*: The function of collecting income tax from the earnings is outsourced to the employer, who may be tempted to misuse the funds to resolve short-term cash flow problems. Smart contracts would automate the process and remove this threat.
- *VAT*: The combination of the DLT and smart contracts could substantially reduce the instances of VAT carousel fraud and recover revenues by closing an associated tax gap.
- *Withholding tax on dividend, interest, and royalty payments*: On a basic level, the tax would be sent directly to the tax authority. When appropriate, smart contracts could aid in the computation and recovery of foreign tax credits.
- *Transfer pricing matters*: Transfer pricing processes and compliance could be streamlined all the way down to the specific transaction. Levels of trust between taxpayers and tax administrators could be vastly improved in a context focused on cooperative compliance. The cross-border exchange of information, including the application of common reporting standards and CbC reporting, could also be facilitated by smart contracts, helping to create an atmosphere of increased transparency and trust.

Other Public Uses

Blockchain is expected to cause significant disruption (notably, a term that can indicate positive change as well as negative effects) in numerous sectors with important public elements. These include, but are by no means restricted to:

- banking, financial services, and insurance;
- health services;
- law and governance;
- energy production/decentralized energy trade; and
- supply chain optimization.

Data Protection and Security Issues

A critical assessment of the likelihood and severity of risks pertaining to the implementation of blockchain technology is important for the public sector in general and tax administration in particular. First, although some degree of experimentation and innovation by public state bodies is necessary for any change, social responsibility significantly restricts the acceptable margin of error. Secondly, because the data held and processed by government agencies are highly sensitive, issues of data protection and security are topical and may present the main obstacle to blockchain adoption in the tax sector.

Table 1 presents some of the most pressing concerns.

Criteria for Public Sector Blockchain Use

Blockchain is a foundational technology capable of permeating every single level of socioeconomic life. However, when the costs of misapplication of technology are high, including both quantifiable and reputational risks, it is important to identify the criteria that indicate the existence of an environment in which the technology should be applied.

Table 2 lists criteria that can help determine whether blockchain solutions are appropriate for public sector use.

Country Experiences and Practical Insights

It is understandable if government bodies are cautious about adopting blockchain. A combination of its phenomenal transformative impact with, at times, poorly understood technical processes that form the very foundation of its potential benefits means the stakes are high for the risk-takers. Some governments prefer to

Table 1. Using Blockchain in the Public Arena: Various Concerns

Balancing Transparency and Privacy	
Access to the Data	Although an increase in transparency is generally a positive outcome, what level of transparency is appropriate? How do authorities ensure that users can access only the information necessary for their needs?
Data Protection	The most common public blockchains (bitcoin, Ethereum) are fully transparent, while private blockchains (Hyperledger Fabric, Ripple) are closed networks. In either case, security is an ongoing and often experimental effort. How can officials prevent unauthorized access to the stored historic data? Is protection inherently compromised if the protection mechanism time-freezes when a transaction is recorded and does not automatically evolve with time?
Exchange of Information	The transparency of DLT holds great potential for reducing tax avoidance and tax evasion not only domestically, but also internationally, in part because of streamlined and improved CbC reporting. This application of technology is viable, provided the data stored on the ledgers is eligible for exchange under the provisions of existing international agreements and tax treaties.
Loss of Private Key	How can authorities address situations when the private key is lost, leaving dangling ends on a network and creating a risk that users may be permanently locked out of the network?
Lack of Intermediary	
Trust the Machine and Trust the Code	Blockchain may mean increased reliance on technical expertise of private parties when functions are outsourced. Tax administration does not traditionally receive advanced training in IT skills, such as coding/programming and cryptography, and it would have to outsource these functions to design platforms and smart contracts for increased transparency and compliance. In this context, lack of technical competences on behalf of tax administration means that once the programmers produce a code, it is difficult for the tax official to read and understand it to verify its completeness, accuracy, and adequacy for the purpose. Thus, the risk of inadequate or insufficiently safe applications being implemented is significantly heightened.
Transaction Costs	Transaction costs are generally reduced by the application of smart contracts, but attention must be paid to the degree of technological *maturity.* Simpler processes, such as reconciliation of balances between the parties, may be easy to automate. Similarly, sharing of information between departments that traditionally operate in silos can reduce replication costs. However, the costs of more sophisticated processes, such as assessments that involve exercise of professional judgment, may not decrease until more complex parallel technologies, such as artificial intelligence, can be developed.
Immutability and Permanence of Ledgers	
Right to Be Forgotten/ Repudiation	The immutability and permanence of the records on the ledger imply the absence of any option to delete an entry. This is in direct conflict with the right to be forgotten.
Integrity of Information	Once a transaction has been accepted and time-stamped, it will remain recorded on the blockchain and there is a very low likelihood of corruption. However, there are no mechanisms to ensure that the rules defined in software code governing the data that is entered onto the blockchain in the first place are valid. This is particularity concerning for smart contracts. Software code can have bugs, but blockchains are (hypothetically) forever. Is there any way to fix a bug that may have resulted in inaccurate information being recorded?
Other Concerns	
Network Effect	Blockchain essentially derives its value from its immutability derived from distribution and decentralization of data across the network of nodes, engaged in validation of the blocks. No one single party can edit/delete the log unilaterally, and 51 percent of the nodes must agree on the changes for such to be accepted across the entire network. Clearly, the value of the blockchain increases as the number of participants increases, and the risk of colluding between them reduces (known as a network effect). If the network fails to grow to reach the critical mass, however, the records on the blockchain are at a higher risk of tampering and manipulation by malicious nodes, fully eroding the value of blockchain.

Table 1. Using Blockchain in the Public Arena: Various Concerns *(Continued)*

Balancing Transparency and Privacy	
Incentives	Directly linked to the network effect. For the network to grow and protect the robustness and immutability of the blockchain, the participation in the validation process has to be rewarded. In the traditional settings, "miners" are responsible for solving the puzzle that verifies the block and receive rewards in the form of cryptocurrency (for example, Bitcoin, Ether) for using their computer power. How to attract users to participate as "miners" in growing the network that is used for tax administration purposes is a challenging issue. The direct rewards in terms of the payment for the services in cryptocurrency is unlikely; however, an alternative incentive — perhaps in form of a token that can be converted into a tax-related reward, such as tax credit reducing the tax liability — can be devised. It is also important to stress that integration of blockchain/DLT-backed solutions into tax administration will result in the long-term benefit to the entire population of taxpayers, which may attract participation in the absence of immediate reward. These include: • extra incentives for behavior that can produce indirect crossover benefits for compliance; • decreased compliance costs for both the taxpayer and tax administration; • improved relationship between the taxpayer and tax administration; • reductions in institutionalized corruption; and • faster transaction speeds.
Maturity of Technology	Blockchain technology is still in its infancy. Initially, it should be applied in a focused manner with a high degree of standardization and operating on a small scale as a proof of concept. However, the evolution of technology will eventually make it appropriate to apply blockchain in increasingly more sophisticated areas and for larger scale processes.
Legacy	Transition to the new, potentially disruptive technology is likely to be both resource- and time-intensive. Therefore, it is important to identify indications that suggest blockchain is indeed necessary versus when identified deficiencies can be addressed by alternative means, such as enhanced databases or manual controls. When operations already are based on highly integrated processes or there is no significant degree of mistrust, the marginal benefit of transferring to the blockchain may not justify the transition's high integration costs.
Regulatory Environment	The absence of a consistent regulatory framework makes investment in and operation of either public or private blockchains challenging given the uncertain legal status of the applications and the contracts developed and implemented in accordance with the applications. The global nature of the technology creates the impetus for a global regulatory framework as opposed to country-specific action. Precedent for this cooperation is evident in the telecommunications, space, and internet sectors. Other key issues on the regulatory agenda are: • The development of common standards underpinning creation of the uniform technology and network protocols. The International Organisation for Standards has organized a technical committee (TC 307) to standardize blockchain and DLT "to support interoperability and data interchange among users, applications and systems." • The development of consumer protection rules for cases when blockchain is at fault.
Data Residency	Users on the blockchain enjoy a high degree of anonymity or pseudo-anonymity. Although blockchain theoretically allows for parties to establish identity, in practice the process can be time consuming and costly. Also, a transaction cannot be tied to a particular jurisdiction since it is executed in the virtual realm. The combination of these two elements — namely, the difficulty of establishing the taxpayer's identity and the place where transaction took place — raises serious issues regarding the compatibility of technology with existing fundamentals of taxation.

Table 2. Evaluating Blockchain for Public Use

Parameters	Conditions Present	Risks
Users	Need multiple geographically dispersed users. Existing degree of system integration is not sufficient to allow for efficient sharing of data.	Network effect. Legacy integration difficulties.
Trust	Lack of trust between participants of the network.	Increase in transaction costs through creation of additional level of technology.
Information security	Transparency is a key issue. The benefits of increasing transparency must outweigh the costs of losing privacy. Risks of data corruption and manipulation are high. Access to data can be limited to the extent necessary for the purposes of the user.	Privacy. Adoption of permanent immutable record when degree of flexibility may be necessary. Private information becomes public in future.
Technical	Highly standardized processes. Large-scale operations. Process can be captured by a code.	Transaction costs. Software bugs.

take a wait-and-see position to observe how the technology is going to play out on the market and better assess its potential. Others are eager to adopt changes and conduct a general overhaul of their domestic systems by increasingly moving to digital platforms, making blockchain a consideration.

Finland, Rwanda, Estonia, Dubai, the U.K., and Singapore are examples of progressive governments that recognize the potential offered by new technology and are already testing its application in some real-life situations.

Estonia, in particular, acts almost as a nationwide digital lab, allowing incubation of technology and applying it to real-life situations. As a result, Estonia is considered as one of the most digitally advanced societies. Because of the migration to online platforms and elimination of paper transactions, processing times have been dramatically reduced. For example, Estonia's E-Tax allows for online submission of income tax returns, which comes with most of the data pre-populated. Since its introduction, compliance has significantly increased, which eventually led to a budget surplus and reduction of taxes. Upgrading another notch, health records are now going to be stored on a blockchain, allowing users to hold access to their medical histories from anywhere in the world.

Finland is also exploring opportunities, as well as recognizing the risks of moving onto blockchain and DLT platforms. The country is home to the Futurice project mentioned earlier, a blockchain application that allows employees to record and get paid for their overtime. Although the application does not interact with the revenue service by withholding and forwarding tax from the salary, the possibilities of using blockchain as a tax agent are being seriously considered. For example, Finland is exploring the option of recording tax information directly from the QR codes printed in the receipts. On the other hand, one of the main threats identified by the Finnish government is a proliferation of private virtual currencies, which could result in the "loss of visibility" (that is, the inability of tax authorities to effectively monitor, control, and tax transactions in these currencies) in the next two to five years.

Rwanda is another real-life success case based on a proactive approach to adoption of new technologies. The country has already seen great benefits from digitalization. In 2013 the government automated business transactions to allow a copy of the daily record of sales to be submitted in real time to tax authorities through an electronic system called the Electronic Billing Machine. As a result, VAT compliance and collection has increased significantly. Although

blockchain applications have not yet been used, Rwanda's government is taking technology seriously as a step toward further progress.

Singapore's central bank (MAS) was the first to lay out a vision and execute a Smart Financial Centre strategy, officially announced on June 29, 2015. In the Smart Financial Centre, a project focused on fostering the use of technology in Singapore's financial industry, innovation is pervasive. Since starting the project, the central bank has been working closely with the financial industry, financial technology start-ups, institutions of higher learning, and other stakeholders toward a shared vision. The bank's role in supporting the financial technology journey is twofold:

- to provide regulation conducive to innovation while fostering safety and security (including a so-called regulatory sandbox, a place for controlled experimentation); and
- to facilitate the infrastructure for an innovation ecosystem and adoption of new technologies.

On May 1, the Smart Nation and Digital Government Office was formed under the prime minister's office in Singapore, consolidating all resources and governmental agencies in the push for adoption of new technology and initiatives, including blockchain.

In 2016 Sheikh Hamdan bin Mohammed bin Rashid Al Maktoum, crown prince of Dubai and chairman of the Executive Council of Dubai, announced ambitious plans for Dubai to become "the first government in the world to execute all its transactions using blockchain technology by 2020." Dubai's government launched several initiatives aimed at making Dubai a fertile ground for breakthrough and transformative technologies, including the Dubai Future Accelerators program and a blockchain public sector "hackathon" with a grand prize of $100,000.

Many have described the European Union's VAT as one of the most suitable cases for a blockchain application. At this moment, the European Commission does not believe that the technology is sufficiently mature to provide an adequate platform onto which VAT can be transferred. However, extensive studies are underway to explore the possibilities of using technology in the areas of taxation that fall under the EU's jurisdiction, namely customs, VAT, prevention of fraud, and administrative cooperation. According to Vice President Andrus Ansip, the European Commission "is already supporting DLT-enabled projects (DECODE, D-Cent, MyHealth MyData). . . . A study will be launched to investigate how DLT can help in reshaping public services and preparing for EU specific DLT actions to address relevant EU challenges."[12]

> *Case Study — United Kingdom.* In October 2015, the U.K. government announced its plans to invest £10 million into research examining the opportunities and challenges of the blockchain and DLT, thus demonstrating its strong interest in and support for the emerging trend. In 2016 the U.K. Government Office for Science published a dedicated report identifying several possible uses for the technology in the public sector. Beyond the broad benefits that might accrue from the use of blockchain technology, such as greater transparency and reduced operating costs, the report also highlighted several more specific advantages, including improvements in the distribution of welfare support, better tracing and monitoring of state grants, and a reduction of tax fraud (especially EU VAT fraud). Within the U.K.'s financial sector, the Bank of England announced in March that it was testing the use of blockchain-based technology for cross-border payments and currency conversion, anticipating "lower settlement risks and improved speed and efficiency."[13]

[12]European Parliament, "Answer Given by Vice-President Ansip on Behalf of the Commission, Subject: Distributed Ledger Technology," E-009012/2016 (Feb. 7, 2017).

[13]Lucy Burton, "Bank of England Trials Artificial Intelligence and Blockchain in Bid to Stay Ahead of the Pack," *The Telegraph*, Mar. 17, 2017.

Summary and Key Takeaways

Blockchain is an ambitious technology with the enormous potential to increase *transparency*, reduce *administrative burdens*, and lower *transaction costs.* Increased transparency and visibility must be counterbalanced by adequate confidentiality, data protection, and *privacy* measures. Furthermore, any solution proposed amid a wave of hype must undergo a careful examination and analysis from technical, legal, and regulatory perspectives to assess its potential to provide viable contributions to fiscal policy design and administrative execution. A list of criteria must be developed that would allow for prompt initial appraisal of blockchain-enabled solutions for a particular set of problems.

At its existing maturity stage, blockchain is most likely to be useful for *sharing data* through distributed ledgers. Improving the integrity of recordkeeping (the distributed ledger) will enhance fraud prevention and improve error detection.

Automation of processes using smart contracts, which can act as tax agents and are especially useful for collecting revenue from split payments, opens the door for the automation of *compliance* and removes the opportunities and incentives for tax avoidance. However, the more advanced *smart contracts* are still at a conceptual stage.

Blockchain is best suited to areas in which data must be distributed across a wide network, composed of unrelated and untrusted parties, and data integrity is an overriding objective. Blockchain and DLT technology hold particular promise for payroll, VAT, customs, and transfer pricing applications.

Incentivizing user participation and reaching critical mass remain key challenges. Large businesses may be motivated to participate by potentially massive reductions in compliance costs, as pilot tests indicate. Experimentation, "regulatory sandboxes," and use-case-based initiatives by governments willing to lead the way have been reported with increasing frequency.

Social responsibility may make government agencies hesitate to implement technology that is being formed outside the regulatory framework. At the same time, as the benefits of technology are clearly recognized, high-level projects aimed at developing standards and definitions are being encouraged. Development of governance frameworks should become a primary objective on state agendas in the future. Collaboration between industry, academia, and tax administrations is paramount to ensuring efficient integration of the new technology and safeguarding optimal policy formulation.

The Next Steps

With blockchain technology growing at an unprecedented speed, it is important that tax authorities do not ignore or misjudge a potentially revolutionary technology that could solve persistent challenges faced by the tax community. On the other hand, authorities must not succumb to the frenzy generated by publicity that presents new technology as a "panacea" against a broad variety of modern socioeconomic ailments, oftentimes mistakenly.

WU GTPC has taken an important first step, creating a pioneering initiative that brings together tax officials and industry experts, IT solutions developers, representatives of the business community, and academics to engage the public sector in a discussion at the time when technology itself is developing.

Multi-stakeholder engagement has proved critical for establishing, as an initial step, a mutual understanding of the basic concepts, terminology, and underlying principles of the blockchain and DLT. From this meeting, it became apparent that blockchain has the potential to be a great tool for tax authorities, facilitating compliance via increased transparency and reduced transactions costs. However, it was also clear that benefits of blockchain must be measured against particular processes to determine whether the gains it promises are truly viable.

As noted above, some fields of taxation appear particularly promising and compatible with blockchain. They include payroll taxation, VAT, customs, and transfer pricing matters, all of which could benefit from increased transparency, compliance, and the reduction of transaction costs through smart contracts. WU GTPC participants also found that this technology is very much at the experimental stage, and while some early adopters in the public sector have already signaled their readiness to transfer some

processes onto the blockchain, the general attitude of many tax authorities remains cautious. This is partly because of the lack of certainty regarding the regulatory and legal infrastructure needed to facilitate wider application. Introduction of regulation may be at this stage premature, with technology still maintaining its largely nebulous state.

Upcoming meetings in Singapore this year and in New York next year will build on the issues already raised and will review interim developments. Protecting data and privacy, providing incentives for participation, and developing regulatory and governance infrastructures remain items of high importance. As technology crosses from the theoretical realm to practical reality, real-life results will provide much-needed, hands-on experience and will offer the opportunity to evaluate the benefits and risks of these emerging technologies. ■