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Affidavit

"On my honour as a student of the Diplomatic Academy of Vienna, I submit this work in good faith and pledge that I have neither given nor received unauthorized assistance on it.

_____ Maximilian Santner

Abstract

Distributed ledger technology (DLT) is a new and quickly evolving field. Its decentralized and cryptographically protected structures allow for the safe transfer, storage, and validation of data without the usage of an intermediary. This gives it transformative potential. Industry and governments have understood its value, but need to adapt existing structures. This also includes traditional civil law. The interdisciplinary research presented here addresses a specific set of efforts in this area. It investigates provisions of the first comprehensive civil law framework for DLT-systems, the Law of 03 October 2019 on Tokens and TT Service Providers (Token and TT Service Provider Act; TVTG) LGBI-Nr. 2019.301, LR-Nr.: 950.6. This is done both from a legal as well as an economics perspective to gain a more comprehensive understanding of the implications and challenges of the introduction of civil law into DLT-systems. The theoretical framework applied is that of transaction cost theory. The aim of these provisions is to establish a legal framework for DLT-systems including a civil law basis for token, the representation of rights in token and the transfer of these token, Art. 1 para. 1 lit. a TVTG. The analysis shows that the legislator provides an inclusive definition of token enabling the introduction of a large variety of rights such as property rights in tangible objects, corporate rights, value rights and more. Furthermore, he manages to avoid a disparity between dispositions of rights in the analogue and the digital world, which if not avoided would cause considerable legal uncertainty. This has implications for economics as well. DLT-systems lower transaction costs, most obviously by replacing intermediaries with encrypted decentralized data storage and consensus mechanisms. The TVTG reduces transaction costs by clarifying the allocation of rights between the "real" world and digital systems allowing for efficient and dependable transactions, which prohibit legal double spending. This forms an important bridge between traditional civil law and DLT-systems, encouraging the full utilization of the potential of DLT-systems by providing legal certainty. The research presented here only covers a small fraction of the questions that arise in connection with the adaptation of established legal systems to this new technology. Thus, the TVTG serves as a discussion point that might strongly influence subsequent research and legislation.

Die Distributed-Ledger-Technologie (DLT) ist ein neues und sich schnell entwickelndes Gebiet. Ihre dezentralisierten und kryptographisch geschützten Strukturen ermöglichen die sichere Übertragung, Speicherung und Validierung von Daten ohne den Einsatz eines Intermediärs. Dies verleiht ihr ein transformatives Potenzial. Industrie und Regierungen haben seinen Wert erkannt, müssen jedoch die bestehenden Strukturen anpassen. Dazu gehört auch das traditionelle Zivilrecht. Die hier vorgestellte interdisziplinäre Forschung befasst sich mit einer spezifischen Reihe von Bemühungen in diesem Bereich. Sie untersucht Bestimmungen des ersten umfassenden zivilrechtlichen Rahmens für DLT-Systeme, des Gesetzes vom 3. Oktober 2019 über Token und VT-Dienstleister (Token- und VT-Dienstleister-Gesetz; TVTG) LGBI-Nr. 2019.301, LR-Nr.: 950.6. Dies geschieht sowohl aus rechtlicher als auch aus wirtschaftlicher Sicht, um ein umfassenderes Verständnis der Implikationen und Herausforderungen der Einführung des Zivilrechts in DLT-Systeme zu gewinnen. Der angewandte theoretische Rahmen ist der der Transaktionskostentheorie. Ziel dieser Bestimmungen ist es, einen rechtlichen Rahmen für DLT-Systeme zu schaffen, der eine zivilrechtliche Grundlage für Token, die Darstellung von Rechten in Token und die Übertragung dieser Token umfasst, Art. 1 Abs. 1 lit. a TVTG. Die Analyse zeigt, dass der Gesetzgeber eine umfassende Definition des Begriffs "Token" vorsieht, die die Inklusion einer grossen Vielfalt von Rechten wie Eigentumsrechte an materiellen Gegenständen, Gesellschaftsrechte, Wertrechte und mehr ermöglicht. Darüber hinaus gelingt es ihm, eine Disparität zwischen den Verfügungen über Rechte in der analogen und der digitalen Welt zu vermeiden, die, wenn sie nicht vermieden wird, zu erheblicher Rechtsunsicherheit führen würde. Dies hat auch ökonomische Auswirkungen. DLT-Systeme senken die Transaktionskosten, am offensichtlichsten durch den Ersatz von Intermediären durch verschlüsselte dezentrale Datenspeicherung und Konsensmechanismen. Das TVTG senkt Transaktionskosten, indem es die Zuordnung von Rechten zwischen der "realen" Welt und digitalen Systemen klärt und damit effiziente und zuverlässige Transaktionen ermöglicht, welche rechtliches double spending vermeiden. Dies bildet eine wichtige Brücke zwischen dem traditionellen Zivilrecht und DLT-Systemen und fördert die volle Ausschöpfung des Potentials von DLT-Systemen, indem es Rechtssicherheit bietet. Die hier vorgestellte Forschung deckt nur einen kleinen Teil der Fragen ab, die sich im Zusammenhang mit der Anpassung etablierter Rechtssysteme an diese neue Technologie stellen. Der TVTG dient somit als Diskussionspunkt, der die nachfolgende Forschung und Gesetzgebung stark beeinflussen könnte.

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German English legal Dictionary

This dictionary is provided to keep the often very distinct meaning of legal terms intact.

Article	Paragraph
Assignment Law	Zessionsrecht
Claims for Restitution	Herausgabeansprüche
Contractual Obligation	Vertragliches Schuldverhältnis
Intangible Objects	Unkörperliche Gegenstände
Law of Obligations	Schuldrecht
Law of Property	Vermögensrecht
Legal Object	Rechtsobjekt
Objects	Gegenstände, Sachen
Owner	Eigentümer
Pecuniary Advantage	Vermögensvorteil
Perception of the involved parties	Verkehrsanschauung
Personal Property Law	Persönliche Sachenrechte
Possession	Besitz/Innehabung
Property	Eigentum
Property Law in Rem	Dingliche Sachenrechte
Property Law	Sachenrecht
Possession Order	Besitzanweisung
Receivables Rights	Forderungsrechte
Securities	Wertpapiere
Services	Dienstleistungen
Servitude	Dienstbarkeit
Statutory Obligation	Gesetzliches Schuldverhältnis
Tangible Objects	Körperliche Gegenstände
Transfer by Declaration	Übergabe durch Erklärung
Transfer by Symbol	Übergabe durch Zeichen
Value Rights	Wertrechte

1. Introduction

The system of distributed ledgers is a new technology that has been taken up rapidly by users. Its new mechanisms, unique properties and rapid growth make it an important topic of study for multiple disciplines. It might have far-reaching implications on a policy, economic, legal, social, technical, or environmental level. These changes include the way we conduct business activity, governance structures or how we establish trust between parties. Its full implications can only be understood by a mix of different fields of knowledge and their expertise. This includes computer science, economics, law, environmental sciences, and social and political sciences (Nascimento et al. 2019, 7).

Therefore Distributed-Ledger-Technology-Systems (DLT-systems) are an ideal topic for an interdisciplinary study such as the following thesis. Looking at it from the perspective of two disciplines gives a fuller picture of its implications. However, due to the limited scope within this format, only a small part of a rather narrow field will be covered here. The following work is concerned with law and economics and looks at a small fraction of the law applicable to DLT-systems – civil law – and how it impacts a specific element of economic activity, namely transaction costs. To be precise it looks at one of the first comprehensive approaches to legislate for DLT-systems in the field of civil law, the Law of 03 October 2019 on Tokens and TT Service Providers (Token and TT Service Provider Act; TVTG) LGBI-Nr. 2019.301, LR-Nr.: 950.6, and how specific provisions of this piece of legislation provide conditions that lower transaction costs at the intersection between rights in an analogue and digitized form.

DLT-systems are cryptographically protected, time-stamped decentralized databases. This structure allows private individuals, firms, and others to update datasets and validate transactions, in turn improving the transfer of assets via digital networks. Compared to the existing structures of digital exchanges, the usage of intermediaries or third parties is no longer necessary. The layout and rules of the system as a decentralized peer-to-peer network replaces these entities. Despite these substantial advantages there are some considerable challenges, such as scalability, slow transacting, energy consumption, reputation, and trust to contend with. The major benefit of DLT-systems as a decentralized, encrypted database technology, that allows for data storage and transfer, without the issues related to double spending and intermediaries, however, remains.

The potential of this technology has been recognized on a European level as well. Proven by the fact, that the European Commission (EC) supports this with research programmes and funding. Several EC services are also looking into ways to utilize DLT-technology, for example in reporting, notarisation, and monitoring of the movement of goods (Nascimento et al. 2019, 38).

Governments need to assess their policies and the current legal system with a view to whether they are able to incorporate DLT-systems or if new frameworks need to be developed. This includes questions such as the legal classification of token, consumer- and data-protection, anti-money-laundering regulations, and more (Nascimento et al. 2019, 7).

The Liechtenstein financial sector (financial and insurance services, legal and tax advice, auditing) is the second biggest sector of the national economy after industry and manufacturing. In 2017 more than 16% of the workforce was employed there. It generated CHF 1,234 billion in gross value added, corresponding to 20% of total gross value added. Corporate income tax from financial institutions represents 53% of corporate tax revenue (Financial Market Authority Liechtenstein 2020, 6).

Fintech companies are particularly interested in the Liechtenstein market. The Financial Market Authority Liechtenstein (FMA) processed 101 Fintech related inquiries in 2017. In this field the FMA actively supports new financial enterprises within the legal framework and based on considerations of financial stability, client protection and the reputation of the financial market (Financial Market Authority Liechtenstein 2018, 10)

The Liechtenstein government has taken the lead in answering some of the above mentioned questions for its own legal framework. From a civil law perspective, the TVTG sets out to establish a legal framework for DLT-systems including a civil law basis for token, the representation of rights in token and the transfer of these token, Art. 1 para. 1 lit. a TVTG.

Civil law discussions of the token economy at this point in time need to address classic questions of property law, namely the conditions under which the legal system recognises a person's legal competence in a subjective right and the conditions which must be fulfilled for a change in this classification to be valid and effective, including in relation to third parties (*erga omnes*) (BuA 54 2019, 166).

Transaction costs – the costs of exchanging ownership titles – are the costs of coordinating economic activities. Effective institutions with clearly defined and enforceable property rights reduce transaction costs (Zak 2002, 55). Improvements of these institutions can reduce transaction costs, which at some point increases economic activity per input unit.

The following chapter will elaborate on the methodology and theoretical approaches taken to assess and discuss the two parts into which the thesis is structured. These are the issues of the TVTG within civil law, as well an economic perspective of DLT-systems and their role in reducing transaction costs.

2. Methodology and Theoretical Framework

This thesis is interdisciplinary and focused on the two fields of law and economics. Both subjects shall be given approximately equal space and weight. It is based on the ideas of New Institutional Economics. The main theoretical prisms will be transaction cost theory, property rights theory and the law and economics approach.

First the general functioning of DLT-systems shall be discussed to gain a deeper understanding of the structure of the technology as well as its advantages and weaknesses. Distributed ledgers are a novel system with unique mechanisms and capabilities, thus it cannot be assumed that all readers are familiar with them. A brief introduction into the components and mechanisms of this system should make it easier to put the legal and economic considerations into context. In relation to this the advantages and disadvantages of DLT-systems compared to the previous state of data transfers shall be discussed, highlighting problem-areas as well.

The main body of this work is divided into two parts. Part I analyses the legal aspects of the TVTG and its implications for the connection between property rights in the analogue and in the digital world. This is structured as a critical discussion of the relevant literature in Austria, Switzerland, and Liechtenstein as well as an analysis of a selected part (section I. General provisions and section II. Civil basis, in particular Art. 7) of the Law of 03 October 2019 on Tokens and TT Service Providers (Token and TT Service Provider Act; TVTG), Gesetz vom 3. Oktober 2019 über Token und VT-Dienstleister (Token- und VT-Dienstleister-Gesetz; TVTG) LGBI-Nr. 2019.301, LR-Nr.: 950.6, using classical legal methodology. The theoretical framework applied is that of law and economics.

Liechtenstein is chosen as an example because it is the first comprehensive attempt of comprehensive legislation for DLT-systems.

Part II discusses the economic side of DLT-systems. It is based on New Institutional Economics and transaction cost theory. In a first step the basic elements of analysis are laid out; institutions, property rights and transaction costs, and definitions shall be given. Following this, transaction cost theory and property rights will be discussed. Additionally, some space will be given to institutional economics. Other theoretical approaches to the economic study of DLT-systems such as neoclassical economics and institutional evolution will be deliberated as well to show alternative views including strengths and weaknesses.

The insights gained from an inquiry into the relevant provisions of the TVTG will then be projected onto economic theory, to gain an understanding of their implications for the economy and to answer the following research question:

Does the TGV establish property rights that reduce transaction costs in Distributed Ledger-systems?

So far there are no other multidisciplinary works that look at the specific impact of DLT-systems-legislation on the economy via a transaction costs framework, let alone a detailed inquiry into provisions of the TVTG. The materials to the TVTG provided by the Liechtenstein government speak of the economic benefits of this legislation but do not provide a structured analysis.

This work focuses on transaction costs and property rights as the main elements of discussion and analysis of DLT-systems. However, there are many more aspects that cannot be covered here, but still are of considerable importance in the context of DLT-systems, such as the economic implications of trust and information asymmetry.

2.1 Distributed Ledgers and Token Explained¹

Computers, digital data, and the internet are all essential technological developments that brought about fundamental societal and economic change. Technologies such as the internet make the dependable transfer of data at record speed possible. This allows for an

¹ All the terms and descriptions used here have a degree of ambiguity and might lack technical precision (especially with regards to terms such as public and private key, nodes and others). This is in part necessary to convey the mechanisms portrayed more briefly and in a way that is more easily understandable for readers without a technical background.

incredible amount of data-transactions to take place in fractions of seconds. Such obvious advantages over conventional transfers are, however, limited in some areas.

Digital data can be copied indefinitely making all assets associated with or embodied in the data vulnerable. This imitability is a strength allowing for fast distribution, but also a fundamental weakness, that complicates the protection and transfer of property and other interests. Assets could be transferred to multiple people at multiple times, making transactions highly unsafe. Called the problem of double spending also known as the Byzantine General's problem, it's one of the main weaknesses of digital data.. Before the advent of DLT-systems it was not possible to coordinate exchanges on the internet without a centralized system to verify the integrity of transactions. By employing the services of trusted intermediaries, such as banks, brokers, or other agents, whose task is to guarantee the integrity of digital transactions by functioning as a centralized processor of transactions, double spending could be nearly eliminated. Intermediaries, although necessary to establish trust, create costs and have other undesirable characteristics. Due to their nature as centralized repositories of data they are firstly, vulnerable to hacking, secondly, exclude parties with limited access to traditional transfer systems such as banks and thirdly slow down exchanges while capturing large quantities of data. In contrast to the use of intermediaries, distributed ledger-systems are a way to transfer digital assets without requiring such intermediaries (Hopf, Loebbecke, and Avital 2018, 1) (Davidson, Filippi, and Potts 2018, 639), hence they achieve two different things at the same time. They do not require intermediaries and largely rule out double spending.

It is important to distinguish distributed ledger-systems from terms such as blockchain, Bitcoin, Ethereum and others. The hype surrounding DLT-systems has caused a great deal of confusion and a blending of terms that have a distinct meaning associated with distinct technological functionality. While distributed ledger-systems are the underlying technology, Bitcoin, Ethereum and others are just applications of this technology. They all have a distinct structure but share the common characteristics of DLT-systems, such as encryption and a decentral layout.

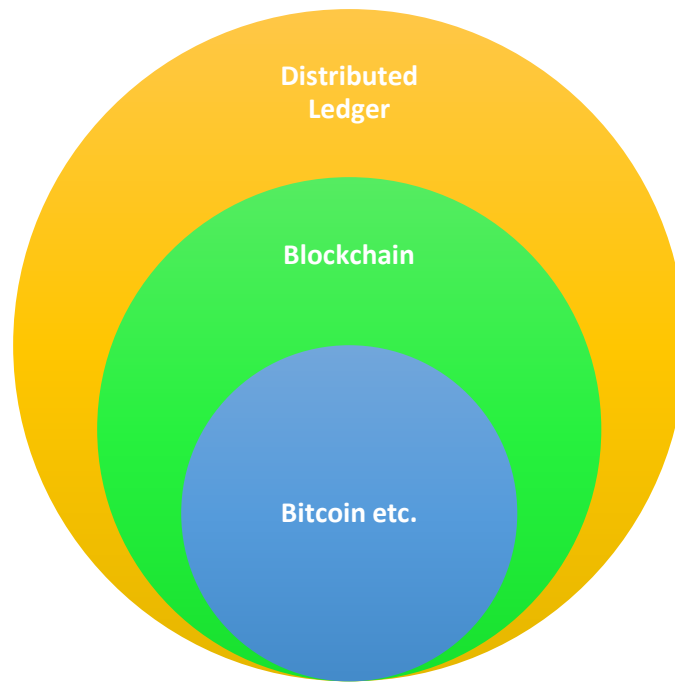


Figure 1: Relationship between DLT-systems and other terms surrounding the technology. Distributed ledgers are the underlying technology and the wider term, all subsequent applications utilize the same principles but have differences in application.

2.1.1 How Distributed Ledgers Work

DLT-systems are easiest explained as decentralized databases (Davidson, Filippi, and Potts 2018, 643). These systems share common characteristics such as peer-to-peer networking, cryptography, and decentralized data storage. As a structured system these features have the potential to improve the transfer of digital assets.

The decentralized database is shared by a number of nodes in a network (Mills et al. 2016, 10). Nodes collectively run the software necessary to maintain the database records. This relates to the aim of sharing and validating information, which distinguishes DLT-systems from traditional databases where one central entity controls and validates the information. Participants in distributed systems may fulfil all or just some functions of the system, such as reading the ledger, validating transactions, updating the transaction history of the ledger or issuing new assets. The information regarding the ownership to an asset is stored on the ledger, thereby maintaining ownership records of all the systems participants (Mills et al. 2016, 10–11).

Distributed ledger-systems use cryptography for many of their functions such as encrypting data, verifying identity and validating transactions. The ownership of an asset, as well as the ability to transfer it, depends on having the necessary private and public key, which are also cryptographically protected. This verifies that the asset belongs to the person who

initiates the transaction. The ledger that records ownership and transactions is distributed to the nodes of the network. The rules for asset transfers in the system such as validation of ownership or the fulfilment of certain conditions are coded into the protocol. Settlement of the transaction in a DLT-system is done by updating the ownership positions to the new status in the common ledger. The process whereby the nodes accept this new ledger is called consensus. Consensus is important for the stability of the system.

Since often more than one participant can write in the common ledger, two seemingly valid transactions might be distributed to the network at the same time, opening a door for double spending to occur. A sender could use funds that are no longer available in a transaction before this is visible in the ledger. This problem arises in systems that have no immediate settlement and no central controlling authority. DLT-systems solve this by using consensus algorithms so that nodes can assign priority to one valid transfer over another. Ultimately just one valid transfer becomes part of the common ledger (Mills et al. 2016, 12–14).

DLT-systems are a cryptographically protected and time-stamped decentralized database, that allows private citizens, firms, governments, and others to validate transactions and update datasets using a decentralised, transparent open access technology. The usage of intermediaries or third parties is no longer necessary because trust between parties is based on the rules everyone follows to add, verify, and validate transactions. The hype surrounding distributed ledgers and its rapid development often underestimates the many challenges of the system. Among them are performance and scalability, high energy demand, integration into existing infrastructures, interoperability, criminal activity, and data protection (Nascimento et al. 2019, 12).

2.1.2 Token

Token or crypto assets are the digital way of mapping an intrinsic or perceived value based on DLT-systems. The value can be based on the token's functionalities, properties or on the rights associated with it. They are the elements of transactions. Three broad categories are often distinguished but many token have mixed characteristics:

1. **Payment token (virtual currencies):** They usually have the function of a private means of payment and regularly do not have intrinsic value, neither are they issued by a central bank.
2. **Security token (equity and other investment token):** Whoever uses them has membership rights or debt claims of asset content, similar to shares and debt securities.

3. Utility token (app token, use token, consumption token): They can only be used to obtain goods or services within the issuing institution's network (Bundesministerium der Finanzen 2019, 9).

The definition of token in the TVTG (*Law of 03 October 2019 on Tokens and TT Service Providers; Token and TT Service Provider Act; TVTG*) is wider than these definitions and was chosen to incorporate all present and future uses of token on DLT-systems (BuA 54 2019, 58–65). The definition and characteristics of token in the case of the TVTG will be further discussed in PART I.

DLT-systems have many benefits and are often discussed within the context of a large potential for growth and fundamental change to the economic system and society. However, there are substantial drawbacks and problems that need to be addressed. Distributed ledgers are often slower than conventional payment platforms such as Visa/Mastercard. At this point in time they are not able to perform the same number of transactions compared to established payment systems (Davidson, Filippi, and Potts 2018, 641). The currently rather large computing power needed to perform encryption, validation and other services consumes large quantities of energy (Hopf, Loebbecke, and Avital 2018, 3). Scaling up the uses of DLT-systems would mean even larger resource consumption with detrimental consequences for the environment. On a societal level DLT-systems suffer from reputational issues and some, such as Bitcoin, have at times become associated with criminal activity, such as money laundering and the financing and clearing of criminal acts. The novelty of the system lowers the rate of adoption by consumers which is associated with limited trust in this technology at this early stage.

While DLT-systems are regularly hyped as well as condemned, distributed ledger technology does have considerable potential. A level-headed analysis of its functions, applications and legal as well as economic potential and limitations is therefore key to gain insights into its character. The literature has demonstrated that the technology has certainly enough potential to warrant further investigations. As a decentralized, encrypted and time-stamped database they can provide token-based data-transfer without the issue of double spending or need for intermediaries.

3. PART I: Law

3.1 Introduction

The following part describes the impact of specific provisions of the TVTG on the integration of civil law property rights into DLT-systems and how this reduces legal uncertainty. The TVTG solves the problems associated with transferring analogue rights to a digital platform.

This part begins with a discussion of Austrian and Swiss property law with regards to DLT-systems and specifically token. In doing so the basic mechanisms of property law, their rules and prohibitions shall be laid out. Austria and Switzerland are used because their property rights systems are not just similar to the Liechtenstein model but historically constitute the basis for Liechtenstein civil law. Liechtenstein's law is in part an amalgamation of Austrian and Swiss legislation, based on historic ties to both nations, a shared legal tradition, and a common language. Liechtenstein property law was received from Switzerland; general civil law is based on the Austrian Civil Code. Most importantly Liechtenstein courts consider literature and jurisprudence from Switzerland and Austria in their own decisions (Rietzler, Frick, and Casellini 2019, 363). Authoritative works covering Austria or Switzerland can, therefore, be used in discussions of Liechtenstein law. Furthermore, basic rules of property law are the same in these nations.

This approach has two benefits. First the general functioning of property law and the associated rights can be described to gain an understanding of the problems arising with the implementation of DLT-systems. Second, a critical discussion of other models for the implementation of DLT-systems and token into property rights systems can be conducted, which broadens the understanding of the problems and compares possible solutions.

In a further step the functioning of the TVTG will be analysed; particularly concerning its dealings with the digitization of analogue rights and the associated problems, such as symmetry and legal double spending. In PART II this analysis shall be placed in a framework of economic theory to explain how these measures potentially help in reducing transaction costs by allocating property rights.

Because of the extensiveness of the topic of DLT-systems and law (as evidenced by the large body of literature that has started to address even the minutest of questions) the scope of this work is limited to a set of fundamental norms of civil law. Thus, considerations of tax-, financial markets-, banking-, or other law will not be covered.

A narrow interpretation of property reduces the applicability of the law. Technological innovations often raise the question whether individuals have to wait for the legislator to create new law or act unilaterally using the present legal tools to incorporate new technology (Bydlinski 1998, 287).

3.2. Austrian Property Law

Austrian Property Law is based on three principles: limited number, compulsory type, and publicity. Parties to a contract cannot agree upon new types of property rights, there is only a limited number of property rights that can be used. In addition to that, content, and scope of different types of property is defined by law. Parties must use a compulsory format that cannot be altered, they can only choose an existing type such as possession, property, or servitude. Due to the exclusivity of property rights, the entitlement to a right must be apparent to the public. For movable property, this publicity is achieved via the possession of a movable object, for immovable property via the land register. Property rights are linked to individual objects, therefore, no absolute right to the sum of the entire property of a person can be established. Property rights need to be established individually on each object via one of the types (Welser and Kletečka 2018, 262–63).

The legal construct of property is the most important form of property law. It is the complete right to an object, as a result, all other rights spin-off the full right of the proprietor to an object and are weaker compared to “full” property. To gain all the benefits from property law, such as protection and enforceability, the assets of a person need to be captured by the property rights system; this starts with the categorisation as an object.

The definition of objects in Austrian property law is very broad; stating that: “*Everything that is distinct from the person and serves the use of people is called an object in the legal sense.*”, Art. 285 ABGB². Objects with different natural qualities such as the gas in a pipeline, a bar of gold or data are all part of the qualification as an object within Austrian property law; yet their special qualities sometimes lead to different treatment.

Based on this broad definition tangible objects such as a computer or a wedding ring and intangible objects like receivables rights, data, services or an internet domain (Peck 2003, 222) are part of the definition of objects in property law. Despite this rather extensive

² Allgemeines Bürgerliches Gesetzbuch, Austrian Civil Code, JGS Nr. 946/1811

definition not all property law provisions are applicable to intangible objects (Welser and Kletečka 2018, 266–67). The norms of property law are largely tailored to physical objects because they are based on actual controllability. Thus, the transfer of legal competence for receivables rights, i.e. for incorporeal things, is not based on property law but on assignment law. Although the ABGB recognises possession of rights (cf. Art. 311 ABGB), they only enjoy protection of possession, if the right is associated with the possession of a physical object (Helmich, m. n 2)³. Data as intangible objects are not per se protected by property law, but rather protected only insofar as this is required by law or their contents are protected by patent or copyrights (Holzner, m. n. 1). This initially broad definition of objects and subsequently more nuanced categorisation distinguishes Austrian property law from others such as Swiss property law (Bydlinski 1998, 290).

This nuanced difference within Austrian law has substantial consequences for the application of blockchain and for the use of token. Only if token can be categorized as objects under property law, is it possible to subject them to parts of property law such as property or possession. Otherwise a new way of incorporating blockchain applications into law would have to be developed. The broad definition of objects in Austrian property law allows many things; tangible and intangible to fit the description, but more detailed provisions such as property itself might exclude objects such as token from fitting into the property law regime.

As shall be demonstrated later, there is an economic argument to incorporate new and growing parts of the economy into the property rights regime and to extend the same benefits to these new sectors to encourage growth.

3.1.1 Token in Austrian Property Law

Property as a right gives the proprietor the possibility to use and destroy an object, but more importantly to dispose of an object in legal proceedings such as selling it, pledging it or bequeathing it (Welser and Kletečka 2018, 306). All these options give considerable economic value to objects by making them tradable, while at the same time guaranteeing enforceability protected by law and reliance on the associated court system. According to Austrian property law, all tangible and intangible objects are subject to property rights. This would also include receivables rights and intellectual property, but similar to the definition

³ Marginal nuber, german: Randziffer

of objects in the legal sense, numerous parts of the law exclude intangibles at least in part from the law governing property. In other words, a distinction must therefore be made between property rights in the strict and the broader sense. The object of property rights in the strict sense can only be applied to physical objects (Welser and Kletečka 2018, 319).

Property law is grouped into property law in rem and personal property law, Art. 307 ABGB. Property law in rem are rights of domination over a physical object which entitle to direct influence over this object; are to be respected by everyone; can be enforced against everyone and are limited to tangible objects. Personal property law concerns all property rights that are not in rem or not absolute and that only obligate certain persons (mandatory rights), regardless of the act of their creation, i.e. those from the area of contract law as well as from the area of unjust enrichment or compensation for damage. Property rights in rem are effective against everyone, whereas personal property rights are effective only against a specific person (Helmich, m. n. 1–7) (Holzner 2016b, m. n. 3).

This dichotomy between the inclusive definition of objects subject to Austrian property law, which incorporates token and the large number of laws that do not fully include intangible objects, makes it difficult to assess which parts of property law are applicable to token and how token can be captured by property law.

So far we have seen that the definition of property rights in Austrian law is broad and that token can be qualified as objects in Austrian property law (Völkel 2017, 387) (Fleißner 2018, 437–38) (Vonkilch and Knoll 2019, 141) (Aigner 2019, 819) (Diwok and Daniel Gritsch 2020, 68). As mentioned above only two qualifications must be fulfilled: first an object needs to be distinct from the person, and second, it must serve the use of people. In the legal sense, to qualify as an object it must – depending on the respective technical progress – be controlled by man (Helmich, m. n. 12). Both qualifications of the definition are present in token. They serve the use of people and can be controlled by them. Due to the fact that token cannot be transferred without a private key, the controllability aspect is particularly pronounced (Völkel 2017, 387).

The law limits the transmission of property and possession as a right to tangible objects (Völkel 2017, 387). Only such objects are tangible, which in the physical sense as matter are spatially delimitable and thus controllable. Data is qualified as an intangible object, because it is not spatially delimitable matter. Token can be seen as intangible objects since they are built from data, which itself is considered an intangible object (Vonkilch and Knoll

2019, 141) (Helmich, m. n. 6) (Holzner, m. n. 1) (Aigner 2019, 819), as is Bitcoin one application of DLT-technology (Helmich, m. n. 8/1) (Holzner 2016a, m. n. 2). Therefore, no property rights in rem, in particular no property, can be established on them. Claims for restitution under Art. 366 ABGB are therefore also inconceivable. Nevertheless both tangible and intangible objects can be subject of sales contracts (Helmich, m. n. 1-6, 17).

Up until this point there is large consensus on how token are to be classified in Austrian law. As explained above there is a specific distinction between tangible and intangible objects, since only tangible objects can be part of property law in rem with different legal consequences from personal property law. Token would fall under the provisions of personal property law, because of their nature as intangible objects. This would prohibit the use of property law for the transfer of token and the transfer would have to be effected by assignment in accordance with the principles of the law of obligations (Völkel 2017, 387) (Aigner 2019, 821) or other legal provisions depending on the circumstances.

This raises the question whether there are any other arguments that could support the application of property rights in rem to token. The private key and address that can be stored on a physical wallet, which itself is a tangible object in Austrian law cannot be applied to token. The physical wallet contains just the private key not the token itself, they are still digital and not tangible. Physical wallets do neither contain token nor do they make token tangible and are therefore not suitable as a means to apply property law in rem to token (Fleißner 2018, 438) (Vonkilch and Knoll 2019, 142).

One option proposed by several authors would be the analogous⁴ use of some provisions of property law in rem for token (Fleißner 2018, 440–41) (Vonkilch and Knoll 2019, 143) (Aigner 2019, 824). Physical transfer of intangible objects is impossible, but in property law both transfer by symbol (§ 427) and by declaration (§ 428) can be considered as a mode (Fleißner 2018, 440). If the physical transfer of an object is disproportionally difficult because it is very heavy or large, the object can be transferred by a symbol. Symbols can be (amongst other things) tools that give power of disposition such as a key to a container (Welser and Kletečka 2018, 290–91). The private key gives the person that knows the key

⁴ Before an analogy can be made an unintentional gap in the law needs to be identified (Welser and Kletečka 2018, 29–31) Technological innovation can be the cause for such a gap (Welser and Kletečka 2018, 30–31) (Vonkilch and Knoll 2019, 148). The law becomes incomplete due to developments that happen after the law has been enacted.

the power over the token associated with this address (Fleißner 2018, 441). Transfer by declaration also works well for blockchain systems, the most likely form being the possession order (Besitzanweisung). The possession order is the transfer of possession from the transferor to the transferee, while the object is in the custody of a third party, the holder. The holder who is in possession of the object during the entire process is instructed to exercise his custody on behalf of the transferee instead of the transferor (Welser and Kletečka 2018, 293–94) (Holzner 2016c, m. n. 6). The blockchain system is the holder, the token itself is not moved but attributed to a new address, that of the transferee.

Tokens are intangible objects and therefore part of personal property law but not property law in rem since only tangible objects are part of property law in rem in the classical understanding. Nevertheless, convincing arguments voiced by several authors point towards the possibility of applying parts of property law in rem to tokens. As shown above Austrian property law already contains a great wealth of legal tools that could be extended to tokens. These arguments should be taken up by legislators and courts alike to further the integration of tokens into the legal system. Austrian law is adaptable enough to incorporate tokens to a large degree but more detailed legislation or clear and concise rulings by the higher courts that allow for the wider blockchain system to be incorporated into law would be a step into the right direction forming a solid foundation for economic development based on strong but not rigid institutions.

This is just a small fraction of the most basic legal questions that arise from the introduction of tokens into the economy that have been raised here. Some credible solutions have been discussed here.

Integrating tokens and blockchain systems into civil law, with adjustments where necessary while encouraging courts to help with this integration seems preferable since the Austrian civil law gives great flexibility.

3.3. Swiss Property Law

Like Austrian property law, Swiss law knows several principles. These rules developed by scholarship and judges help as a guide in the application of Swiss property law. Property is absolute, directed against everyone. Therefore, it is necessary that those affected by the absolute nature of property can recognize these rights. This publicity is achieved by instruments such as the land register or by the possession of a movable object. Parties to a contract are not able to come up with new types of property rights. Property rights are

limited to the means found in Swiss civil law. Property rights can also only be established on individual objects, one by one, not on all the assets of a person, a company or all the items in a warehouse. The law distinguishes between a commitment transaction (a person commits himself to another under the law of obligations) and a disposal transaction (the person disposes of his right, transfers it). No right can be acquired without a valid commitment transaction. Principles further state that an older right has priority before a younger right and that all parts of an object share the same legal destiny (Breitschmid and Jungo 2016, 9–10) (Schmid and Hürlimann-Kaup 2017, 16–20).

Akin to Austrian law, there are rights that must be respected, and which are enforceable against everyone; they are absolute. Relative rights on the other hand are only directed against certain people (receivables rights, personal rights). Swiss property right in rem is absolute. Swiss property law deals with property law in rem, in the sense that it deals with the absolute (real, in rem) rights to an object (Wolf 2016, 1217) (Breitschmid and Jungo 2016, 8) (2017, 1-5). **As a result, the definition of an object is crucially important: only objects under the law can enjoy protection and enforcement as absolute rights.**

Under Swiss law objects are not defined, but legal scholarship has developed characteristic elements. To qualify, an object needs to be impersonal (humans cannot be an object), tangible, spatially definable and subject to factual and legal human control. In addition to that object's physical attributes, its economic function and the perception of the involved parties needs to be taken into consideration. Objects must be impersonal in the sense that they are different from humans. Only tangible three-dimensional objects meet the requirements for the definition of object in Swiss law, which puts it into strong contrast to Austrian law, where intangibles also qualify as objects. Therefore, receivables rights, companies and many more things are not objects, on the other hand a bar of gold, a car or a computer are. Objects are considered spatially definable based on their physical structure (plant, stone) or by the ability to be put into a vessel (water). For objects, which are normally sold in specific quantities such as flour, the quantity (1 kilo) is qualified as an object. An object is controllable if it can be bought or used and is, therefore, factually or legally controlled (Wolf 2016, 1216–17) (Breitschmid and Jungo 2016, 6–7) (Schmid and Hürlimann-Kaup 2017, 1–3).

3.3.1. Token in Swiss Property Law

As mentioned above to qualify as an object under Swiss law an item needs to be impersonal, tangible, spatially definable and subject to human control.

Data forms the basic structure of the digital world, thereby serving as a good starting point to develop a deeper understanding of how digital objects can be incorporated into civil law. Based on the perception of the involved parties, data has similarities to tangible objects. It is stored, traded, and transported and immense value can be attributed to it. Data can be factually controlled and to some extent legally controlled. The opinion that data can be qualified as tangible, because it is stored on a physical storage device, does not adequately consider the technical attributes of digital information that are different from that of the storage device. The fact alone that token and blockchain applications are made from data does not mean that token are completely ruled out as objects in property law since they have further qualities that have to be taken into consideration.

Because data does not meet the formal requirements of an object in the Swiss definition new ways of capturing this phenomenon need to be devised.

Tangible in the sense of Swiss law are only material (tangible) objects that extend into the surrounding space. Energy or different types of rights are therefore not objects (Breitschmid and Jungo 2016, 7). In some cases, property law is extended to intangible things. The forces of nature (electrical energy, water or nuclear power and other natural forces), although intangible, are regulated by the law of movable property. This is not based on the definition of property law as discussed so far, but on Art. 713 ZGB⁵ that applies the law of movable objects to natural forces by way of analogy (Breitschmid and Jungo 2016, 349–50). Token can by no means be qualified as a natural force and analogy is only possible where the necessary legal basis to extend property law exists (Eggen 2018, 563). Nevertheless, this showcases that at least theoretically the rules of property law in rem could be applied to things that are not tangible. Since they are not material, token are not objects in Swiss property law (Lombard 2019, 255) (Müller and Ong 2020) (Zogg 2020, 6) (Enz 2020, 294) (Bundesrat-Schweizerische Eidgenossenschaft 2018, 48) (Maurenbrecher and Meier 2017, 6–7) (Eggen 2018, 563) (Hürlimann-Kaup 2018, 142).

⁵ Schweizerisches Zivilgesetzbuch vom 10. Dezember 1907 (ZGB; SR 210), Swiss Civil Code

Contrary to the dominant view in the literature, some authors argue that token should nonetheless be qualified as objects in property law. On the one hand there is the opinion that data can be stored on an object and via this object become tangible (Eckert 2016, 249). The same argumentation can be used for token and physical wallets (Lombard 2019, 255). As mentioned above, both theories do not adequately take into consideration the difference between the tangible object and the token. In addition, the necessity of tangibility as a feature of objects has been questioned based on the fact that controllability is guaranteed via the private key (Schönknecht 2016, 311). Similarly, and based on the controllability argument an analogy to movable objects has been proposed. Considering that legal scholarship has developed further criteria for the definition of objects in the legal sense, such as their economic function, the opinion of the involved parties and ethical considerations, a functional interpretation of the term can be applied that could include token as well as other intangible things (Seiler, B. and Seiler, D. 2018, 158–59).

The dominant view, that token are not objects in property law and therefore do not benefit from its protections, does not detract from the necessity to incorporate blockchain applications into law. What is debated is the means by which this incorporation should be achieved. The extension of the definition of property or an analogy are being refuted with valid arguments. The more likely solution would be passing legislation.

There are several more ways that have been proposed to incorporate token into current Swiss law. One way would be to qualify them as a receivables right, in a system agreement that exists between all system participants (Zogg 2019, 104).

If the token is structured as a payment token like Bitcoin the qualification as a receivables right becomes difficult. Because of the decentralized nature of the system, no central entity in the legal sense emits the token or facilitates exchanges, no entity functions as the debtor of the receivable. Therefore, payment token cannot be incorporated into the receivables rights system (Enz 2020, 295). This might be different for other blockchain based systems depending on their structure (Zogg 2019, 108).

Furthermore, the qualification as Securities, Wertrechte⁶, Bucheffekten⁷ or as intellectual property rights have been discussed. The literature largely argues against including Bitcoin and other payment token into either of these groups (Zogg 2019, 108,109,111) (Enz 2020, 295) (Bundesrat-Schweizerische Eidgenossenschaft 2018, 57–62). Whether or not this also applies to other types of token such as security or payment token, remains a question for further research, depending on the structure of the system (Zogg 2019, 108-111).

This does not exclude token from law in general since they are still a tradable pecuniary advantage that can be subject of civil law contracts (Zogg 2019, 111–12).

The Swiss Federal Council issued a report that analysed selected legal frameworks in Switzerland with a view to assessing which are conducive to the sustainable development of DLT and blockchain applications while limiting the associated risks (Bundesrat-Schweizerische Eidgenossenschaft 2018). This was followed by a period of public consultation and a report on the insights of that consultation (Bundesrat-Schweizerische Eidgenossenschaft 2019b). Based on this process the draft for a *Bundesgesetz zur Anpassung des Bundesrechts an Entwicklungen der Technik verteilter elektronischer Register*, Federal Act on the Adaptation of Federal Law to Developments in Distributed Ledger Technology (Bundesversammlung der Schweizerischen Eidgenossenschaft 2020) was issued.

The Federal Council decided that no fundamental adaption of the legal framework should take place and that no comprehensive, specific law was needed. This approach was considered more prudent given the rapid development of the technology. Specific regulation was considered problematic, because of the slow legislative process compared to the rapid technological development and other side-effects that were not elaborated more closely. The Federal Council argues that the existing legal framework is sufficiently flexible, offering the necessary tools. The draft law, nevertheless, includes targeted

⁶ Wertrechte are non-certificated rights (i.e. not linked to a deed) with the same function as securities Art. 973c OR, Bundesgesetz vom 30. März 1911 betreffend die Ergänzung des Schweizerischen Zivilgesetzbuches (Fünfter Teil: Obligationenrecht) (Obligationenrecht, OR; SR 220) Swiss Code of Obligations

⁷ Bucheffekten are a fungible claim or membership right that is securitised in a security or encapsulated in a Wertrecht (so-called underlying), which is deposited with a central depository for collective custody or as a global certificate or entered in its main register and has been credited to a securities account Art. 3, Art. 6 Bucheffektengesetz, Bundesgesetz vom 3. Oktober 2008 über Bucheffekten (Bucheffektengesetz, BEG; SR 957.1), Bucheffekten Code

amendments and additions to the current body of law, including banking law, financial markets law and insolvency law (Bundesrat-Schweizerische Eidgenossenschaft 2019a, 8).

Not included in this draft law are any amendments or additions to property law that would incorporate token. Neither was the definition of objects extended to include intangibles nor was an analogy similar to movable objects made. However, the Federal Council decided to incorporate other changes with a view to encouraging growth and to increasing trust, protecting the integrity of the Swiss financial marketplace, while allowing for technological innovation.

The draft does not contain provisions for payment token since the Federal Council in their evaluation purely considers them a pecuniary advantage. Therefore, no adaption of civil law is needed in this area. Token that are supposed to represent a legal position and, according to the will of the users fulfil a similar function as securities traditionally do, are to be treated differently. This includes an adaptation of securities law. It treats this kind of token like securities. The intention of the Federal Council is to provide a solution in civil law that allows parties to map and transfer their rights but giving them freedom to design the technical details based on a contractual agreement of the parties. As there is no governmental body that certifies or oversees these benchmarks, this is left to the involved parties (Bundesrat-Schweizerische Eidgenossenschaft 2019a, 10–11).

The debates elaborated up to this point explain not only the basic mechanisms and rules of the law but also showcase the considerable level of complexity. The discussion surrounding the current state of DLT-systems and token in Austria and Switzerland is nevertheless lively. While Switzerland might be closer to concrete legislation, Austria might benefit from its flexible property rights system. What they have in common are basic notions of defining objects as tangible or intangible with consequences for the classification as property rights in rem or personal property rights. These characteristics determine exchangeability and enforcement. Only clearly defined and enforceable property rights provide the preconditions for low transaction cost marketplaces. It is therefore important that Austria and Switzerland, but also other jurisdictions, adopt according legislation or introduce DLT-systems otherwise into their legal systems.

Incorporating the complex rules of property rights into DLT-systems would be more than challenging. This might explain the decision in Liechtenstein to take another approach.

3.4. Liechtenstein

3.4.1. Introduction - A Small Nation's Economy

Liechtenstein geographically situated between Austria and Switzerland in the heart of the Alps is a relatively small but highly developed nation. The principality has been independent since 1866 and was intricately linked to Austria up until World War I after which it entered into a customs union with Switzerland and adopted the Swiss franc as its currency. This shift is also visible in the country's legal system, which moved from a strong Austrian influence to a Swiss influence. Liechtenstein's economy saw a period of extraordinary growth following the second world war, in part thanks to its policy of low taxes (Analytics 2020).

Liechtenstein is one of the smallest independent nations on earth. Neither its small size nor its limited access to natural resources (including a considerable reliance on energy imports from the surrounding nations) has hindered economic progress. Liechtenstein is highly developed and enjoys one of the highest GDP-per capita (PPP) levels in the world. The economy is industrialized, diversified and free-enterprising with a strong service sector. Liechtenstein is part of the European Economic Area (EEA) and works on harmonizing its economic policies with that of the EU (Analytics 2020).

In March 2019, the government of Liechtenstein issued a program called the Digitale Agenda Liechtenstein which is part of the government agenda 2017-2021. The program is supposed to integrate the potential of digital innovation into the economy and society of Liechtenstein. As part of this strategy the Liechtenstein government wants to support businesses in adapting and developing blockchain technology by providing a clearly defined legal basis (Regierung des Fürstentums Liechtenstein 2019, 23).

Strong interest due to the attractiveness of the Liechtenstein financial market and improved regulatory circumstances based on the TVTG, which is at least in part aimed at the markets (Silbernagl 2020, 10), suggest that blockchain businesses will invest in the market, further expanding the already sizable financial sector.

The government of Liechtenstein first announced plans to legislate in the field of blockchain in March 2018. In June 2019, the so-called Bericht und Antrag (BuA) was published. The law passed in October 2019 and entered into force on 1 January 2020.

3.4.2. Civil Law and the Tokenisation of Rights - The TVTG

As has been discussed above blockchain applications and token raise fundamental legal questions that are still largely unanswered. Nevertheless, legal certainty provided either by express legislation or judicial review is important to encourage growth in a new industry.

Economic analysis of the law is intricately linked to considerations of efficiency in exchanges and enforcement. Central to this is the reduction of transaction costs (Welser and Kletečka 2018, 23). Transaction costs – the costs of exchanging ownership titles (Demsetz 1968, 35) – matter, because they allow for the efficient factor and product markets that are the foundation of economic growth (North 1992, 6).

This chapter does not intend to address the numerous legal queries that are yet unanswered regarding the TVTG. This is not a weakness of the law but largely a consequence of the novelty of the subject, the time it takes for all new legislation to develop and the courage of the legislator to design a fundamental framework for the DLT-economy. Much more needs to be done to fully include token into the legal world. Instead, this chapter will try to outline the broader structure of the digitization of real-world assets on a digital system.

The law is divided into four sections (I. General Provisions, II. Civil Basis, III. Supervision of TT Service Providers, IV. Transitional and final provisions). Due to the focus on civil law in general and property law in particular only sections I. and II. will be covered here. First the main aim and structure of the law will be discussed followed by an analysis of token under the TVTG and the kinds of assets that can be transferred by token in accordance with the law. This will be continued with a detailed discussion of Art. 6 and 7 TVTG and how they create the circumstances for a token economy by synchronizing dispositions of rights on DLT-systems and in the “real”⁸ or “analogue” world, thus reducing double spending and providing a low transaction cost environment.

First this part will look at the object and purpose of the law to understand the intend of the legislator. Thereafter some of the main obstacles to the integration of property rights into DLT-systems will be discussed. This is necessary to assess weather the objective of the law to provide a civil basis for rights to be represented and transferred in token has been achieved. In another step the extent to which different kinds of rights can be transferred to

⁸ The term real is chosen for illustrative purposes and to make a distinction that is easily understandable for the reader. The digital sphere is arguably no less real than other parts of our surroundings.

DLT-systems will be appraised. From an economic point of view an extensive transformation of a wide array of rights (tangible goods, company rights, intellectual property) is favourable. In a last step the way the law chooses to represent analogue rights on digital systems will be discussed. This is important since only well defined property rights provide the preconditions for a low transaction cost economy.

Based on the view that blockchain technology has the potential to change the financial sector, the Liechtenstein government expressed that regulation in line with the needs of businesses will improve legal certainty and encourage development (BuA 54 2019, 11).

The similarity of token to (in)tangible objects as discussed above in the case of Austria and Switzerland was also contemplated in Liechtenstein. Local property law has the same restrictions as Swiss property law. It limits the definition of objects to tangibles and excludes token because they consist of data which is itself intangible (Layr and Marxer 2019, 13-14) (Silbernagl 2020, 10-11) (Raschauer and Silbernagl 2020, 13). Extending the definition to include intangible objects was, however, ruled out based on considerations of legal certainty. Including intangibles would have been a far-reaching adaptation of property law, that would have affected large parts of the system of civil law (BuA 54 2019, 62). These problems have been discussed earlier in this part and are most likely the reason why the legislator has chosen a different approach.

3.4.3. Object and Purpose

Token are a new concept for the legal system. The Liechtenstein government concluded that the existing legal framework was not equipped to answer some fundamental questions that arise from token and their application. The legal processes and consequences that follow from putting real world assets on a digital platform needed to be addressed because of their relevance for the users of these systems (BuA 54 2019, 41). Not forgetting that the TVTG is a framework-law that should function as a basis for token applications, it does not supersede or replace other legislation that is applicable to financial markets or other token activities such as financial market-, corporate- or civil-law (BuA 54 2019, 36).

Law of 03 October 2019 on Tokens and TT Service Providers (Token and TT Service Provider Act; TVTG)⁹

Art. 1

Object and Purpose

1) This law establishes the legal framework for all transaction systems based on Trustworthy Technology and in particular governs: a) The basis in terms of civil law with regard to Tokens and the representation of rights through Tokens and their transfer; b) The supervision and rights and obligations of TT Service Providers.

2) It aims: a) to ensure trust in digital legal communication, in particular in the financial and economic sector and the protection of users in TT Systems; b) to create excellent, innovation-friendly and technology-neutral framework conditions for rendering services concerning TT Systems.

The objectives of the law are to safeguard and increase confidence and trust in the digitalization of legal communication and the protection of those who use DLT-systems. This is achieved by the creation of a legal transfer mechanism, which regulates the disposal of token. This gives the user of a DLT-system legal certainty if he/she acquires or transfers a token including the right represented in the token. This legal certainty also extends to service providers on DLT-Systems, since they have a similar desire for clarity regarding the delimitation of their business activities with regard to other regulations such as financial market law, additionally the law intends to increase user trust under the umbrella of the legal system (BuA 54 2019, 126–27).

Section two (II. Civil Basis) constitutes a civil law order for token, regulating the disposition of token and the representation of a large number of rights via token on DLT-Systems. Most importantly it attempts to create symmetry between the disposal of token in the digital world and the disposal of rights represented by them in the “real” world. Achieving this symmetry is the most important challenge that must be overcome to create legal certainty.

⁹ For the purpose of coherence English translations of the law are based on the unofficial translation provided by the Liechtenstein Government, https://www.regierung.li/media/medienarchiv/950_6_08_01_2020.pdf?t=2.

Legal certainty and trust are required for the representation of the real world on a DLT-system. Token can represent digital assets as well as objects in the real world or contractual rights in a digital form. The person who acquires an object or a right by using a token must be able to rely on the law to give her/him clarity on her/his legal position. This is important because there is the possibility that a right could be disposed of in the real world without the consent of the digital owner. Token in a legal sense need to be able to represent a significant share of present and future applications. This also raises questions regarding the property of token (BuA 54 2019, 49).

3.4.4. Token in Liechtenstein Law

The Liechtenstein government deliberately chose an inclusive approach to token. From a historic point of view blockchain developed first as a virtual currency. A narrow interpretation of token only based on the use as a virtual currency/payment token/utility coin is not adequate to capture all current and future uses of the technology and might exclude potentially relevant applications (BuA 54 2019, 41).

Art. 2 TVTG

Definitions and designations

1) The following definitions are established for the purposes of this Act:

- a) “Trustworthy Technology (TT)”: Technologies through which the integrity of Tokens, the clear assignment of Tokens to TT Identifiers and the disposal over Tokens is ensured;*
- b) “TT Systems”: Transaction systems which allow for the secure transfer and storage of Tokens and the rendering of services based on this by means of trustworthy technology;*
- c) “Token”: a piece of information on a TT System which: 1. can represent claims or rights of memberships against a person, rights to property or other absolute or relative rights; and 2. is assigned to one or more TT Identifiers;*

...

The TVTG establishes a container-model. A large variety of rights can be represented digitally in a token or the token may be left empty functioning as a means of payment. A bar of gold, a painting or a company right can be tokenized with legal effect. Token do not create a new right, their function is to represent an existing right and to subject it to the authentication and transfer-system of the blockchain (BuA 54 2019, 60-61). There is no uses-based distinction between different types of token linked to different legal treatment

of some token (this only applies to the TVTG, based on their function token can be subject to other legal regimes outside the TVTG).

This leads to the question: What rights can be contained in a token, what can be tokenized? Although Art. 2 para. 1. lit. c. TVTG gives a definition of token and a list of rights that can be tokenized, questions remain. Claims-rights against a person, rights of membership against a person, absolute property rights (property law in rem), relative property rights, other absolute rights and other relative rights are explicitly mentioned. This enumeration can either be seen as exemplary; mentioning some but not all rights that can be tokenized or as absolute; mentioning all types of rights that can be tokenized with legal effect according to the rules of the TVTG, meaning that all rights not mentioned here cannot be contained in a token with legal effect.

Based on the wording of the law no indication is given that the enumeration is absolute. Wording like “only claims...”, “just claims...” is missing. Neither do other sections of the law indicate an absolute list. However, neither the German original¹⁰ nor the English translation contain wording typical of an exemplary definition such as “in particular”, “this includes”, “including but not limited to”. The wording including the term “can represent claims or...” has to be seen in context with the possibility to transfer empty token (BuA 54 2019, 141).

The interpretation as an exemplary definition in the law seems more plausible for several reasons. First, the law mentions “other relative and absolute rights” that can be tokenized, indicating that more than just the rights enumerated here can be tokenized. Second, the materials to the law state that it is intended to be inclusive and support the development of the token economy (BuA 54 2019, 53,58-59). This suggests that more than a limited number of rights can be tokenized to allow greater integration of the “real” economy on DLT-Systems. Third, tying into the aim to include many applications of the token-economy, the government used an extensive definition of rights including parts of the legal and economic system (this understanding of rights although not detailed, goes most likely beyond the civil law definition of rights) (BuA 54 2019, 58).

¹⁰ Token: eine Information auf einem VT-System, die Forderungs- oder Mitgliedschaftsrechte gegenüber einer Person, Rechte an Sachen oder andere absolute oder relative Rechte repräsentieren kann;

The materials on the other hand explicitly exclude some rights from being contained in a token, strengthening the argument for an absolute list of rights that can be tokenized.

The property right to land (such as a plot of land in Liechtenstein) cannot be tokenized, because of other mandatory legal requirements for the disposal of this right (BuA 54 2019, 141). However, this problem can be circumvented since the receivables right to the transfer of the land can be tokenized. Similar issues have been raised regarding token containing registered shares with restricted transferability (one kind of “rights of membership”). These can be bound to mandatory legal or contractual obligations of consent by a third party. Restricted membership rights can be tokenized as expressly stated in the materials. A further limitation is that tokenization is aimed (at least partly) at transferable rights. This excludes untransferable rights such as personal-rights (BuA 54 2019, 143-144).

Property rights to land and untransferable rights such as personal rights are explicitly mentioned as rights that cannot be tokenized. Property rights to land are excluded because for a legally effective transferral of the right mandatory formal requirements need to be observed (entry into the land registry) (BuA 54 2019, 141). This specific case can probably be extended to all transfers of rights that require the entry into a public record for their legal effect. Nevertheless, this barrier can most likely be overcome by tokenization of the receivables right to the transfer of property.

Multiple arguments, including the wording and the intention of the law, speak for an exemplary definition. But still no definitive list can be given to answer the question what groups of rights can be tokenized. There will be more detailed cases regarding the tokenisation of rights in the future that have to be interpreted by the courts using the TVTG and other law or by more specific legislation. By itself, the definition of token in the TVTG already allows for the tokenisation of a great wealth of rights and the economy. This is also beneficial from an economic perspective because it widens the applicability of token to a larger section of the economy as opposed to just sectoral tokenisation.

3.4.5. Symmetry Between Online and Offline World-The Problem of Double Spending

Following the container model, all rights represented on the DLT-system and all associated legal consequences remain intact, no new rights are created. Token are necessary to digitize rights safely on a DLT-system. But within the digital system representation, assignment and transfer of assets need a durable legal framework. This has to be provided by the civil

law section of the TVTG in order to meet the stated objective. The transfer of the contained right is affected by the transfer of token according to the rules of the DLT-system, Art. 7 TVTG. This raises a whole new set of legal questions, most importantly the legal relationship between the right and the token (BuA 54 2019, 58-59,165).

Because token are objects that are part of the legal structure imposed by the TVTG they can be the subjects of rights. Persons can transfer the token with legally binding effect. The person entitled to dispose of the token (termed “Verfügungsberechtigter” in the TVTG) is similar to the owner in the property law system. He/She is at the same time quasi owner of the token and of the right contained in the token (BuA 54 2019, 63). Token are digital representations of analogue rights. These digital rights cannot be transferred or asserted without the token, Art. 6 TVTG. The person entitled to dispose of the token (as reported by the DLT-system) is considered the rightful holder (possessor) of the right, Art. 8 para. 1 TVTG and the obligor is released by payment to the person entitled to dispose of the token Art. 8 para. 2 TVTG (BuA 54 2019, 166).

This has serious consequences for legal certainty and the functioning of large parts of civil law. It raises questions of the link between offline civil law and online blockchain law. Legal dispositions in one need to have simultaneous effects on the other to avoid fundamental legal uncertainty. What if an object such as a painting is sold legally binding offline in accordance with civil law but not transferred on the blockchain system via its token according to the TVTG? This could lead to the paradoxical situation where one right can be disposed of by two persons. Civil law would attribute it to one person the TVTG to another, causing substantial legal and economic uncertainty. Token become economically valuable by linking them to offline legal positions (BuA 54 2019, 168). In this scenario a conflict like data double spending (the Byzantine General’s problem) as discussed above might emerge. The same asset can be sold twice.

Double spending is not unique to the TVTG but one of the main legal challenges emanating from the introduction of DLT-technology (Ypma et al. 2020, 55) (Schuster 2019, 14). Therefore, the duality of the systems, one offline and one online need to be addressed.

Civil law although general and universal has distinct rules of its own. Property law in particular addresses the legal allocation of goods, including control and disposal (Welser and Kletečka 2018, 261). This is linked to its own set of rules. Dispositions need to be in accordance with these rules to have legal effect. Just because a token containing a right is

disposed in accordance with the TVTG does not mean that this disposition takes legal effect offline.

The government was aware of this problem and made legal certainty one of its key priorities. Online and offline certainty for digital and analogue assets needs to be guaranteed. The buyer of a token in the digital system needs to be certain that he/she acquires the associated right, just as the person who acquires a right or an object in the “real” world needs to be certain that he/she will not be left empty handed in comparison to the acquirer of the token (BuA 54 2019, 64).

The law takes two measures to ensure the symmetry of the online and offline world and to avoid a double spending.

Art. 7

Effects of Disposal

1) Disposal over the Token results in the disposal over the right represented by the Token.

2) If the legal effect under (1) does not come into force by law, the person obliged as a result of the disposal over the Token must ensure, through suitable measures, that:

a) the disposal over a Token directly or indirectly results in the disposal over the represented right, and

b) a competing disposal over the represented right is excluded.

...

First the law prescribes that the disposal over the token results in the disposal over the right represented by the token. This statutory rule seems extensive, giving priority to the disposal over token compared to other civil law dispositions and rules. A system of hierarchy between the TVTG and civil law would be the easiest way to deal with the problem of priority, which leads to the question of the effects of Art. 7 para. 1 TVTG.

There is no system of hierarchy between laws on the same level. Civil law and the TVTG, regulating rights in the “real” world and online respectively, are on the same level, therefore there is no priority. The provisions of the TVTG that regulate civil law could be seen as part of civil law that deals in more detail with token and their part in the economy, opening up other ways of interpreting this section.

Other ways of interpretation such as *lex posterior* (the more recent law takes priority to the older) or *lex-specialis* (the more specific or the law that regulates in more detail takes priority to the more general law) could be utilized in this context (Welser and Kletečka 2018, 40). This would suggest that since the civil law part of the TVTG is both more recent and more specific than general civil law, Art 7 para. 1 TVTG with its express disposition over rights takes priority over contravening civil law. In effect that would give priority to dispositions of the token whenever there is a conflict between the real and online systems. This interpretation is supported by the materials that state that the transfer of rights according to the TVTG as a *lex-specialis* takes precedent over property law (BuA 54 2019, 202).

However, the materials also clearly exclude an interpretation in such stark terms, stating that Art 7 para. 1 TVTG only applies if the law that determines the offline right, adheres to the TVTG (BuA 54 2019, 169). Meaning that if general civil law has specific rules for the disposition of rights such as mandatory formal requirements Art. 7 para. 1 TVTG does not apply (Layr and Marxer 2019, 14). This might exclude property rights in immovable and movable objects, securities, and receivables rights, limiting the applicability of Art. 7 para. 1 TVTG severely and making it the less relevant (except for the important group of *Wertrechte*, Value Rights) of the two measures. Furthermore, the materials state that despite *lex-specialis* status of Art.7 para. 1 TVTG a possession order or other methods might be necessary to ensure synchronicity between the online and offline world (BuA 54 2019, 203). The very existence of the second measure indicates that para 1 does not have priority over general civil law. There would be no need for para. 2 if the legal prescription would be absolute. It is however the primary step in assessing the legal effects of the disposal.

The most important case of Art. 7 para. 1 TVTG will be the value right as a completely dematerialized security, which enables the disposition of rights without further ado in connection with Art. 81a para. 1, para. 4 SchlT^{11 12} on DLT-systems (BuA 54 2019, 108-110, 169) (Subhash and Knobl 2019, 612-613, 619). Considering the weight of the financial sector in Liechtenstein dematerialized securities will be of great importance. For all other rights that can be tokenized Art. 7 para. 2 TVTG is the relevant norm.

¹¹ Personen- und Gesellschaftsrecht (PGR) vom 20. Januar 1926, LGBL. 1926 Nr. 4, LR-Nr. 216.0, Law on Persons and Companies of 20 January 1926, LGBL. 1926 No. 4, LR-Nr. 216.0.

¹² Art 81a SchlT was inspired by Art. 973c OR, Swiss Code of Obligations (BuA 54 2019, 120).

As a second measure the law requires the person obliged¹³ as a result of the disposal over the token, to ensure that the disposal of the token leads to the disposal of the right and that a rival disposal is excluded. The limited applicability of the legal prescription of para. 1 makes Art. 7 para. 2 TVTG especially important for a large variety of rights and will most likely be the central structure for the tokenization of property rights. The measures by which the obliged person achieves these two requirements are not mentioned in the law and are decided by the obliged person.

This considerable burden placed on the person obliged is in keeping with the general principle of freedom of contract, allowing the obliged to bear the responsibility to ensure that the disposal of the token leads to the disposal of the right, if this responsibility is linked to an economically beneficial agreement.

Suitable measures could be the use of an intermediary¹⁴ that guarantees the safekeeping of the right. The property of an object could be transferred to a trustee, who in turn is legally bound to only recognize the person entitled to dispose of the token according to the DLT-system (physical validators Art. 2 para. 1 lit. p TVTG have a similar function). Contractual obligations that limit the transfer of receivables rights to DLT-systems and simultaneously exclude civil law or company law for transfer can also function as a suitable measure (BuA 54 2019, 171-172). Given the amount of rights and the ease of concluding such a contract, this might prove to be the most important means of tokenizing rights, giving all the benefits of legal clarity, efficiency and enforceability, while gaining the exchangeability and security of DLT-systems. Making analogue receivables rights digital by contractually specifying their transfer using DLT-systems, a large part of the offline world can be

¹³ The materials are somewhat contradictory in several respects, especially if the evolutionary stages of the law are not considered. This is particularly evident in the change of responsibility from the producer of the token to the person obliged. Originally the producer of the token had to make certain that the disposal over the token gives direct legal disposition to the contained right and that other dispositions regarding the contained right are excluded. The selection of measures was left to the producer (BuA 54 2019, 64-65). The producer would have been legally responsible for the legal quality of the rights contained in the token he/she produces, which would have potentially far-reaching consequences for his/her liability versus his/her customers and might limit the application of the TVTG to sectorally limited solutions, like token for specific rights such as property in works of art or voting rights in a corporation, but also limit the larger tokenisation of a variety of rights.

¹⁴ This might seem as running contrary to the advantages of blockchain technology, needing no intermediaries. However, this position might be useful for some rights. Time will tell what legal options prove most useful in tokenizing rights.

tokenized. This connects offline civil law and the TVTG to function as a unit; together guaranteeing that dispositions of rights function symmetrically.

Property rights to tangible objects are still somewhat problematic, because the law requires certain procedures under publicity to transfer the right. Several options to solve this problem and to avoid legal uncertainty online and offline could be used. Among them are the possession order, as discussed above for Austrian law or the use of a physical validator.

Art. 2 TVTG

Definitions and designations

...

p) "Physical Validator": a person who ensures the enforcement of rights

in accordance with the agreement, in terms of property law, represented in Tokens on TT systems;

The problem of symmetry is particularly pronounced with objects and the duality of digitally tokenized property and tangible objects. To bridge this gap the government introduced the role of the “physical validator”. Its purpose is to connect the token and the rights contained within it to the object. This is associated with a multitude of legal and factual responsibilities ranging from the identification of the owner of an object and ensuring that this person is the legal owner of the object, making sure that the object is free from legal burdens that would limit dispositions, identifying the object and storing it. He/She is responsible for the safekeeping of the object and that only the person entitled to dispose of the token (Verfügungsberechtigter) is allowed to alter the objects location or legal characteristics (sell it, encumber it with a lien) in accordance with the DLT-System (BuA 54 2019, 72-73) (Layr and Marxer 2019, 15-16).

With the number of tokenized objects, the number of possible defaults raises, even newly produced objects that are tokenized from the beginning could be sold or encumbered without the knowledge of the physical validator. The physical validator is not expressly required by section II. of the law but other sections indicate that tangible objects can only be tokenized if the property rights are clarified by a physical validator (Sild 2020, 57) (BuA 54 2019, 106).

The TVTG builds the structures for a civil law that captures the digital world. By creating a legal object sui generis (Layr and Marxer 2019, 18) – the token – which can contain and

transfer a large variety of rights; be it property rights in tangible objects, receivables rights, corporate rights or value rights, it includes large parts of the economy via their legal categories making them tradable.

While DLT-systems solve the problem of digital double spending the TVTG solves legal double spending; two people who can legally transfer the same right, leading to considerable legal uncertainty and an increase in economic transaction costs.

Value rights are incorporated by statutory prescription, giving priority to dispositions on DLT-systems. For those rights that cannot be transferred to the blockchain immediately (traditional property rights, such as rights to tangible goods) a system of liability is created, thereby establishing symmetry between offline rights and online rights, tearing down this particular barrier. These functions are fundamental for economic activity. From a systematic perspective it has the potential to reduce transaction costs by institutionalizing a system of property rights. As Coase himself pointed out all government regulation has social costs, it is the role of the economist to measure and compare (Coase 1960, 18) (Shirley, Wang, N., and Menard 2015, 233).

It takes time for all new legislation to develop and to see whether it can deliver legal certainty and encourage long lasting growth with the flexibility to adapt to technological advances (Raschauer and Silbernagl 2020, 16). Based on a first assessment the courage of the legislator to design a fundamental framework for the DLT economy has resulted in a suitable and reliable structure for the digitization of assets (Raschauer and Silbernagl 2020, 18) that integrates into the existing legal order and runs symmetrically with conventional civil law.

4. PART II: Economics

The second part of this thesis deals with the relationship between DLT-systems and the economy and investigates how legal measures are necessary to facilitate this relationship. First some elements of New Institutional Economics – institutions, property rights and transaction costs – will be described, discussed and an attempt to find a working-definition will be made. Later this will be placed in general transaction cost and institutional economics theory. Thereafter a general theory of the impact of DLT-technology on transaction costs as well as other approaches will be presented. Subsequently this will be applied to the insights gained in PART I about the characteristics and benefits of the TVTG.

In 1991 the Prize in Economic Sciences in Memory of Alfred Nobel (colloquially known as the Nobel Prize for Economics) was awarded to Ronald H. Coase. He received the prize for his “discovery” and studies on the significance of transaction costs and property rights for the institutional structure and functioning of the economy. His work highlighted the connection of economics, law and organisation (Coase 1991).

Two years later Douglass C. North and Robert W. Fogel received the same prize. North was honoured for shedding new light on the economic development in Europe and the United States before and in connection with the industrial revolution and for emphasizing the role of property rights and institutions (North 1993). In his work he developed a theory of how institutions such as social and legal rules help to reduce transaction costs and boost economic activity. *When transaction costs are significant, then institutions matter. A set of political and economic institutions that provide low-cost transacting makes possible the efficient factor and product markets underlying economic growth* (North 1992, 6). These elements and interrelationships shall be discussed in more detail in the following sections.

4.1. Elements and Definitions

Institutions: Economic outcomes are shaped by institutions such as markets or property rights (Acemoglu, Johnson, S., and Robinson 2004, 1). On their most basic level, institutions are the constraints devised by humans that shape our interactions. They are the rules of the game in a society. This shows how closely related they are to a general definition of law in the legal sense. Institutions give priorities to exchanges in economy, politics, and society. Changing institutions shapes the evolution and growth of society. Economic performance is intricately linked to the way institutions evolve. Institutions affect the costs of exchange and production and are a determinant of transaction costs

(North 2009, 1–6). Ideally they work as devices for reducing uncertainty and simplifying decision making reducing the costs of coordinating economic activities (Furubotn and Richter 2014, 7).

Property rights: Property rights themselves are defined in numerous ways. Classic scientific literature has a more legal, later literature a more general approach. Defining economic property rights has its difficulties because of the large number of scholarly work on this topic and the resulting variety in definitional approaches (Musole 2009, 52). Similar to the legal distinctions illustrated in part one and based on considerations originating in legal theory, property rights can be based on civil law (only tangibles are included), common law (including intangibles as well) or social convention. They can also be categorized as absolute (directed against everybody, similar to property rights in rem as mentioned earlier) or relative (directed against one or more specific persons, similar to personal property rights) (Furubotn and Richter 2014, 86–87). Yet many economists have employed other concepts of property rights that diverge from legal considerations (Cole and Grossman 2002, 317–18). Nevertheless, this evolution from a property rights definition based on law to an independent economic property rights term has broadened the understanding of the working of institutions, property rights and growth. Most incorporate property rights in the legal sense and the property rights concepts unknown to law such as social conventions and the operation of markets. Property rights in the economic sense can be described as: *the formal and informal institutions and arrangements that govern access to land and other resources, as well as the resulting claims that individuals hold on those resources and on the benefits they generate.* (Wiebe and Meinzen-Dick 1998, 205–6)



Figure 2: Relationship between Economic and Legal Property rights definitions. There is substantial overlap between the legal and economic definition of property rights. Most economic definitions are however more extensive.

Transaction costs: Property rights and transaction costs are inextricably linked. However, not one universal definition of transaction costs exists and authors have suggested various different ways of describing the essence of the concept (Musole 2009, 46). Not even theoretical consensus on the nature of transaction costs has been established (Wang, N. 2003, 2). Coase himself never defined the term and resorted to the use of examples (Allen 2015, 381). Regardless, it is still important to attempt to find some definitions or at least descriptions to gain a better understanding of the term.

Transaction costs have been described as the cost of exchanging ownership titles (Demsetz 1968, 35). Transaction costs have also been defined as: the costs of running the economic system (which can impede or even completely stop the formation of markets if they are too large) (Arrow 1969, 60), exchanging and enforcing property rights, obtaining information and measurement attributes or the making and enforcing of contracts (Shirley, Wang, N., and Menard 2015, 229). One definition that gives a good indication of the essence of transaction costs was presented by Allen: “*transaction costs are the costs of establishing and maintaining economic property rights.*” describing economic property rights as: *the ability to freely exercise a choice* (Allen 2015, 382).

A more comprehensive understanding emerges when transaction costs are categorized in the various subcategories and the parts of the economy they effect. From an institutional

perspective they are the costs of maintaining or changing the systems institutional framework, which includes the costs that stem from establishing, using, maintaining, and changing institutions in the sense of law (the Austrian Civil Code) and institutions in the sense of rights (a claim based on a contract). Capturing the full spectrum of economic activity, transaction costs can be divided into three categories: **1. managerial transaction costs**; setting up and running a company or giving orders within a company **2. political transaction costs**; the costs of running a polity, and most important for this work, **3. market transaction costs**; which are mainly bargaining and information costs that arise when using a market. These can be further divided into **a.** the costs that go into the preparation of a contract (search and information costs) **b.** the costs of concluding contracts (bargaining and decision making costs) **c.** the costs of monitoring and enforcing contracts, **d.** the costs of establishing and maintaining social relations (Furubotn and Richter 2014, 51–58).

While transaction costs are an established feature of economic thinking, but giving exact numbers as to their impact on the economy is difficult. The costs of running the economy are measured as diversely as they are defined. Literature trying to answer this question comes from various sides such as financial economics which benefits from a wealth of data on transactions in the financial market; comparative institutional analysis which compares one form of organisation or contract to another in the light of their transaction costs; economy wide approaches that take the entire transaction sector as opposed to the production sector to produce the aggregate size of transactions in the economy; or work that looks at institutions like law, financial markets or trust to demonstrate empirically that institutions encourage economic growth (Wang, N. 2003). This wealth of measurement methods is also a cause for rightful criticism. Like the many definitions of the term, transaction costs can be quantified in different ways yielding different results.

Based on this short general elaboration, it becomes obvious that there might not be consensus on the exact numbers, but there is when it comes to the importance of transaction costs in the economy. Some estimates say that as much as 45 to 55 percent of GNP of the entire American economy (1970) is related to transaction costs and that managerial and market transaction costs combined amount to between 50 and 57 percent of the price a consumer pays for the final product. This high and still growing share of production costs as part of GNP emphasises the importance of transaction costs in the economy (Furubotn and Richter 2014, 60–63).

In summary, it can be said that there are no universally accepted definitions of institutions, property rights and transaction costs. All elements are described differently in the literature, depending on the context and author. For the purposes of this analysis the following definitions shall be applied: Transaction costs are the costs of exchanging ownership titles and can be subdivided into different groups as presented above. Institutions are the humanly devised constraints that shape our interactions and give priorities to exchanges in the economy, politics, and society. Property rights are the formal and informal institutions that govern access to scarce resources, as well as the claims to those resources. They are the determinants for the allocation of rights.

4.2. Economic Theory

In 1937 Ronald Coase argued that the field of economics was too focused on the price mechanism. According to the classical understanding the major factor in all economic activity is the price. The direction of resources is dependent on prices, supply adjusts to demand and production to consumption. This model in his view was underequipped to explain the economy, in particular the functioning of a firm. His study of the economic system went further than that and concerned itself with the foundations on which the system was erected (Coase, 386-387). More than half a century later, in his 1991 Nobel Prize lecture he still stated the same concerns, namely that economics is too preoccupied with the pricing system, neglecting other aspects of the economy. The level of abstraction in the analysis which is too far removed from reality leads to an incomplete theory (Coase 1991). Coase's contribution was to bridge this gap in economics and to expand the understanding of economic mechanisms.

The fundamental step towards greater understanding was that **there are costs to using the price mechanism** and that these costs can be reduced by the formation of a system of organisation that directs resources. These costs can be the costs of finding out what the relevant prices are or the costs of the contracts for each transaction on a market. In the context of the firm they determine if a firm should be established: If transactions on the market are more costly than cooperating within the firm, then establishing a firm might be profitable. This depends on how much transaction costs are saved (Coase 1937, 390–95) (Shirley, Wang, N., and Menard 2015, 228).

The introduction of transaction costs was only the first step in a more fundamental analysis of economic mechanisms. Social costs (depending on context and definition also called

spillovers or negative externalities) are costs that stem from the economic activity of one actor that negatively affects another actor such as noise or pollution (Shirley, Wang, N., and Menard 2015, 232). Traditional economic thinking most prominently by authors such as Pigou would propose solutions like taxation, compensation for damages or emissions regulation to avoid these costs (Pigou 1932).

However, Coase was more sceptical of government regulation and took a different view (Shirley, Wang, N., and Menard 2015, 230).

Costs in these kinds of situations would arise on both sides; on the one side the pollution on the other the costs of compensation for the pollution. This could be remedied by lawsuits from the people affected by the pollution or government regulation, as well as by money transfers to the people affected by the polluters to offset negative effects. All these solutions entail some costs. However it is hard to tell, which costs are larger and which are smaller, since corrective measures like the ones Pigou proposed might cause as much or even more harm than the problem that they are trying to solve (Coase 1960, 26–27). The task of economists is therefore to compare these different regimes (Coase 1960, 42–44) (Shirley, Wang, N., and Menard 2015, 232–33).

In an idealized world with no transaction costs polluters and those affected by the pollution could freely negotiate the allocation of rights (the right to pollute or the right to sue the polluter) thereby maximizing production. Under these circumstances the original allocation of rights matters little because the people involved can freely reassign rights. This is much closer to the classical understanding with no transaction costs in which the most important determinant is the price (Coase 1960, 2–15) (Coase 1991). It was, however, not Coase's intention to state that government intervention was the less favourable option or that negotiations between individuals entail less transaction costs, but that in the real world transaction costs matter and, because transaction costs are a substantial factor in economic activity, the determinants of these costs need to be studied (Coase 1991).

What the Coase-theorem shows is that in a world with zero transaction costs, institutions such as well-defined property rights are not needed, because individuals can freely reallocate rights. However, since such a world does not exist, as Coase and others showed in previous work, the determinants of positive transaction costs need to be studied (Coase 1960, 18). This call to arms for economists was taken up by two new schools of economic

research; New Institutional Economics and Law and Economics (Shirley, Wang, N., and Menard 2015, 233).

In classical economics, property rights are given and not further discussed. General equilibrium theory does not include efficiency aspects of ownership in its models. In a zero-transaction cost economy property rights to the factors of production do not matter. In a Coasean world, with large positive transaction costs, uncertainty and asymmetric information are a factor and property rights matter for economic results. The effects of property rights help to reduce transaction costs thus increasing the economic welfare of society (Furubotn and Richter 2014, 80–81). The system of property rights is the basis for all market exchange. Well-defined property rights are fundamental for the functioning of markets. Consequently unclear property rights cause market failures (Cole and Grossman 2002, 317). Clearly defined and enforceable property rights help reduce transaction costs in market exchanges.

One further crucial insight gained from Coase's work is an understanding of the nature of exchanges in the market that looks at the most basic unit of exchange. Descriptions of economic activity are regularly based on a view that, what is exchanged on a market are mostly physical entities such as products but also services. If we look at a deeper level, physical entities such as a plot of land that can be sold, are just composites of a number of rights that are the core unit of the actual transaction. The plot of land is associated with the right to use the land, gain resources from it, build on it or any number of other rights. On the most fundamental level, it is rights to perform certain actions that are traded on a market. The system of rights is formulated in the legal system (Coase 1960, 43–44) (Coase 1991).

The ideas and concepts formulated by Coase influenced subsequent generations of economists and laid the foundation for the work of Douglass North. His argument, briefly stated, is that in a world with transaction costs, institutions matter (Shirley, Wang, N., and Menard 2015, 234).

Similar to Coase, North voiced criticism of the traditional system of neoclassical economic analysis for its inability to describe economic development. Its function of describing how the market mechanism works does not cover the development of markets. North described it as based on technology and capital investment, but did not consider the incentive structure inherent in institutions (North 1993). As previously mentioned, institutions can be characterized as a set of man-made rules that shape the structure of human interaction. They

can be categorized into formal (legal system) and informal (social rules) and are accompanied by their enforcement mechanisms. These rules incentivise economic behaviour. They are, thus, an essential part of transaction costs. In a world with transaction costs as described by Coase, institutions matter because they have an impact on these costs (North 1993).

The criticism of classical economics is somewhat warranted, but the basic concepts of the relationship between institutions, property rights and economic activity that North formulated are already visible in the work of Adam Smith: *Commerce and manufactures can seldom flourish long in any state which does not enjoy a regular administration of justice, in which the people do not feel themselves secure in the possession of their property, in which the faith of contracts is not supported by law, and in which the authority of the state is not supposed to be regularly employed in enforcing the payments of debts from all those who are able to pay* (Smith and Wight 2007, 594).

For an efficient market there needs to be strong competition, information feedback and arbitrage. Under these conditions with efficient information, feedback transaction costs are low and individuals can realize gains as described in neoclassical economics. There are several requirements for this kind of efficient market. Individuals must know their objectives and devise ways to achieve them, information feedback and arbitrage can correct suboptimal methods of achieving objectives and improve outcomes (North 1993).

However, this optimal situation is far from the observable reality. Individuals most often have incomplete information and act based on frequently erroneous models that are not corrected by information feedback. Institutions are not necessarily efficient, because their rules are decided by those with political bargaining power and, hence, often suit their needs most. Efficient economic markets are the exception and high transaction costs the norm (North 1993). Efficient institutions with well-defined property rights and enforcement mechanisms are the answer to these problems; they improve economic performance by reducing transaction costs and uncertainty (Zak 2002, 55).

Coase summarizes well what has been discussed so far: *The welfare of a human society depends on the flow of goods and services, and this in turn depends on the productivity of the economic system. Adam Smith explained that the productivity of the economic system depends on specialization (he says the division of labor), but specialization is only possible if there is exchange-and the lower the costs of exchange (transaction costs if you will), the*

more specialization there will be and the greater the productivity of the system. But the costs of exchange depend on the institutions of a country: its legal system, its political system, its social system, its educational system, its culture, and so on. In effect it is the institutions that govern the performance of an economy, and it is this that gives the "new institutional economics" its importance for economists. (quoted directly from Coase for its brevity and accuracy) (Coase 1998, 73).

4.3. DLT-Systems, Property Rights and Transaction Costs

So far there is no established economic model or way of analysing the economic implications of DLT-technology. Work has been done on some use cases, but no universally accepted general model has been produced. It is far beyond this analysis to propose such a model. What shall be attempted here is merely to discuss different approaches and to apply the insights of property rights and transaction cost theory to distributed ledgers and later describe the relationship between transaction costs, property rights and DLT-technology as it applies to the TVTG.

First, there is the neoclassical analysis of distributed ledger technology's impact on the economy. From this perspective DLT-systems reduce inefficiencies by employing technology to improve payment systems or transfers of assets. Using distributed ledgers increases total factor productivity by reducing production costs. Its effect is to make existing factors more productive (Davidson, Filippi, and Potts 2018, 647–48). DLT-systems reduce the costs of verification; the ability to verify past transactions and present ownership, and networking; the ability to operate a marketplace without a centralized intermediary (Catalini and Gans 2016, 6–20). In a neoclassical analysis the gains of DLT-systems stem from the technological change that lowers the cost of production (Davidson, Filippi, and Potts 2018, 648).

Then there is the institutional approach. Contrary to the classical understanding, distributed ledgers are not to be seen as part of the existing economic system but as a new way of doing things. Its primary impact is not improving efficiency of the present economic system, but the making available of a new mode of coordinating economic activity. This new model of coordination and governance is said to be an institutional evolution (Davidson, Filippi, and Potts 2018, 654–55). This view argues that distributed ledgers are an additional way for people to coordinate their economic activity, just like the existing forms such as markets, firms, contracts or governments (Davidson, Filippi, and Potts 2018, 641). The system does

no longer needs trusted third parties and creates a decentralized system that still has an organisational mechanism, which can substitute markets, firms or other institutions (Davidson, Filippi, and Potts 2018, 649).

Both classical economics and the approaches arguing for an institutional evolution raise valid points and emphasise inherent qualities of DLT-systems as their main arguments. Neoclassical considerations are too narrow as has been discussed earlier. Nonetheless, exchanges on DLT-systems are much closer to the neoclassical model than most real-world markets because of their formalized and rigid structures. The argument for institutional evolution correctly states that DLT-systems lower transaction costs by eliminating intermediaries. Whether the institution behind this is an old one or a new one is less relevant, what matters is the reduction in transaction costs. The fitting theory for the impact of DLT-systems is therefore that of transaction costs.

4.3.1. Transaction Cost Theory and DLT-Systems

The advent of digital networks has aided the development of an ever-growing digital economy. Digital goods can be replicated and distributed at minimal marginal cost being their main advantage over physical goods. The existence of networks and the benefits of fast distribution at low cost give the digital economy an important advantage over traditional exchanges. However, there are some significant drawbacks to this technology (Hopf, Loebbecke, and Avital 2018, 1).

Speed, transferability, and the possibility to copy data make the protection of assets in the digital sphere a top priority. Significant efforts must be made to safeguard the assets and exchange processes in a digital economy. Falsification and duplication of the data associated with digitized property rights are the main concerns that limit the full utilisation of the advantages of digital goods. The solution to this problem has for a long time been a system of intermediaries that verify the transfer of digital property rights. This system however reduces speed while it increases costs by relying on intermediaries. Although the need for trusted third parties is not unique to digital transactions it is particularly pronounced here (Hopf, Loebbecke, and Avital 2018, 1).

Digital property rights can embody a great number of real-world assets. These can be digital assets as well as physical objects such as a painting, a bar of gold or the inventory of a firm, but also as other values such as stocks or bonds. DLT-technology helps to utilize the advantages of digitization by providing a system that greatly reduces the risk of falsification

and duplication yet providing the speed and transferability of online networks. Property rights can be transferred via a distributed network without the need for an intermediary (Hopf, Loebbecke, and Avital 2018, 2–3).

This might have substantial effects on transaction costs, property rights and economic activity. DLT-technology can enable the exchange of property rights without the need for an intermediary. On a simplistic, functional level the entries on a DLT-system can represent individual property rights (which are contained in token) that are listed in the system. Tokenized rights are subsequently transferred in a safe manner via the system (Hopf, Loebbecke, and Avital 2018, 3–4). These rights are associated with token, making them tradable on this secure system. This reduces transaction costs by minimizing the need for third parties' services based on the functionality of the decentralized cryptographically protected system (Hopf, Loebbecke, and Avital 2018, 3).

4.4. TVTG, Property Rights and Transaction Costs

As has been discussed earlier, transaction costs and property rights matter in an economy. Digital data benefits from low transaction costs but cannot provide solutions for the problem of double spending. Digital data can be copied and reused elsewhere making it more difficult to digitize assets and requiring intermediaries which in turn increases costs. This problem has been solved by DLT-systems. There remains however another complication already mentioned in Part I: legal double spending and symmetry.

From the perspective of civil law as it pertains to DLT-systems and token multiple problems arise. The intricate rules of Liechtenstein, Swiss, Austrian, and other civil property law, as discussed above, make it difficult to integrate new technology on a large, economically significant scale while keeping transaction costs low. The law has its problems in adequately capturing digital data as an object. Transferring a significant fraction of rights to a new system of exchange, while keeping the old offline system intact is a novel challenge.

Averting legal double spending between the real world and the digital world as well as the required symmetry are the main concerns in this regard. The right to a bar of gold, a voting right in a corporation or another right might be disposed of with legally binding effect in the real world. If this right has been tokenized and subjected to a DLT-system another person with the necessary tools (such as private and public key) could dispose of the same right in the digital world. This causes major legal uncertainty and has detrimental economic

effects. A clear allocation of rights is a key matter for the functioning of the legal system in general, but also for transfer and enforcement.

Uncertainty is one of the major obstacles to a wider adoption of DLT-systems. As with many technologies in their early stages of development a lack of trust by consumers, firms, and governments to adopt new systems exists.

This problem is similar to digital double spending and has comparable economic consequences. Transaction costs rise with insecure property rights. Integrating the current civil law mechanisms of property rights allocation into DLT-systems to avoid legal double spending is therefore key to comprehensively utilize the advantages of this technology and to incorporate economically significant groups of rights into the digital world. Symmetry between dispositions in the real and in the digital world is decisive in this regard. While distributed ledger technology reduces transaction costs in the digital world it is the task of the law as an institution to reduce these costs by creating legal certainty, at the same time also guaranteeing enforceability by defining property rights and establishing symmetry.

4.4.1. TVTG and Transaction Cost Savings

The law establishes the legal framework for DLT-systems and governs the representation and transfer of rights through token, Art. 1 para. 1 TVTG. This reduces transaction costs at the intersection between law and digital systems.

Art. 7 para. 1 TVTG, Effects of Disposal

1) Disposal over the Token results in the disposal over the right represented by the Token.

Art. 7 para. 1 TVTG stipulates that disposal over the token results in disposal over the right contained in the token. As discussed above this particular provision does not apply to rights in general but is mainly aimed at value rights. From a legal perspective this provision gives priority to legal dispositions on DLT-systems and not in other systems. In essence the person who disposes of a (value) right contained in a token according to the DLT-system takes the legally relevant disposition, other dispositions have no impact on the legal status of the right. It gives a clear guidance for dispositions of value rights and excludes other dispositions. This Article works as a general rule in the allocation of property rights and eliminates the problem of double spending. Even if another disposition were to be taken the disposal according to the distributed system would take precedent. Contravening claims would be void and the person entitled to dispose of the token according to the system could

enforce his/her claim. This gives clarity to the allocation and enforcement of property rights possibly reducing transaction costs.

Although Art. 7 para. 1 TVTG covers a small section of the large group of rights that could potentially be tokenized on a DLT-system in accordance with the TVTG (as previously discussed), it is nevertheless highly significant economically. The financial market is not only the second biggest sector of the Liechtenstein economy but also one that is heavily reliant on intermediaries. Financial transactions require banks, brokers, and other specialized service providers to facilitate the secure exchange of rights. Making these rights transferable without the need for an intermediary, because of the special properties of DLT-systems (as discussed above), can reduce transaction costs significantly.

However, there needs to be another layer of increasing transferability, for other rights such as property in tangible objects, corporate rights or intellectual property.

Art. 7

2) If the legal effect under (1) does not come into force by law, the person obliged as a result of the disposal over the Token must ensure, through suitable measures, that:

- a) the disposal over a Token directly or indirectly results in the disposal over the represented right, and*
- b) a competing disposal over the represented right is excluded.*

...

There is a considerable amount of types of rights that cannot be tokenized according to para. 1. This is largely due to requirements originating in property law, that prohibit a simple stipulation but have to take the principles of property law as discussed above and other provisions into account. A fundamental reorganisation of property law that would have allowed for an integration of DLT-systems directly into the body of property law was ruled out due to the considerable impact this would have on the established system.

To integrate the large parts of civil law and the associated rights into DLT-systems a further step is necessary. In the case of the TVTG this is done by assigning responsibility to the person obliged, as a result of the disposal over the token. This person has to ensure that the disposal over the token results in the disposal over the represented right and that a competing disposal is excluded. This has two effects. First, it allows for an incorporation

of a large variety of rights with various differing rules of exchange to be contained in token and transferred on DLT-systems. Circumventing the need to integrate the manifold, interrelated but yet different legal requirements associated with different groups of rights independently. Second, it assigns responsibility for the disposal and enforcement of rights on a DLT-system. The person responsible functions as a safety mechanism in case of double spending. If the right contained in the token does not provide the envisaged legal positions, or a competing disposal exists, then the law assigns responsibility which could potentially include liability. This is not as direct as the disposition in Art. 7 para. 1 TVTG but represents an option that omits the need to change substantial parts of civil law while granting a structure to deal with the legal consequences of double spending and symmetry. It provides a fund for compensation in case a disposition on a DLT-system does not bring about the stipulated legal position. Therefore, it might be possible to enforce a claim of compensation. This is a substantial improvement compared to having insecure dispositions which compromise (property) rights.

The physical validator has a distinct role that applies to dispositions of tangible objects and adds an extra layer of accountability. By connecting the right contained in the token to the tangible object he/she performs an important function as an agent between the real and the digital world. Identification, verification of ownership, unencumbered status and storage services performed by the validator reduce the risk of dispositions of the object in one sphere, digital or real, that run contrary to dispositions in the other. However, the role of the physical validator is that of a classical intermediary.

This runs contrary to the logic of both DLT-systems and the transaction costs savings potential of the TVTG. Whether or not the physical validator brings an overall increase in transaction costs due to his/her extensive services or a reduction due to increased legal certainty is hard to quantify. Most low to medium worth assets probably will not be handed over to a physical validator based on a cost benefit comparison and a degree of uncertainty will be accepted by most users.

In essence the TVTG helps the adoption of DLT-systems by providing the legal certainty via a system of rules that limit the likelihood of double spending in large parts of the economy. This delineates property rights more clearly and enables enforcement in turn reducing transaction costs.

“If transaction costs are high, institutions matter.” (North 1993) can be applied in this context. Transaction costs are high, if property rights are not clearly defined and one person can dispose of a right that might have already been disposed by another. As a result, institutionalizing a regime of property rights that makes it more likely that rights can only be transferred by one person at a time has considerable capacity to reduce transaction costs with beneficial economic effects. It is the institutions that govern the performance of an economy (Coase 1998, 73).

Conclusion

This work has taken an interdisciplinary approach to studying the implications of DLT-systems, analyzing it from the perspectives of law and economics.

DLT-systems have considerable transformative potential, because of their structure as cryptographically protected, time-stamped decentralized databases. This allows private individuals, firms, and others to update datasets and validate transactions, in turn improving the transfer of assets via digital networks. Compared to the existing structures of digital exchanges, the usage of intermediaries or third parties is no longer necessary. These advantages make them the subject of debate for businesses and governments. Since this is a new technology, regulators need to assess whether the existing legal framework is fit to incorporate DLT-systems or if new norms are required. This includes the legal classification of token, consumer and investor protection, data-protection and much more.

In this work the most basic questions pertaining to the topics relation to civil law have been discussed. How are token to be classified and how can analogue rights be represented on DLT-systems to make them exchangeable using the benefits of these systems? The difficulty of incorporating basic civil law into DLT-systems has been shown in the cases of Austria and Switzerland. Both have taken different approaches, and while Switzerland might be closer to enacting legislation, Austria could benefit from the flexibility of its system that could allow (at least in part) for the incorporation of DLT-technology into the exiting legal structure. Property law in both nations is highly complex, thus emphasising he difficulty of incorporating it into a digital transfer system.

Liechtenstein has presented the first comprehensive legislative proposal in this regard by enacting the Law of 03 October 2019 on Tokens and TT Service Providers (Token and TT Service Provider Act; TVTG), LGBI-Nr. 2019.301, LR-Nr.: 950.6. The objective of the law is to establish a legal framework for DLT-systems including a civil law basis for token, the representation of rights in token and the transfer of these token, Art. 1 para. 1 lit. a TVTG.

The definition of token in the TVTG is deliberately broad with the aim of including all current and future uses of the technology. With some exceptions such as the property right to land, a great wealth of civil law rights can be tokenized, therefore, a larger section of the economy can be represented on DLT-systems as opposed to just sectoral tokenisation. Another consideration is the symmetry between dispositions of rights in the analogue world

and dispositions over the same rights once they are tokenized. Legal dispositions online and offline need to have simultaneous effects to avoid fundamental legal uncertainty. It must not be possible that an object sold with legally binding effect in the real world to one person can be sold online to another. The TVTG solves this problem in a twofold way. Value rights, which might prove especially important for the financial sector, are incorporated by statutory prescription, giving priority to dispositions on DLT-systems. For other rights such as receivables rights, the TVTG creates a system of liability by assigning responsibility to the person obliged as a result of the disposal over the token.

The methodological framework applied to study the effects of DLT-systems and the effects of specific parts of the TVTG was that of transaction cost and property rights theory. Multiple theoretical approaches to the study of the economic effect of DLT-systems exist. Neoclassical analysis does not seem to be an adequate method of inquiry, based on Coase's arguments and the narrow perspective it purports, while considerations of an institutional evolution overlook the underlying transaction cost argument inherent in institutional evolution. Nevertheless, both have some merit in their own right.

From a transaction cost perspective DLT-systems can reduce these costs by replacing intermediaries with a system of cryptographically protected decentralized ledgers, while at the same time solving the problem of double spending. The ledger creates a low transaction cost economy, a precondition for economic efficiency and prosperity.

Only if rights can be transferred with little to no transaction costs can the benefits of distributed ledgers be utilized completely. The TVTG has made a considerable step into the right direction. It presents an extensive model for token as containers for a multitude of civil-law-based-rights, such as property in tangible objects, receivables rights or value rights. Either by statutory prescription, assignment of responsibility which might include liability, or special service providers such as physical validators, it reduces legal double spending and increases symmetry. Both are indispensable for a low transaction cost transfer of rights between the analogue and the digital world.

Whether or not this law will function as intended remains to be seen. But it will definitely be a source for discussion and a starting point for many other nations, which will have to adopt this new technology at some point. The TVTG is especially relevant for Austria and Switzerland as well as for other nations with similar legal structures. There are many more aspects that cannot be covered here, but still are of considerable importance in the context

of DLT-systems, such as the economic implications of trust and information asymmetry as well as questions emanating from other fields such as company law, banking and capital-markets regulation or trade law.

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