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The Effectiveness of Economic Regulation of Network Industries: The Case of Estonia

Raigo Uukkivi

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Hereby I declare that this doctoral thesis, my original investigation and achievement, submitted for the doctoral degree at Tallinn University of Technology has not been submitted for doctoral or equivalent academic degree.

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Võrguettevõtete majandusliku regulatsiooni tulemuslikkus Eestis

RAIGO UUKKIVI

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Contents

List of publications

Copies of the publications constituting the thesis are included in the appendix and marked in Roman numerals as follows:

I Uukkivi, R.; Ots, M.; Koppel, O. (2014). Systematic approach to economic regulation of network industries in Estonia. Trames: Journal of the Humanities and Social Sciences, 18 (3), 221−241.

II Uukkivi, R.; Koppel, O. (2018). Economic regulation assessment of network industries: railway infrastructure management in Estonia. Discussions on Estonian Economic Policy, 1-2, 155−171.

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Author's Contribution to the Publications

Contribution to the papers in this thesis are:

I Lead Author. The research plan was designed in co-operation with the supervisor Dr. Ott Koppel. Data collection was carried out by the research team guided by the author. Author contributed to the data analysis and interpretation, drafting the article, revisions to the paper and final approval of the version to be published.

II Lead Author. The design of the research plan was compiled based on the results of the Article I in co-operation with the supervisor Dr. Ott Koppel. Data collection was carried out by the research team guided by the author. Data processing and assessment of the results was performed by the author and checked by Dr. Ott Koppel. The author drafted the paper, contributed to the revisions and final approval of the version to be published.

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Introduction

Network industries supply economy with intermediate goods and provide essential services to the society. The importance of network industries to a country's economic output and employment is usually significant. In the EU, it is estimated to be at around 7% of harmonised index of consumer prices (Martin *et al.*, 2005). In northern countries, the economic benefit attributable to network industries is higher due to district heating infrastructure. Universal consumption of network industry services amplifies the considerations of affordability and safety of supply, as well as attracts political opportunism to favour consumers against the investors.

The definition of network industries is ambiguous in academic literature. A characteristic feature of all network industries is that competing suppliers need to interconnect to utilize the facilities of one another and to provide services to their final customers. Since typically the industries are marked by considerable asymmetry between an established incumbent and much smaller entrants, the determination of interconnection prices and conditions is crucial for the economic feasibility of entry and the viability of competition. (Carter and Wright, 1999) For the purposes of this thesis, network industries has been referred to as physical infrastructure primarily in transportation and energy sectors (refer to Table 1 for full detail).

Capital intensity and sunk costs are common features of network industry's production technology due to underlying infrastructure component. As put by Gómez, network industries are bound to the physical space where they are located in (Gómez, 2013). Such characteristics of production technology establish natural barriers to competitive new entry and therefore lead to monopolistic market structure. Network industries are often subject to high degree of regulation because of substantial imbalance of market power and limited competition. Covaleski labels network industries as "administered markets" that are designed by public policy to prevent monopolistic market failure. Administered market is neither a hierarchy, where executive directives replace prices, nor a market, where demand and supply determine prices. (Covaleski *et al.,* 2003) The high importance of network industries to economy requires that the interests of wide range of stakeholders are adequately balanced in the design of regulatory frameworks. Investors would need to receive adequate return on deployed capital as investments in network industry infrastructure are sunk. On the other hand, monopolistic behaviour must be contained and customers provided with essential service at a reasonable price.

Regulation is an inherent part of the complex web of a nation's public policy (Spiller and Tommasi, 2005). Economic regulation is implemented through a range of measures targeted on the conduct and institutional structure of the regulated network industries. Industry structure, policy objectives and regulatory tradition of the jurisdiction usually determine how regulation is set up in practice. Furthermore, a regulatory interaction evolves over time as a result of changes to endogenous and exogenous factors impacting the regulated industry. Although the academic literature stipulates a number of universal objectives of economic regulation, regulatory frameworks also establish specific regulatory objectives that depend on a particular context. Therefore, the effectiveness of a regulatory framework must be analysed with reference to the objectives that such framework is intended to achieve. Generalisation of results is limited due to variation in regulatory governance in different jurisdictions. As noted by Finger and Rosa, each country is often a type in terms of regulatory governance. Regardless of the harmonising role of the policies

of the EU, the institutional path of the country is essential and no jurisdiction seems to be entirely settled into a lasting system even when developments have been introduced in stages. (Finger and Rosa, 2012).

Empirical studies show that the governance of regulatory framework sets important incentives to the stakeholders. Independent regulatory institutions and judicial review are considered crucial to establish a coherent "regulatory contract" (Spiller, 2011) and safeguard against political opportunism. Appropriate boundaries of the regulated infrastructure determine the governance of the network industry. Arguably, vertical separation establishes acceptable non-discriminatory practice and supports effective competition on non-monopolistic part the industry value chain. Vertical integration, however, capitalises on lower transaction costs as a result of aligned interests and easier coordination.

The regulatory approach to network industries advocated by the EU and the OECD is based on the imperfect competition narrative. Vertical separation of the industry's value chain and harmonized design of the regulatory institutions constitute the instrumental provisions of the regulatory toolkit. In Estonia, economic regulation has been embedded in many network industries and the full vertical separation of the network infrastructure value chain enacted in railway and energy sector. The knowledge about the effectiveness of such structural measures and the framework of economic regulation is limited.

The volume of empirical work on economic regulation of network industries in Estonia is limited. For example, Eermaa and Sepp (2011) discuss competition policy issues in naturally monopolistic infrastructure industries. Peda *et al.* (2013) studies the infrastructure governance of water utilities in Estonian municipalities with explicit attention to transaction cost economics perspective. Ots (2016) gives a detailed account of price regulation practices in Estonian energy sector. The author of the thesis studies the implementation of economic regulation of naturally monopolistic infrastructure in several works. Article I defines a comprehensive framework of the economic regulation of five network industry sectors in Estonia. Article II analyses economic regulation in Estonian railway sector, and Article III addresses the regulation of vertically integrated oil shale value chain composed of naturally monopolistic and competitive industries.

The subject of this thesis is interdisciplinary and is relevant to various fields of study in transport and logistics, supply management, political economy and economics. Network industry exhibits a specific production and distribution phenomena which involves sophisticated solutions around value chain governance, technology and government regulation. Current thesis aims to fill the gaps in empirical research on the effectiveness of economic regulation of network industries using Estonia as an example. The research objectives of this thesis are:

- First, to identify the institutional context in which economic regulation of network industries in Estonia is implemented. Establish how relevant regulatory authorities and legislation of network industries have evolved to their current form (addressed in Article I);
- Second, to explain the regulatory practice on the structure of the market and business conduct of companies in regulated network industries in Estonia (addressed in Articles II and III);
- Third, to define the mechanism for setting regulatory objectives and for evaluating results of economic regulation. Assess how regulatory objectives have been achieved in selected network industries in Estonia (addressed in Articles II, III, and in author's thesis).

Abbreviations

avg	average
C	court complaints
CA	Competition Authority
EC	the European Commission
EF	essential functions
EU	the European Union
FC	fixed cost
gtkm	gross tonne-kilometre
IM	railway infrastructure manager
MoEAC	Ministry of Economic Affairs and Communications
OECD	the Organisation for Economic Co-operation and Development
passengerkm	passenger-kilometre
PPI	producer price index
PSO	public service obligation
R	regulatory complaints
RI	Railway Inspectorate
RPI-X	retail price index minus efficiency ratio X
RU	railway undertaking
Stdev	standard deviation
T	total complaints
TRA	Technical Regulatory Authority
tkm	tonne-kilometre
trainkm	train-kilometre
VC	variable cost

1 Literature review

1.1 "Natural monopolism" of network industries

Spiller and Tommasi define utilities as sectors that exhibit three fundamental features: their products have wide domestic consumer base; they present economies of scope and scale at relevant demand levels; and there is a high level of sunk investments (Spiller and Tommasi, 2005). All utility services are associated with specific network component required for the delivery of services from the production unit to the place of consumption thereby adding the logistical "time and place characters" to the service. The delivery network usually forms a technologically integral part of the utility with no viable alternative to deliver the service or to utilize the network. The terms *utility*, *network utility* and *network industry* are often used interchangeably in academic literature and are used as such also in the thesis.

Production technology that involves high level of sunk investment and declining average costs due to a combination of economies of scale, economies of scope and economies of density, is a common characteristic of the natural monopolies. Industries that exhibit sub-additive cost function, *i.e.* single firm can supply the whole market demand at a lower cost per unit than any other combination of several companies, are called naturally monopolistic (Baumol *et al*., 1977; Carlton and Perloff, 2004). Sunk costs in long-lived physical and human assets is the most important attribute that links sub-additivity, behavioural definitions, and the economic performance challenges within unregulated natural monopolies (Joskow, 2005). Thus, natural monopolism may also arise from technological complexity of the industry (Cogman, 2001), be based on the preferences of political constituents (Hertog, 2010) or be based on a notion that it is socially optimal to restrict competition in certain industries (Amir, 2003). Academic literature often employs a differentiated approach on separate phases of network utility's production technology. Table 1 summarizes the naturally monopolistic and inherently competitive segments of network industry value chain.

Table 1. Natural monopoly and competitive phase of network industries

Network industry	**Natural monopoly segment**	**Potentially competitive segment**
Railway	Railway infrastructure	Railway transport services
Electricity	Electricity transmission and distribution infrastructure	Electricity generation
District heating	Heat generation; district heating infrastructure	None
Heating gas	Gas pipeline infrastructure	Gas supply and storage
Water and sewage	Water and sewage treatment; pipeline infrastructure	None

Source: author

Joskow summarizes that there is no "bright line" between natural monopolies and competitive industries *per se* and the balance depends on relevant product market and on existence of substitute products in a particular context (Joskow, 2005). A comprehensive account of the origins of natural monopoly phenomenon in academic literature is provided by Mosca (2008) and Joskow (2005), Palma and Monardo (2019) explain the natural monopoly properties of transport networks.

1.2 Discussions of network industry regulation

1.2.1 Direct economic regulation

Koop and Lodge note that due to the absence of explicit definition and common concept of regulation, a wide range of categorisations are proposed in academic literature (Koop and Lodge, 2015). This thesis adheres to prominent inputs by Ogus and Selznick according to which regulation refers to legal means through which market deficiencies are managed and mitigated, and socio-economic objectives are implemented by a public agency (Ogus, 1994; Selznick, 1985). Regulating an industry therefore involves defining relevant legislative rules (*i.e.* regulations) and establishing the system of institutions that are mandated to implement the rules (*i.e.* regulator). Although not directly enforceable, legally mandated industry specific strategic policy is also considered an inherent part of regulatory narrative as it sets out principles for future legislation and provides guidance to regulators who are responsible for implementing the legislation. Therefore, regulation is not limited to what the regulators do, but also how they do it (Noll, 1980).

Academic and empirical research traditionally differentiates between economic and social regulation. Such distinction, however, is diminishing in the modern discourse as a wide range of social and environmental externalities are expected to be considered and compensated for as part of the regulatory process. Economic regulation focuses on the structure of the market and the business conduct of companies by restricting entry or exit, establishing licencing regimes, setting tariffs, imposing quality standards, requiring to service all demand etc. (Veljanovski, 2010; OECD, 1997). In broad terms, "regulation by agency" and "regulation by contract" are the common alternatives for economic regulation that governments can choose from (Jensen and Wu, 2017).

Specific production technology and sunk investments result in highly consolidated network industries which often operate as monopolies. As e*x post* oversight by general competition law is not timely nor sufficient to address monopolistic market failure and incentivize efficiency, providing a substitute for competitive market pressure is the major pretext for introducing *ex ante* economic regulation (Boyd, 2018). Smith argues that there are two principal mechanisms through which economic regulation could have positive impact on production efficiency. First, direct actions of regulators that influence the level of costs, quality of service and investment plans. Second, indirect actions that seek to prevent discrimination with the aim of promoting competition. Greater competition, in turn, is expected to have an indirect impact on the productive efficiency. (Smith *et al.,* 2018) Regulation is also expected to intermediate between industry's interest-groups and counterbalance political opportunism.

Regulated access and tariff regime present the most intrusive measures of network industry's property rights. Rate-of-return and price-cap are two distinct methodological alternatives outlined in academic literature that form the fundamental basis to all regulatory tariff models. Both approaches rely on an independent regulator for setting the maximum level of revenues with reference to defined quality of service based on *ex post* analysis of actual costs from recent years. The key differences between rate-of-return and price-cap approach come down to how managerial incentives are set, disclosure of information is encouraged, and production and allocative objectives of regulation are established.

Rate-of-return model (also called cost of service regulation) is effectively a "cost plus" contract between the regulator and the company where cost of the service is quantified and rate of return established as a percentage of the regulated asset base (Gómez, 2013). In contrast, price-cap regulation sets utility's total revenue cap for a longer period

(*e.g.* five years) whereas return on investment depends on firm's ability to manage and optimise its cost base. Revenue cap is adjusted annually by retail price index and a margin of pre-determined efficiency ratio (the so-called RPI-X). In-depth analysis of the implications of and comparison between rate-of-return and price-cap tariff methodologies is provided by Vogelsang (2002), Joskow (2005), Hertog (2010), and Pardina and Schiero (2018).

1.2.2 Vertical separation, privatization and franchising

Establishing and maintaining regulatory framework incurs costs to all associated parties, including cost of financing regulatory authorities, cost of setting up a regulatory reporting process, cost of compliance etc. Additionally, implementation of economic regulation is affected by a range of informational and behavioural phenomena (information asymmetry, skill deficit, opportunism, principal-agent problem, regulatory capture, etc.) that undermine its effectiveness and produce suboptimal results (Markovits, 2018).

A volume of academic work has emerged that acknowledges the utility production technology as a characteristic of a natural monopoly but seeks to complement economic regulation of a monopoly with additional measures. Two prominent approaches can be identified in this discourse. First, measures on the organizational structure and governance of a monopoly in order to establish distinct property rights and incentivize competition in the industry. Second, measures that provide the monopoly with market-like incentives through an *ex ante* contract.

There are two prominent challenges in the regulatory discourse: the degree of separation of the monopolistic infrastructure that is required to sustain competition in the other parts of the industry value chain, and the effect such separation has on the cost of network. Vertical unbundling has become one of the important structural measures advocated by academic literature (Newbery, 2002; Vogelsang, 2003) and promoted by the EU and the OECD in network industries like electricity, railways, heating gas etc. This approach separates economic incentives between production and transmission-distribution functions in a network industry. Services related to naturally monopolistic infrastructure are carved out from the industry's value chain (Opolska, 2017) and separated from inherently competitive production function (*e.g.* electricity generation, natural gas production, provision of railway transport services). Knieps explains that regulatory access and tariff regime that supports non-discriminatory access to service providers is only required in the presence of network-specific market power (*i.e.* monopoly "bottleneck"). The market power is achieved through the sub-additivity of the relevant cost function (no active competition) and geographical irreversibility (no potential competition). (Knieps, 2014) Künneke and Fens identify four general types of economic and legal unbundling differentiated mainly by the extent of unbundling under each approach: accounting, business units, legal entity, ownership (Künneke and Fens, 2007). Under the EU legislation, ownership unbundling is only considered a measure of the last resort that is utilised if the other measures have failed to achieve effective competition, and there is no or little prospect of that to change within a reasonable timeframe (OECD, 2013).

The main negative consequence of vertical unbundling is lower production efficiency of disintegrated companies due to higher transaction costs and misaligned business interests (Mizutani *et al.,* 2015). Empirical studies of vertical unbundling implications on costs are diverse but inconclusive. Crocker and Masten (1996) note that widespread policy initiatives on disintegration of utility services have given only limited attention to

potential losses of governance economies from such actions. Kwoka (2002) finds that vertically integrated network industries achieved superior productive efficiency relative to disintegrated alternatives. Bolle and Breitmoser (2006) inter-sectoral study shows that ownership unbundling led to higher customer prices. Joskow (2002) argues that vertically and horizontally integrated regulated monopolies can be potentially efficient organizational arrangements for vertical coordination and externality problems in electricity markets. The findings by Heim *et al.* (2020) suggest that legal unbundling of electricity distribution utilities has proven effective in limiting price discrimination of downstream rivals while minimizing the loss of vertical economies.

Regarding railway sector, Bitzan (2003) and Pittman (2005) identify strong economies of vertical integration of railway infrastructure management and transport operations in case of US railway infrastructure companies suggesting that vertical separation increases costs. Mizutani and Uranishi (2013) present an analysis of railways in the OECD countries and find that vertical separation leads to cost reduction for low traffic density railways and to cost increase for higher traffic density railways. McNulty (2011) and Merkert *et al.* (2012), Growitsch and Wetzel (2009) show that transaction costs are higher in separated systems whereas Cantos *et al.* (2010) and Asmild *et al.* (2008) find no significant change in costs attributable to vertical separation of railway networks. In the European context, Tomeš argues that technological interconnections between railway network infrastructure and operations are closer than in other network industries. This leads to additional coordination challenges that likely outweigh the benefits from the reform especially in smaller European states. (Tomeš, 2011)

Privatization of network industries has been promoted in order to increase innovation, reduce political intervention and government borrowing, lower subsidies etc. (Hertog, 2010). It is argued by the property rights theory that private ownership leads to increased production efficiency (Hart and Moore, 1997), however, private monopoly would exhibit equivalent negative attributes and is likely to require even more invasive economic regulation against the exploitation of market power. Some authors state that privatization of public utilities transfers public value to private interests. The associated profit motive of private equity is not necessarily aligned with the needs of a broad base of customers. (Carbonell-Nicolau, 2020) Difference between private and public ownership alternatives of network industries have attracted empirical study in the European context, see for example Newbery (2004). Privatization of network industries has often been accompanied with benchmarking or "yardstick" competition measures in case of horizontally (regionally) separated utilities. The method focuses on managerial efficiency by comparing factor adjusted average costs of network utilities in different regions and setting regulated prices based on the pool of all utilities (see Shleifer, 1985; Dijkstra *et al.*, 2014; Bjørndal *et al.,* 2016; Mizutani and Usami, 2016).

Franchising is the most prominent contract based alternative to regulation that substitutes "competition on the field" with "competition for the field". The approach, popularized by the seminal article of Demsetz (1968), awards an exclusive franchise of a monopoly for a certain period to the bidder that accepts the lowest subsidy for the service with defined quality criteria. Under such circumstances, competition for the franchise in the bidding phase is considered to compensate for or neutralize the disadvantages of monopoly in the operating phase. However, several authors argue that inherent attributes of a natural monopoly prohibit efficient franchising regardless of the contract period. All-encompassing long term contract with a natural monopoly would be a very complicated and impractical exercise (Williamson, 1976). At the same time,

repeated auctions of short-term fixed-price contracts would lead to inefficient investments in long-lived assets with high level of sunk costs (Joskow, 2005). Furthermore, the franchising agency dealing with the single incumbent effectively becomes a regulatory agency because institutional mechanism is required for solving disputes (Goldberg, 1976). The implementation of franchise bidding in network industries in Europe has been limited mostly to railway sector. Empirical studies of the franchise bidding practices are presented in Jupe and Funnel (2017), and Preston (2016).

1.2.3 Transaction cost implications on the regulation of network industries

Neoclassical economics approach to treatment of firms, markets and regulation is often criticized for ignoring governance and continuity of contractual relations between economic operators. According to Williamson, any problem that can be formulated as a contracting problem can be studied through transaction cost economizing terms (Williamson, 2010). Transaction cost economics broadens the perspective of economics to contract law and organization theory, and addresses markets and regulation as alternative governing institutions of the industry. Transaction cost approach is the most utilized theoretical perspective in logistics and supply chain management studies (Defee *et al.,* 2010), and has supported a wide spectrum of empirical applications in public policy and regulation (Macher and Richman, 2008).

Transaction cost economics is based on the concept that any market transaction includes an element of cost and such costs are the reason why markets are imperfect intermediaries. Structure of the firm is seen as a measure to economize on transaction costs. (Crook *et al*., 2013) The seminal work of Williamson explains important features of transaction cost approach. The concept relies on two behavioural assumptions. First, that human agents are prone to opportunism. Second, that human agents exhibit bounded rationality. Vertical integration and collaborative arrangements across the value chain reduce such opportunism and transaction costs by utilizing trade-offs between production cost (in which the market may have advantages) and governance cost (in which internal organization may have advantages). A particular impact of transaction cost on the governance of network industry value chain stems from the specificity of capital assets. Such specificity can arise in three forms: site, physical asset and human asset specificity. In case of a large fixed investment made in relation to a particular transaction (*i.e.* the investments are sunk and non-marketable), once the investment has been made, the parties are effectively operating in a bilateral (or at least quasi bilateral) relationship for a considerable period. They are expected to make significant efforts to establish an exchange that has good continuity properties. It is expected that economic organisation is continuously adapted and transactions aligned to achieve optimal governance structure in service of efficiency (*i.e.* optimization of transaction costs). (Williamson, 1981)

Figure 1 represents governance costs of transactions as a function of specificity of associated assets. Conceptually, the asset specificity can be described on a scale $A \in [0,1]$, where the value of A represents the probability that a contractual counterpart cannot be replaced and adaptation costs will be incurred. The higher the value A, the higher the expected cost of such replacement. (Tadelis and Williamson, 2013) Volume of empirical research proves that asset specificity does increase the duration and change structure of contractual arrangements towards more vertically integrated or long-term approach. (Macher and Richman, 2008) Due to substantial sunk investments in infrastructure, the common assumption is that the asset-specificity of network industries is very high.

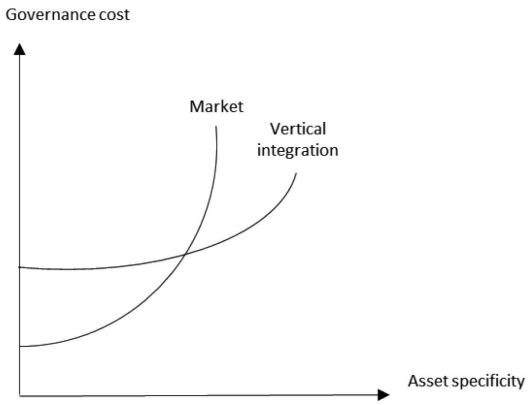

Figure 1. Asset specific function of transaction costs

Source: author's adaptation (Tadelis and Williamson, 2013)

The prominent work of Spiller applies the principles of transaction cost economics on the study of regulatory interaction between governments and investors. Transaction cost regulation establishes that the institutions and arrangements of regulatory governance are determined by the nature of contracting risks associated with "regulatory contract". Similar to the "make or buy" choices of value chain governance, the underlying objective of a regulatory framework structure is to minimize the costs of associated transactions. (Spiller, 2011) According to Goldberg, defining a regulatory framework is like preparing a long-term contract between private counterparts. A range of common challenges need to be addressed such as maximizing and dividing the economic benefits of the relationship, protecting parties against opportunism after sunk investments have been made, nominating overseeing institutions etc. (Goldberg, 1976)

Parties associated with regulatory framework exhibit opportunism. Investors are opportunistic to maximize the value of their investment, government maximizes political support and third parties (*e.g.* consumers) maximize vested interest (Spiller, 2011). Dependency between the counterparts of the regulatory contract is extensive. Investors have undertaken substantial investments in specific assets that are sunk and non-marketable, they are interested in protecting their equity. Government and consumers are interested in the continuity, reliable supply and pricing of network industry services due to universal domestic consumption.

The exposure of network industries to political intervention is a dominant challenge of transaction cost regulation. The threat of *ex post* expropriation may lead to insufficient investment in network infrastructure and result in inefficiencies that are equivalent to exploitation of monopolistic power. Spiller explains that governments have superior power to change rules *ex post* by passing new legislation and standards, changing the nature of contracts through administrative process, imposing fines, denying tariff increases etc. Investors facing the risk of governmental opportunism will either not invest or demand upfront compensation for the risk of increased political intervention. (Spiller, 2011) There is ample of evidence in academic literature (see Levy and Spiller, 1994; Henisz and Zelner, 2001; Bergara *et al*., 1998; Spiller and Tommasi, 2005) that appropriate legal and institutional framework with ability to limit governmental opportunism and resolve disputes is a precondition to private investment in network

industry infrastructure and successful performance of this sector. Superior results were produced by regulatory systems where (a) substantive restraints were placed on regulators, (b) the political and judicial systems placed restraints on changes in the regulatory system itself, and (c) institutions existed which enforced restraints both on regulators and on system changes (Levy and Spiller, 1994).

1.3 The case of the European Union railway regulation

The EU transport policy stresses the importance of railways as one of the safest, environmental friendly and sustainable modes of transport. A wide range of regulatory measures are utilized in order to support the competitiveness of railways. The common railway policy to revitalise railways in Europe started with the Directive 1990/440. Subsequent legislation included in four Railway Packages (see Gutiérrez-Hita and Ruiz-Rua, 2019 for in-depth overview) gradually increased the scope of intervention and evolved to an extensive system of economic and technical regulation of the railway sector.

Nash *et al.* state that the primary role of railway regulators in the context of the wider objectives of the EU railway policy is to introduce within-mode competition. The regulators are supposed to prevent discrimination against new entrants on issues such as track access charges and allocation of capacity in order to develop a competitive market. A secondary, but also an important objective, is to ensure the efficiency of the monopoly infrastructure manager. Regulation and its impacts will be interrelated with the structural setting and the degree of competition. (Nash *et al*., 2018)

The principal initiatives of the EU's coordinated regulatory effort of railways over almost three decades promote an organisational reform of railway companies, a change from state operated railways to a competitive regime, a free access to network and essential railway facilities, the common principles for setting tariffs, an interoperability of infrastructure and rolling stock, the common control and safety requirements (European Parliament, 2015). Due to natural monopoly characteristics of railway infrastructure, majority of the EU member states have a single dominant state-owned company responsible for the railway network. Vertical unbundling of integrated railway companies has been instrumental for the so-called market pillar of the EU's railway policy in order to support competition among the railway operators. The First and the Fourth Railway Package, in particular, define the framework of new railway regulatory bodies and establish provisions with strong implications on the organisation and functional structure of the railway sector value chain. In order to ensure financial and managerial independence of the infrastructure manager, specific requirements are put forward to separate the so-called essential functions of railway infrastructure management from economic interests in railway operations.

Table 2 summarizes the models of railway infrastructure governance in the EU. The data indicates that 11 member states have chosen a vertically integrated model for railway infrastructure management and railway transport services (four organised in an integrated company and seven via a joint holding company), whereas 15 member states have pursued a complete organizational separation of the railway infrastructure management going beyond what is required by the EU legislation. It must be noted that, prior to being rejected by the European Court of Justice, a legal interpretation of mandatory organizational separation of railway infrastructure management was promoted by the European Commission. The ruling of the European Court of Justice stated that organisation of railway infrastructure management and provision of railway

transport services via a holding company structure could be regarded as independent and therefore considered in compliance with the EU law (European Court of Justice, 2013). There is no consensus on what the optimal model for the organization of railways is in the EU. The argument from the supporters of a more integrated railway system is that vertical separation prohibits overall system optimization, leads to the duplication of fixed costs, reduces the potential for innovation, and increases overall coordination costs. (Finger and Montero, 2020)

Table 2. Organizational form of railway infrastructure management in the EU member states

Organizational form / Functional form	Integrated	Integrated (separate body for EF)	Holding (limited autonomy)	Holding (strong autonomy)	Separated
IM in charge of all functions (incl. capacity allocation and charging)			Austria France Germany Italy	Latvia Poland Slovenia	Belgium, Bulgaria, Czech Republic, Croatia, Denmark, Estonia, United Kingdom, Finland, Greece, Netherlands, Portugal, Romania, Slovakia, Spain, Sweden
EF (capacity allocation and charging) under a separate body		Hungary Ireland Lithuania Luxembourg			

Source: author's adaptation from (European Commission, 2019b)

The EU's common railway policy has brought along major changes to the institutional and regulatory landscape of railway sector in Europe. The European Commission's report on the development of rail market indicates substantial progress in transforming to a competitive market structure in member states' railway sectors. Approximately half of the member states have liberalized railway freight market and had competitive entry in the sector since as early as in 2000. Vast majority of the member states have achieved that by 2006. In 2016, competitors had on average around 39% of the market share, an increase of 13% from 2011. With the exception of Estonia and Romania, there was more effective competition in 2016 than in 2011. (European Commission, 2019b)

It appears, however, that the reforms have not had significant impact on the competitiveness nor financial viability of the railway transport in Europe. Although total expenditure of railway infrastructure in the EU almost doubled between 2011 and 2016, total train-kilometres of freight and passenger transport for the same period remained

stable. Rail passenger traffic has shown a modest growth rate whereas rail freight traffic has struggled to grow. GDP growth has significantly outpaced the growth in railway freight traffic across most of the member states suggesting that rail freight is playing continuously less of a role in the economic development of the EU. In 2016, the modal share of railways was around 17% in freight and 7.6% in passenger transport. Road remained the dominant mode within the EU handling more than 90% of passenger traffic and around 75% of freight traffic. (European Commission, 2019a; European Commission, 2019b) On average, track access charges that users pay represented around 79% of the total revenues of railway infrastructure managers (PRIME, 2019), however, such charges do not finance more than the running and current maintenance cost (5–10% of total costs) (European Parliament, 2015). Lack of data and common methodology does not allow forming concrete conclusions, substantial share of capital expenditure of railway infrastructure management is borne by national budgets (70% on average) and grants from the EU which implies that private investment in the railway infrastructure is being phased out. Unsatisfactory performance of the European railway regulation has been repeatedly noted by the European Parliament (European Parliament, 2015) and the European Court of Auditors (European Court of Auditors, 2016; 2018).

1.4 Problem statement

Network industries supply important services to the functioning of the overall economy. The production technology of network industries is based on capital intensive infrastructure that is unreasonable to duplicate. Such circumstances create high barriers to entry and require a public policy solution against exploitation of monopolistic market power. There is a high degree of consensus in academic literature that the combination of large sunk costs and asset specificity of network industries leads to natural monopolies in network industries. The academic discourse covers a wide spectrum of potential measures (regulation by public authority, contracts, private or public ownership etc.) that establish operational and economic incentives to stakeholders.

The practice of economic regulation of network industries in the EU and the OECD countries is widespread. Different domestic political preferences, industry structure and other political and economic aspects that determine the governance of regulatory frameworks in each jurisdiction have led to the evolution of different institutional systems. The EU directives have established a harmonized economic regulation and uniform governance of regulatory institutions in railway and energy industries due to the scalability to the pan-European marketplace. The regulation is established on the notion of imperfect competition and relies on vertical separation of the essential functions of the infrastructure management. In Estonia, the network industries of railway, energy, heating gas, district heating and water and sewage are subject to regulation around the access to the infrastructure and tariff setting. Estonia has been an early adopter of the EU's directives in network industries and implemented full vertical separation of infrastructure management in railway and energy industries.

There is a volume of theoretical and empirical research on the impacts of economic regulation. The results of the studies, however, are context-specific due to variations in regulatory frameworks and objectives of regulation. In Estonia, the volume of such research is low. The impact of regulatory measures and the effectiveness of economic regulation of network industries is largely unknown which presents a substantial deficit of knowledge and, therefore, the scope of this thesis is to address this. The research plan to deliver the objectives of the thesis is established in the next chapter.

2 Research Design

2.1 Research Strategy

In case of complex or ambiguous variables, qualitative approach to research supported by detailed description is preferred to build an understanding of the phenomenon. As context is intrinsic in the qualitative approach, phenomena that involve the exploration of well-known concepts in new contexts are also a good match for using qualitative methods. (Golicic and Davis, 2012). The study of economic regulation is sensitive to the context due to significant variation in regulated industries, objectives of the regulatory policy and the organisational design of associated institutions. Heavy micro analytic dose in assessing real behaviour, by real people in real environments within real institutions is therefore required (Spiller, 2011).

The thesis is based on three articles. Article I outlines a meta-analysis and systematization of the current body of knowledge on the framework of economic regulation of network industries in Estonia. The article identifies, conceptualises and explains the emergence of coherent economic regulation and related institutional environment. The thesis outlines the evolutionary path of regulatory authorities and legislation in network industries to the current form. In addition, the taxonomy of regulatory procedures is systematized.

The case studies in Article II and Article III investigate the application of the concepts identified in the Article I in two different network industry sectors in Estonia. The case of railway infrastructure management is presented in the Article II. The article provides the summary of institutional setup and objectives of economic regulation of railway infrastructure management in Estonia. Thereafter, relevant policy objectives are identified and relevant indicators to monitor the results of regulation are established. The Article III outlines the case study of oil shale value chain in Estonia, a combination of network industry and competitive industries. First, the oil shale value chain is mapped, and vertical hierarchies are identified. Thereafter, regulatory objectives are compiled, and corresponding indicators established with discussion of results and conclusion.

The first activities of the author's thesis are reviewing relevant literature on network industry regulation, governance of specific assets, and the key features of the EU's regulatory policy in railway sector. The overview is followed by a formulation of the problem statement and a description of the case study.

Empirical section of the author's thesis analyses the case of railway infrastructure management in Estonia. Estonia has been an early adopter of the EU's legislative measures of railway market liberalization and non-discriminatory open-access to railway infrastructure. The period of study is from the liberalization of railway market in 2004 until 2019. The thesis identifies the overarching objectives of economic regulation of railways of the EU and proposes relevant indicators for monitoring. Thereafter, the author establishes a typology of railway infrastructure governance models in Estonia. The main changes in institutional arrangements of railway infrastructure management and railway regulation are identified as milestones and longitudinal quantitative analysis is performed on how the objectives of economic regulation are achieved across alternative models of railway infrastructure governance in Estonia. Student's t-test is performed on the cost efficiency data samples to form an assessment on the alternative infrastructure governance models. This is followed by a discussion and conclusions.

Table 3. Research design of the thesis

Research problem		Goals
Network industries are important to the society/economy. Regulatory frameworks are context-specific; effectiveness is related to the regulatory objectives. There is limited knowledge and evidence on how effective economic regulations are.		Clarify the effectiveness of economic regulation of network industries based on the example of Estonia. Provide empirical evidence to support the analysis. Contribute to filling the gap in empirical research.
	Objectives and tasks	**Results**
Article I	**Objective:** to identify the institutional context in which economic regulation of network industries in Estonia is implemented. **Tasks:** • Meta-analysis of the economic regulation of network industries in Estonia. • Setting out the concepts of the regulatory framework; systematization of legislation, institutions, methods and regulatory practice. • Preparation and provision of context for the empirical analysis of the effectiveness of economic regulation in selected network industries.	The framework of economic regulation in Estonia is mapped. The evolution and current state of regulatory institutions, legislation, and network industries are traced. It is established that the practice of economic regulation in Estonia is based on the imperfect competition narrative. Economic regulation leverages tariff setting based on the rate-of-return model approach. There is no framework for monitoring the effectiveness of implementation.
Article II	**Objective:** to explain the regulatory practice on the structure of the market and business conduct of companies in regulated network industries in Estonia. The case of railway infrastructure management. **Tasks:** • Mapping of the institutional framework (regulations, institutions, regulated companies). • Study of the regulatory objectives and corresponding indicators. Assessment of results.	Regulatory framework in railway sector is mapped. Regulations are based on the EU directives that require vertical separation of the railway infrastructure and set harmonised rules for essential functions. It is established that the regulatory objectives in Estonia are defined on the general/strategic level only. Detailed objectives on technological quality of railway infrastructure were defined only recently in the context of financing contracts.

Table 3 (cont.)

	Objectives and tasks	Results
Article III	**Objective:** to explain the regulatory practice on the structure of the market and business conduct of companies in regulated network industries in Estonia. The case of oil shale value chain. **Tasks:** • Mapping of the institutional framework (regulations, institutions, regulated companies). • Study of the regulatory objectives and corresponding indicators. Assessment of results.	Regulatory framework of the oil shale value chain is mapped. The system of regulatory objectives and indicators is proposed on national development plan level. Methodological problems identified with several of the indicators, no regulatory reaction in case of negative trend. The system of tariffs is established to set incentives, however, the real value of tariffs over the period is stable and the improvement of indicators has not been achieved.
Author`s thesis	**Objective:** to assess how regulatory objectives have been achieved in selected network industries in Estonia. To clarify empirically the effectiveness of achieving the EU's regulatory objectives using the case of railway infrastructure management.	Results are summarised in author's thesis.

The objective of the author's thesis is to clarify the effectiveness of economic regulation of railways in Estonia to achieve EU's regulatory objectives in railway sector. Specifically:

- To clarify the evolution of institutional arrangements around regulatory governance of network industries in Estonia. Define the essential functions of associated institutions (addressed in section 2.2.1);
- To identify the types of railway infrastructure governance and corresponding setup of regulatory institutions in Estonia (addressed in section 2.2.2 and 2.3);
- To establish the objectives of economic regulation of railways in Estonia (addressed in section 2.4);
- To clarify whether the objectives of economic regulation of railways have been achieved. Compare the level of regulatory performance during the periods of alternative types of railway infrastructure governance in Estonia (addressed in section 3).

Information requests and surveys are the primary sources of data and inputs into the author's thesis. Financial and technical data of railway infrastructure management and railway traffic operations has been obtained from AS Eesti Raudtee (Estonian Railways), Estonian Consumer Protection and Technical Regulatory Authority and Ministry of Economic Affairs and Communications of Estonia. Data on complaints on the non-discriminatory open access to railway infrastructure is based on the records of Estonian Competition Authority and Estonian Consumer Protection and Technical Regulatory Authority. Secondary data has been compiled from published legislative and statistical databases. The analysis outlined in the author's thesis leverages primarily the process tracing and legislation analysis method in qualitative sections and various applications of statistical analysis in quantitative sections.

2.2 Case description

Network industries in Estonia are subject to economic regulation of limiting access to the market and setting tariffs. The introduction of regulatory framework of economic regulation in Estonia coincided with the adoption of the EU's sector-specific legislative norms in electricity, gas and railways. The EU's subsequent regulatory policy towards harmonised pan-European marketplace in these industries has been established by several phases of legislation and has had a particularly dominant impact in Estonian context. Going beyond what was required by the EU, Estonia implemented coherent economic regulation also in other domestic network industries like district heating and water and sewage. Two distinct of patterns of regulatory practice can be noted in Estonia, they are based on the evolution of sector-specific regulators: Estonian Competition Authority and Estonian Consumer Protection and Technical Regulatory Authority. The following chapter summarises the Article I, provides update on the more recent developments and validates key principles from the review of academic literature in the context of network industries in Estonia.

2.2.1 Economic regulation of network industries

The technology in electricity and gas transmission and distribution, district heating, and water and sewage industries has typical characteristics of a natural monopoly. Capital investment in long lived assets is effectively sunk with no viable alternative use. Small and scarcely populated Estonian domestic market in combination with substantial level of sunk costs of infrastructure create significant economies of scale, economies of scope and economies of density within the service area. Service area of a network utility depends largely on technological determinants. Water and sewage and district heating networks are traditionally considered a "local service" as water and heat cannot be transported over large distances. In contrast, electricity and gas networks can be interconnected and the aggregation in size is only limited by the consumer base. Power generation and supply of gas to the network are inherently competitive activities. It is not possible to use the network infrastructure in alternative function, the value of such capital would be substantially lower. Therefore, all these network industries are characterized by high degree of asset-specificity.

Energy Market Inspectorate, the first independent sector-specific economic regulator in Estonia, was established in 1998 and transformed into Estonian Competition Authority in 2008. Estonian Competition Authority is responsible for economic regulation of electricity distribution and transmission, gas, district heating, and water and sewage industries. The institutional framework, principles of access to the market and tariff regulation have remained practically unchanged since accession to the EU in 2004. Regulatory practice of Estonian Competition Authority is coherent across the network industries it oversees.

In order to avoid unreasonable duplication, access to the market in network industries is restricted by the principle of non-competition between infrastructure. Territorial monopolies are established by legislation and the utility is required to service all demand within the area of operation. The ownership of the network utilities varies from state to municipal and private equity. Due to the absence of competitive market pressure, the Estonian Competition Authority has historically taken an active role in scrutinizing tariffs and the profitability of network utilities by applying the rate-of-return model of price regulation. Tariffs must be pre-authorized by the regulator and are designed to compensate for the acceptable level of operating and capital expenditure

and reasonable profit on investment. That said, however, due to the *ad hoc* timing of tariff decisions, the incentives can effectively be reminiscent of a price-cap due to impact of inflation.

Estonian Competition Authority utilizes benchmarking and yardsticking methods to determine the regulated cost base of utilities. Tariff regulation practices of the Estonian Competition Authority led to a widely publicized dispute with the Tallinn water and sewage company. Specifically, the tariff regime that was agreed on with the investor during the privatization of the company (effectively a regulatory contract) was later unilaterally re-legislated by the parliament and then revised by the regulator when the new legislation gave it jurisdiction over the domain in 2011. This can be considered as one the most prominent examples of regulatory hold-up in Estonia.

Measures on the structure of network industry's value chain are particularly important in the energy sector. EU's regulatory measures of vertical separation require the insulation of the essential functions of the transmission operator in electricity and gas markets (directive 2009/72/EC and 2009/73/EC). The regulations went further in Estonia compared to what was required by the EU and implemented full vertical separation of ownership. In electricity market, gradual separation of the transmission grid from incumbent monopoly Eesti Energia AS (Estonian Energy) value chain was initiated with requirements for separate accounts (2004) and full ownership separation (2010). Since 2010, the ownership of the Eesti Energia AS and transmission company Elering AS are represented by the Estonian Ministry of Finance and Estonian Ministry of Economic Affairs and Communications respectively. Similar path to vertical separation was undertaken in Estonian heating gas sector. The requirement for separate accounts of transmission network of the incumbent monopoly Eesti Gaas AS (Estonian Gas) was introduced in 2006 and ownership separation finalised in 2016. Both electricity and gas transmission grids in Estonia are owned by Elering AS since 2016.

2.2.2 Economic regulation of railways

Railway infrastructure has the characteristics of a naturally monopolistic network as large capital investment and moderate variable costs lead to decreasing average cost function. Provision of railway transport services is inherently competitive but the small Estonian railway market has struggled to sustain competition among operators. The high specificity of railway infrastructure assets is amplified by Estonia's different technical standard compared to the railways in continental Europe, proprietary technology and limited pool of human capital. Unlike other network industries, railways operate in a highly competitive environment with alternatives offered by other modes of transport. In the Estonian context, only public service passenger transport and long haul railway freight transport are viable.

Economic regulation of railways in Estonia has been dictated largely by the evolution of the EU railway legislation. The monopoly over public interest railway network is mandated by the Railway Act and competition on the tracks is regulated by the principles of open access. Vertical separation of the infrastructure value chain which is one of the key measures of the EU's railway directives, has been similarly adopted in Estonia. Starting from the major overhaul of railway legislation in 2004, the authority over market access and tariff setting functions was transferred from vertically integrated railway infrastructure manager to the railway regulator, Estonian Railway Inspectorate. The sector-specific institutional model later evolved to a multi-sectoral regulator Estonian

Technical Regulatory Authority in 2008 and Estonian Consumer Protection and Technical Regulatory Authority in 2019.

Estonia attempted to modernize and increase the efficiency of state-owned incumbent monopoly AS Eesti Raudtee by spinning off specific functions and south-west part of the railway infrastructure into separate companies. Given Edelaraudtee AS (South-West Railways) infrastructure is used only for public passenger service with limited freight operations, the following analysis focuses on the infrastructure of AS Eesti Raudtee. Two-thirds of AS Eesti Raudtee was privatized in 2001, however, years of coordination issues and disputes over the "regulatory contract" between the state and private investors led to renationalisation of the company in 2007. Institutional separation of railway infrastructure management from railway operations was implemented in several phases. First, separate accounts were established within the incumbent for railway infrastructure management and other activities. Thereafter, railway infrastructure management was organised as a separate company under the holding model. Eventually Estonia went beyond what was required by the EU railway legislation and instituted a full legal separation between the railway infrastructure management and railway operations in 2013. Opening up of railway transport services market to competition has been implemented according to the demands of the EU railway legislation, however, Estonia still leverages the exemption that allows awarding direct contracts with regard to public service obligation.

Table 4. Liberalisation of railway transport services in Estonia

Legal milestone	Measure description
2003/11 railway act	Transposition of early railway directives and the first railway package. Open access to domestic and international freight market
2010/02 amendment of the railway act	Transposition of the third railway package. Open access to international passenger market
2018/12 amendment of the railway act	Legislating of the regulation 2016/2338. Open access to domestic passenger market. Estonia uses the exemption that allows PSO direct contracts

Source: Compiled by author

The rate-of-return and full cost recovery principles on basic and extra services ensuring access to railway infrastructure used to be characteristics of the 1520 mm gauge railway networks in the Baltic states. In Estonia, this approach remained virtually unchanged from 2004 to 2017. Direct costs, depreciation of assets, proportional share of overhead costs and reasonable profit was included in the regulatory cost base and thereby compensated for via the railway tariffs. The framework of railway infrastructure tariffs was overhauled in Estonia with the adoption of regulation EU 2015/909 in 2017. According to the regulation, tariffs for basic services ensuring access to railway infrastructure are allowed to include only the costs directly incurred by the train operation (the so-called minimum access package) and optional mark-ups subject to the ability to bear such increases. The regulated cost base can also include corresponding proportion of overheads and depreciation of capital assets but must exclude business profit.

Cost allocation model sets strong incentives to railway infrastructure manager and railway undertakings. The choice of model depends on rail infrastructure financing policy and charging objectives (Calvo and de Ona, 2012). Vuuren's approach divides the costs of railway infrastructure management into three segments: sunk, fixed and variable.

Sunk and fixed costs do not vary dependent on the volume of traffic whereas variable costs do. (Vuuren, 2002) For simplicity, this thesis aggregates sunk and fixed costs of railway infrastructure management. The fixed costs are associated with managing traffic on a railway network that complies with relevant technical norms and regulations whereas variable costs are directly incurred due to wear and tear caused by operating the train service.

The earlier regulatory approach of the full cost tariff methodology in Estonia used to allocate 70% of the total costs of railway infrastructure management as fixed costs and 30% as variable costs. Fixed costs of railway infrastructure management were charged according to forecasted traffic volume measured in train-kilometres whereas variable costs were covered based on the actual gross tonne-kilometres transported on the railway network. While the concept of direct cost in the EU 2015/909 has similar economic substance to variable cost, some studies have criticized the method for being unsuitable with the 1520 mm gauge railway technology of the Baltic countries. For example, Hudenko *et al.* establish that unpredictable traffic flows of freight traffic oriented to 1520 mm railways increase the costs of infrastructure management relative to the 1435 mm gauge railways in the continental Europe. Several technological distinctions of the 1520 mm gauge railways (higher maximum axle loads, train lengths requiring longer tracks and platforms, widespread use of diesel traction etc.) have also similar impact on costs. (Hudenko, Ribakova and Pocs, 2016). During the period 2017–2020, an average of 17.9% of the total costs of railway infrastructure management of AS Eesti Raudtee were categorized as direct costs.

Railway tariff decisions demonstrate that the recovery of railway infrastructure costs via user tariffs on AS Eesti Raudtee railway network decreased from ~100% between 2004–2017 to an average of 67% in 2018–2020 and ~50% in 2020. Significant share of the infrastructure tariffs is paid by PSO passenger traffic that is also financed from public funds. As a result, the implementation of direct cost recovery principle and limited mark-ups as per the regulation EU 2015/909 effectively shifted the financing of railway infrastructure capital expenditure from user tariffs to funding by the state budget.

2.3 Governance models of railways

According to transaction cost economics, the governance of contractual frameworks is designed with the objective of reducing risks (*i.e.* decrease transaction costs) and increasing cost-efficiency for related parties. The governance model of railways includes institutions of economic regulation and railway infrastructure management, and thereby represents all the institutional actors responsible for governing the network industry (sector-specific regulator, competition regulator, domain ministry, appeal body, infrastructure manager) and outlines respective decision-making authority. Based on the evolution of the railway infrastructure management in Estonia, the thesis differentiates between three modes of railway infrastructure governance: vertically integrated railway company with separate accounts (integrated), separate legal entities of railway infrastructure management and railway transport services under a holding model (holding), and fully separate railway infrastructure manager (separated). The periods of alternative governance types are rounded to full calendar years and complemented with data on regulatory governance and the responsibility for key functions as shown in Table 5.

Table 5. Institutional governance of economic regulation of and railway infrastructure management in Estonia 2004–2019

Period	Infrastructure governance model	Regulatory governance model				
		Legislation	**Funding**	**Allocation**	**Tariff**	**Appeals**
2004–2008	Integrated	MoEAC	None	RI	RI	CA
2009–2012	Holding	MoEAC	None	TRA	TRA	CA
2013–2019	Separated	MoEAC	MoEAC	Eesti Raudtee	TRA*	CA

*Source: Compiled by author. *TRA was reorganised to Consumer Protection and Technical Regulatory Authority in 2019*

The table shows that the model of railway infrastructure governance in Estonia between 2004–2019 has gradually evolved from vertically integrated railways to full legal separation of railway infrastructure management. The governance of regulatory functions during the same period has remained unchanged. The Ministry of Economic Affairs and Communications bears responsibility for domain-specific legislation and for ensuring the balance of revenues and expenditure of railway infrastructure management over 5 year periods. The latter responsibility is based on the Directive 2012/34/EU and was legislated in the Railway Act as of 2015. The essential functions of railway capacity allocation and tariff setting were conducted by sector-specific economic regulator during the integrated and holding model of railway infrastructure management. Railway infrastructure manager AS Eesti Raudtee regained authority over capacity allocation after the full vertical separation of railway infrastructure management. In order to incentivize operational efficiency and prudent investments in railway network, tariff setting has been the responsibility of the sector-specific regulator regardless of the governance of railway infrastructure management. Estonian Competition Authority is responsible for monitoring competition in the railway sector and handling disputes over non-discriminatory access to the railway infrastructure.

2.4 Regulatory objectives of railway infrastructure management

The objectives of economic regulation of railway infrastructure management in Estonia, addressed in detail in the Article II, are primarily focused on operational targets of safety, level of railway expenditure, and progress of implementing investment projects. Railway performance contracts with AS Eesti Raudtee for the period 2018–2020 continue the established pattern and pledge funding based on the achievement of contractually agreed railway infrastructure upgrades. The author's thesis investigates how economic regulation of railways in Estonia has achieved the objectives EU's railway policy. The objectives and indicators are summarized in Table 6 and explained below.

Table 6. Regulatory objectives and indicators of economic regulation railway infrastructure management in Estonia 2004-2019

	Regulatory objective		**Regulatory indicator**
1	Increased competition between railway undertakings through open and non-discriminatory access to railway infrastructure.	a	Number and market share of railway undertakings not-associated with the incumbent
		b	Number of complaints on capacity allocation and tariff setting
2	Increased production efficiency of railway infrastructure management	a	Efficiency of railway network (fixed cost efficiency)
		b	Efficiency of railway traffic management (variable cost efficiency)
3	Increased competitiveness of railway transport compared to other modes		Modal share of railway transport in Estonia

Source: Compiled by author

Non-discriminatory access to railway infrastructure and effective competition between railway undertakings is the key task of the EU's economic regulation of railways. This measure is investigated from two aspects. First, the level of competition on railway infrastructure after market liberalization is represented by the number and aggregated market share of railway undertakings not associated or spun off from the incumbent railway infrastructure monopoly (indicator 1.a).

Second, railway undertakings are unable to affect railway infrastructure manager's decisions on traffic management and expenditure *ex ante* due to asymmetric market power. The dynamics of complaints on capacity allocation and tariffs therefore reflect the level of perceived and factual discrimination of railway undertakings *ex post* (indicator 1.b).

The absence of competitive pressure does not incentivize railway infrastructure manager to be cost efficient, therefore, the regulator is expected to directly incentivize the monopoly on the level of operating costs and investment plans. Economic regulation is also expected to have an indirect positive effect on cost efficiency by discouraging discrimination and promoting competition. According to the principles of transaction cost economics, alternative types of governance of specific infrastructure assets should *ceteris paribus* lead to different cost-efficiency levels. The efficiency of fixed costs (indicator 2.a) and variable costs (indicator 2.b) of railway infrastructure management is calculated in the author's thesis and the Student t-test is performed to investigate the potential difference of mean values between the opposite infrastructure governance models.

Effective competition between railway undertakings is expected to lead to better production and allocative efficiency in the sector. Consequently, the overall competitiveness of railway transport should improve and be reflected by the increased modal share of railways in passenger and freight transport (indicator 3).

The effectiveness of economic regulation can be expressed as a function of regulatory indicators (2.1):

$$E_r = f(I_1;\ \ I_2;\ \ I_3;\ \ \ldots\ \ I_n), \tag{2.1}$$

where $I_{[1,\,n]}$ – regulatory indicator

3 Empirical work

3.1 Non-discriminatory access to and competition on the railway infrastructure

The author's thesis investigates the level of competition on Estonian railway sector by analysing the dynamics of new entry and disputes on non-discriminatory access post railway market liberalization. First, the author compiles data on the utilization of AS Eesti Raudtee railway infrastructure capacity by railway undertakings during the period 2004–2019. Given the competitive entry applies only to freight operations, passenger traffic volumes and a*d hoc* non-commercial train traffic (maintenance and reserve) are excluded from the analysis. Railway freight operations of AS Eesti Raudtee and later that of AS EVR Cargo and AS Operail are considered as being part of the incumbent railway monopoly. All other railway operators are considered independent. Annual railway traffic volume is calculated for both groups. Due to methodological inconsistencies of available train-kilometre data on AS Eesti Raudtee railway infrastructure, gross tonne-kilometres is used to measure and assess the volume of train operations.

Secondly, the author conducts an analysis of complaints about discriminatory access to railway infrastructure during the period 2004–2019. This analysis covers all railway related appeals filed through a formal procedure to the domain ministry, sector-specific regulator, competition regulator and administrative court (labelled R-regulator, C-Court). The data was grouped based on the year of submission and reviewed by the category of non-discriminatory access (tariff; access to the railway network) and type of defendant (railway infrastructure manager or sector-specific regulator). The division of complaints across railway infrastructure governance models is calculated based on the following formula (3.1):

$$\overline{x_k} = \frac{1}{n_k} \sum_{i=1}^{n_k} x_k^i \,, \tag{3.1}$$

where x – total complaints on discriminatory access,
k – index of infrastructure governance period,
n – number of observations in a period k,
i – value of i-th observation in a period k.

The results are presented in the Table 7 and in Figure 2.

Table 7. Freight market liberalization on AS Eesti Raudtee railway infrastructure 2004–2019

Year	Governance model	R/C/T	Avg T; stdev	Number of RU	Traffic share of independent RU	Freight traffic growth (2004=100%)
2004	Integrated	3/1/4	3,4; 1,34	2	6%	100%
2005		3/1/4		3	23%	105%
2006		3/1/4		4	32%	102%
2007		3/1/4		3	41%	81%
2008		1/0/1		4	54%	58%
2009	Holding	0/1/1	1; 0	3	63%	58%
2010		0/1/1		2	65%	66%
2011		1/0/1		2	53%	66%
2012		0/1/1		2	42%	54%
2013		0/1/1		2	48%	49%
2014	Separated	0/1/1	1,6; 1,63	2	28%	34%
2015		0/1/1		2	29%	31%
2016		0/1/1		2	20%	21%
2017		0/1/1		2	25%	20%
2018		5/0/5		2	2%	23%
2019		1/0/1		2	0%	21%

Source: authors' calculations. (AS Eesti Raudtee, 2020; Estonian Consumer Protection and Technical Regulatory Authority, 2020; Ministry of Economic Affairs and Communications of Estonia, 2020)

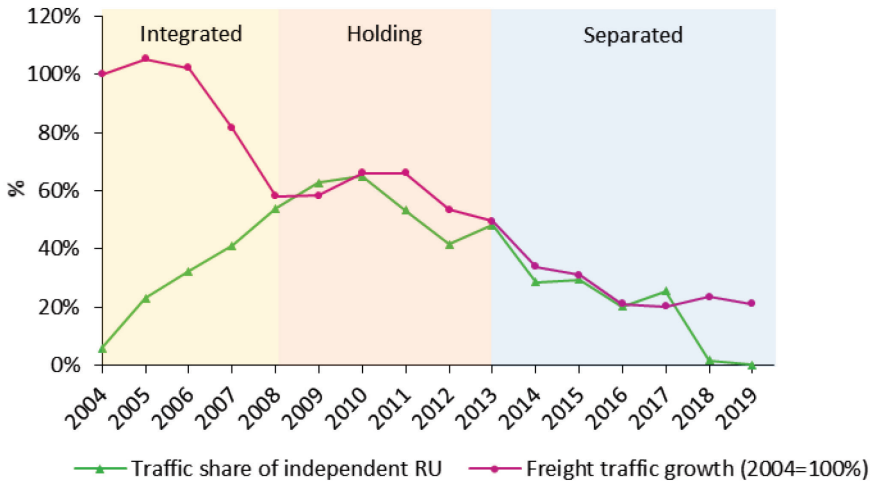

Figure 2. Freight market liberalisation on AS Eesti Raudtee infrastructure 2004–2019

Source: author's calculations (AS Eesti Raudtee, 2020)

The analysis shows that competition in freight operations emerged immediately after railway market liberalization. AS Eesti Raudtee network capacity was allocated between four independent railway freight undertakings and moderate increase in the total freight volume was achieved in the beginning. Thereafter, however, the market of freight

operations started to consolidate between two railway undertakings. After peaking at 65% in 2010, the market share of the independent railway undertaking started to decline and eventually wound up completely. Interestingly, total freight volume during the period shows that competition between the railway undertakings did not increase the size of the railway freight market but rather redistributed the existing operations. As of 2019, the market is serviced by a single railway freight undertaking AS Operail (formerly integrated railway undertaking of the incumbent AS Eesti Raudtee), the volume of railway freight operations is only about 20% of its level in 2004. The competition was never achieved in passenger services, the current market structure is dominated by three *de facto* monopolies: railway infrastructure manager AS Eesti Raudtee, freight transport undertaking AS Operail and passenger transport undertaking AS Eesti Liinirongid (Elron). As a result, Estonia is one of the few countries in the EU where the current level of competition in railway operations is lower than it was post market liberalization.

The study of complaints on discriminatory access to railway infrastructure indicates a high number of submissions during the first years of open access regime. Such asymmetry can be attributed to the unprecedented changes in the regulatory environment and transfer of essential functions to the railway regulator. Majority of the complaints were submitted to the sector-specific regulator and the Competition Authority. In addition, then privately owned AS Eesti Raudtee filed a court complaint on regulated railway tariffs. The subsequent ten-year period of railway infrastructure 'holding' and 'separated' governance models was characterized by low number of disputes. The number of complaints on discriminatory access increased rapidly again in 2018. As a result, the Competition Authority conducted an assessment of the competition on the railway market. The claims of discriminatory practices were not substantiated by the court and appeal proceedings.

3.2 Cost efficiency of railway infrastructure management service

The author utilizes the classification method of corporate accounts and determines the actual fixed and variable cost of railway infrastructure management based on the accounting system of AS Eesti Raudtee. According to the cost accounts of AS Eesti Raudtee, variable costs of basic and extra services ensuring access are included in the infrastructure materials and maintenance account that aggregates all of the expenditure associated with the upkeep and current maintenance of the railway infrastructure. Fixed costs represent all other direct cost accounts of railway infrastructure management, including depreciation of assets with the exception of overheads and business profits. The author compiled the data on annual aggregate expenditure of railway infrastructure management and adjusted the results with producer price index (PPI). Train-kilometres and gross tonne-kilometres are used as operational cost drivers on fixed and variable costs, respectively. The first describes the intensity of traffic management activities on the network and the latter the actual payload that uses the railway infrastructure.

Fixed cost (FC) and variable cost (VC) efficiency of railway infrastructure management and averages for each infrastructure governance model are calculated based on the following formulas (3.2), (3.3), (3.4), (3.5):

$$FC_k^i = \frac{z_k^i}{v_k^i}, \tag{3.2}$$

$$VC_k^i = \frac{y_k^i}{q_k^i}, \tag{3.3}$$

$$\overline{FC_k} = \frac{\sum_{i=1}^{n_k} z_k^i}{\sum_{i=1}^{n_k} v_k^i}, \tag{3.4}$$

$$\overline{VC_k} = \frac{\sum_{i=1}^{n_k} y_k^i}{\sum_{i=1}^{n_k} q_k^i}, \tag{3.5}$$

where z – fixed cost of railway infrastructure management (EUR),
v – train traffic on the railway network (trainkm),
y – variable cost of railway infrastructure management (EUR),
q – payload on the railway network (gtkm),
k – index of infrastructure governance period,
n – number of observations in a period k,
i – value of i-th observation in a period k.

Table 8. Fixed and variable cost of railway infrastructure management of AS Eesti Raudtee 2004–2019 (inflation adjusted)

Year	Governance model	FC (mil. EUR)	FC efficiency (EUR/train km)	FC avg; stdev (EUR/train km	VC (mil. EUR)	VC efficiency (EUR/1000 gtkm)	VC avg; stdev (EUR/1000 gtkm)
2004	Integrated	43,22	7,286	7,19; 1,29	9,85	0,542	0,64; 0,13
2005		37,36	5,117		9,94	0,519	
2006		48,56	7,239		12,63	0,680	
2007		51,28	8,656		9,43	0,636	
2008		49,20	7,636		8,84	0,836	
2009	Holding	40,57	6,746	6,4; 0,54	8,51	0,789	0,74; 0,09
2010		38,45	5,824		8,41	0,642	
2011		39,11	5,868		8,87	0,714	
2012		41,05	6,542		8,45	0,867	
2013		41,94	7,029		6,23	0,693	
2014	Separated	42,92	6,656	6,96; 0,38	6,62	1,077	1,16; 0,17
2015		44,43	7,489		5,53	0,981	
2016		40,42	7,216		4,93	1,285	
2017		39,77	7,150		5,11	1,394	
2018		41,39	6,631		4,23	0,994	
2019		40,95	6,597		4,77	1,249	

Source: authors' calculations (AS Eesti Raudtee, 2020)

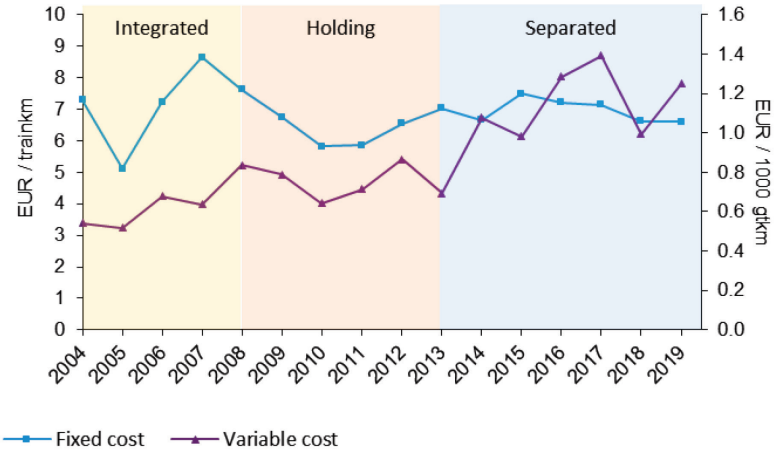

Figure 3. Fixed and variable cost of railway infrastructure management on AS Eesti Raudtee 2004–2019

Source: author's calculations (AS Eesti Raudtee, 2020)

Analysis of network utilization and expenditure levels of AS Eesti Raudtee railway infrastructure highlights that aggregate fixed cost of railway infrastructure management and corresponding unit cost per train-km in real prices have been stable with decreasing standard deviation of the parameters. Gradually decreasing volume of freight train traffic has been substituted by corresponding increase in passenger train operations. The substantial decline of aggregate variable cost of railway infrastructure management has been surpassed by the even larger fall in gross tonne-km volume on the network leading to deteriorating variable cost efficiency over the years. Both fixed and variable cost indicators suggest that the length of AS Eesti Raudtee railway infrastructure and the railway technology have remained unchanged without significant improvement in production efficiency.

Student t-test is performed on the cost-efficiency of alternative infrastructure governance models (integrated and separated) to assess whether the mean values of two groups differ. Fixed cost (FC) data samples are used due to insensitivity to the fluctuations in railway traffic volume. No relationship between the cost efficiency and the infrastructure governance model is formulated as the null hypothesis of the test.

Table 9. Student t-test on fixed cost efficiency of integrated and separated railway infrastructure governance

	FC efficiency (integrated)	FC efficiency (separated)
Mean	7,186591927	6,956591199
Variance	1,664168834	0,14281764
Observations	5	6
Hypothesized Mean Difference	0	
df	5	
t Stat	0,38513784	
P(T<=t) one-tail	0,357987197	
t Critical one-tail	2,015048373	
P(T<=t) two-tail	0,715974393	
t Critical two-tail	2,570581836	

Source: compiled by author (MS Excel, two-sample assuming unequal variances)

The P value of the test is ~0,36 which indicates that the null hypothesis is correct (P≥0,05).

3.3 Modal split of railway transport

Statistics Estonia and Eurostat apply markedly different methodologies to publish modal split of transport in Estonia. Statistics Estonia aggregates modal data based on enquiries to transport companies only and does not include the traffic generated by non-transport entities (*e.g.* passenger cars, non-transport companies' freight operations etc.). Eurostat publishes the modal split of passenger and freight traffic on road, railway and inland waterways for both transport and non-transport entities. The latter is therefore more suitable for the purpose of the author's thesis. Data published by Statistics Estonia

excludes a sizable part of road traffic in Estonia. However, the exclusion of air and maritime traffic by Eurostat does not pose a methodological issue because these modalities are not substitutes for railways in Estonian transport market. Eurostat publishes modal data of passenger traffic for the period 2004–2018 and freight for 2005–2018. To address the difference in periods, the author used linear trend function to extrapolate the missing yearly data. Modal share of railway freight transport (m) and railway passenger transport (p) in Estonia and averages for each infrastructure governance model are calculated based on the following formulas (3.6), (3.7), (3.8), (3.9):

$$m_k^i = \frac{u_k^i}{s_k^i}, \tag{3.6}$$

$$p_k^i = \frac{r_k^i}{t_k^i}, \tag{3.7}$$

$$\overline{m_k} = \frac{\sum_{i=1}^{n_k} u_k^i}{\sum_{i=1}^{n_k} s_k^i}, \tag{3.8}$$

$$\overline{p_k} = \frac{\sum_{i=1}^{n_k} r_k^i}{\sum_{i=1}^{n_k} t_k^i}, \tag{3.9}$$

where u – volume of railway freight transport (tkm),
s – volume of freight transport (tkm),
r – volume of railway passenger transport (passengerkm),
t – volume of passenger transport (passengerkm),
k – index of infrastructure governance period,
i – value of i-th observation in a period k.

Table 10. Modal split of railway transport in Estonia 2004–2019

Year	Governance model	Railway passenger transport (% of total passenger)	Railway passenger transport avg; stdev	Railway freight transport (% of total freight)	Railway freight transport avg; stdev
2004	Integrated	1,8	2; 0,13	85,9	77,3; 6,61
2005		1,9		80,0	
2006		2,0		78,4	
2007		2,1		74,2	
2008		2,1		68,2	
2009	Holding	1,9	1,8; 0,15	74,1	70,3; 4,93
2010		2,0		75,4	
2011		1,9		71,6	
2012		1,8		66,9	
2013		1,6		63,7	
2014	Separated	1,9	2,1; 0,26	55,2	47,1; 5,45
2015		1,8		52,4	
2016		2,0		42,9	
2017		2,3		44,4	
2018		2,5		46,2	
2019		2,1		41,7	

Source: authors calculations (Eurostat, 2020)

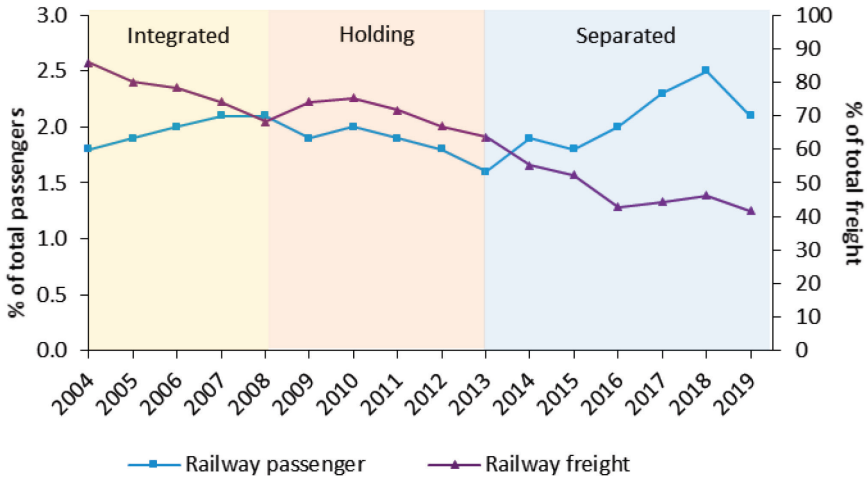

Figure 4. Modal split of railway transport in Estonia 2004–2019

Source: author's calculations (Eurostat, 2020)

Empirical analysis of the modal split of railway transport in Estonia demonstrates steady decline of railway's share in freight market. The corresponding parameter has gradually decreased from 86% in 2004 to 41% in 2019 despite the overall growth in freight transport. The modal split of railways has increased moderately in passenger transport due to the introduction of modern rolling stock and more frequent train connections since 2014. However, the importance of railway transport remains insignificant (~2%) compared to other modes of transport and the growth rates in railway transport are lower than the overall growth in passenger transport market in Estonia.

4 Discussion and Conclusions

The primary objective of the thesis was to assess the effectiveness of economic regulation of network industries based on the example of Estonia. The author concludes that all research tasks of the thesis have been achieved.

The thesis established that economic regulation of network industries was introduced after the commencement of Estonia's accession negotiations with the EU. The Estonian approach in some network industries exceeded the requirements of the EU. Independent regulatory institutions and sector-specific regulatory requirements were established gradually. The institutional governance of the regulatory framework has been based on two independent sector-specific regulators: Estonian Competition Authority and Estonian Consumer Protection and Technical Regulatory Authority. The evolution of sectoral regulatory legislation in Estonia has been largely driven by the revisions of the EU legislation.

The thesis identified that the EU's regulatory approach to network industries is based on the imperfect competition narrative. Establishment of coherent regulatory governance of independent institutions and harmonized sectoral rules is an integral part of the legislative measures. Structural rules that separate the economic interests of the infrastructure management and traffic operations on the infrastructure present an important pillar of the regulatory strategy. Regulatory framework is designed to enforce the neutrality of the infrastructure and achieve effective competition on other parts of the industry's value chain. Overall, it is assumed that the containment of monopolistic behaviour and creation of a level playing field for competition will lead to higher production efficiency. Similarly, economic regulation of network industries in Estonia is designed to support effective competition in the infrastructure. In railway and energy industries, Estonia has implemented full vertical separation of the infrastructure governance that goes beyond what is required by the EU directives.

The practice of economic regulation in Estonia is coherent and has evolved according to the administrative tradition of two sector-specific regulators. Tariff setting is based on the rate-of-return type of regulation, it has been implemented as an annual regime in railway industry and an *ad hoc* regime in other network industries. As a result of the different implementation approach, the incentives of the latter can effectively be reminiscent of a price-cap due to impact of inflation. Regulatory measures around the access to the market are focused on the enforcement of non-discriminatory treatment of users of network infrastructure. Horizontal competition between the networks does not exist due to disperse population and relatively small size of the Estonian market.

The study highlighted that Estonia has not implemented a framework or a mechanism to assess the effectiveness of economic regulation. The practice of setting regulatory objectives and monitoring regulatory indicators is inconsistent and varies greatly across network industries. This is a substantial impediment to the ability to scrutinise whether the regulatory cycle achieves its intended objectives and to identify adjustment to the measures where necessary.

The thesis constructed three distinct models of railway infrastructure governance in Estonia with different levels of vertical separation. Thereafter, it evaluated the effectiveness of economic regulation to improve competition on railway network, increase cost efficiency of railway infrastructure management and thereby the modal split of railway transport across the infrastructure governance models. The empirical work shows that competitive entry in railway freight operations established immediately

after the liberalization of the railway market but it was not sustainable. As of 2019, there was no competition in the Estonian railway sector and the market was served by monopolistic companies in railway infrastructure management, freight operations and passenger operations segment. Indicators of cost efficiency of railway infrastructure management for the period of study have been largely unchanged or deteriorating which indicates limited adjustment to the network infrastructure to the markedly lower traffic volumes or introduction of new technologies. The aggregate modal split of railway transport in Estonia has not improved as moderate growth in passenger-km and tonne-km has been outpaced by the increase in total traffic flows. The difference between infrastructure governance model and cost-efficiency performance was not confirmed by statistical analysis.

The main theoretical contribution of the thesis demonstrates that the current paradigm of economic regulation in the EU based on imperfect competition measures and vertical separation is ineffective in the case of Estonia. Whilst further study is merited it may suggest that the underlying approach of the EU regulation has limited potential in smaller member states more broadly. Vertical separation in network industries could lead to transaction problems and coordination inefficiencies due to high level of asset-specificity. The potential to support competition in the network infrastructure is specific to the context. In small countries, limited size of the market may not be able to sustain effective competition and the degree of network industries' asset-specificity is amplified by limited pool of physical and human capital. The results of the thesis could be used in developing the methods of the economic regulation of network industries in the EU.

The primary practical contribution is the composition of an empirical framework of economic regulation across network industries in Estonia. The recommendations from the assessment of the effectiveness of the regulatory policy cycle are addressed to policy-makers and regulators. Transaction cost considerations of railway infrastructure value chain and the results of economic regulation of railways in Estonia is relevant to policy-makers as restructuring of railway infrastructure manager AS Eesti Raudtee is being analysed.

Further research is recommended on establishing a comprehensive system of objectives and indicators of economic regulation across network industries in Estonia with monitoring and benchmarking mechanisms. Also, more empirical studies to measure transaction costs of alternative governance models of the network industry value chain would be warranted.

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"All streams flow into the sea, yet the sea is never full. To the place the streams come from, there they return again." (Ecclesiastes 1:7).

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That's it. It is finished.

"Well, George, we knocked the bastard off." Sir Edmund Hillary (May 29, 1953, the Himalayas, Nepal).

Abstract
The effectiveness of economic regulation of network industries: the case of Estonia

The author researches the domain of economic regulation of network industries based on the case study of Estonia. Estonia is chosen for the study due to extensive application of the EU's directives and regulatory principles in the Estonian economic regulation framework. Network industries contribute an important share to the overall economy and supply services that are universally consumed in the society. Production technology of network industries is associated with capital intensive infrastructure that creates high barriers to competitive entry and supports naturally monopolistic market structure. Railway, electricity transmission and distribution, water and sewage, heating gas are widely accepted examples of network industries. Economic regulation of access to the market and tariff setting is implemented under such circumstances to avoid the exploitation of monopolistic power and balance the interests of the stakeholders.

Economic regulation of network industries has attracted a sizeable volume of academic research, however, empirical work is context-specific due to variations in regulatory practice and institutional governance. The volume of empirical research in Estonia is low. Therefore, the impact of regulatory measures and the effectiveness of economic regulation of network industries is largely unknown which presents a substantial deficit of knowledge. The objective of the thesis is to contribute towards filling that gap in empirical research.

The thesis is based on three articles. Article I systematizes the current body of knowledge on the framework of economic regulation of network industries in Estonia. The evolution of regulatory institutions and legislation to its current form is traced and the taxonomy of regulatory procedures is established. Article II and Article III present case studies of two network industry sectors in Estonia to empirically investigate the application of the concepts identified in the Article I. The study of railway infrastructure management in Article II researches the institutional setup and objectives of economic regulation in the industry. Article III conducts the study of economic regulation of oil shale value chain in Estonia that includes both monopolistic and competitive industries. The research is concluded by the author's thesis that constructs the typology of railway infrastructure governance models in Estonia and conducts a longitudinal quantitative analysis of competition, expenditure and modal split indicators across these governance models. The research objectives of the thesis are:

- First, to identify the institutional context in which economic regulation of network industries in Estonia is implemented. Establish how relevant regulatory authorities and legislation of network industries have evolved to their current form (addressed in Article I);
- Second, to explain the regulatory practice on the structure of the market and business conduct of companies in regulated network industries in Estonia (addressed in Articles II and III);
- Third, to define the mechanism for setting regulatory objectives and for evaluating results of economic regulation. Assess how regulatory objectives have been achieved in selected network industries in Estonia (addressed in Articles II, III, and in author's thesis).

The thesis established that economic regulation of network industries in Estonia was introduced after the start of Estonia's accession negotiations with the EU. Evolution of the regulatory legislation in Estonia has been primarily driven by the revisions of the EU directives.

The paradigm of imperfect competition is the centrepiece of the EU's regulatory approach to network industries. Establishment of coherent regulatory governance of independent institutions and harmonized sectoral rules is an integral part of the legislative measures. Regulatory framework is designed to enforce the neutrality of the infrastructure and support effective competition in the other parts of the industry's value chain. Estonia has implemented full vertical separation of the infrastructure governance in railway and energy industries which goes beyond what is required by the EU directives. The study confirmed the absence of an institutionalised mechanism of monitoring and evaluating the effectiveness of economic regulation in Estonia. The current practice is inconsistent and varies greatly across network industries.

The thesis constructed three distinct models of railway infrastructure governance in Estonia that differ in the level of vertical separation. The empirical work outlines that competitive entry in railway freight operations was established immediately after the liberalization of the railway market but was not sustainable. As of 2019, there is no competition in the Estonian railway sector and the market is serviced by monopolies in railway infrastructure management, freight operations and passenger operations. Indicators of cost efficiency of railway infrastructure management have remained unchanged or deteriorating which indicates limited adjustment to the network infrastructure to the markedly lower traffic volumes or introduction of new technologies. The aggregate modal split of railway transport in Estonia has not improved as growth has been outpaced by the increase in total traffic flows. Statistical analysis on the potential relation between integrated and separated infrastructure governance cost efficiency data samples provided inconclusive results.

The thesis demonstrates that imperfect competition paradigm of the EU's economic regulation relying on open access and vertical separation measures may be unsuitable in smaller member states. In small countries, the size of the market is limited and may not be able to sustain effective competition in network industry. Asset-specificity of network infrastructure assets is enhanced by limited pool of physical and human capital.

Lühikokkuvõte
Võrguettevõtete majandusliku regulatsiooni tulemuslikkus Eestis

Käesolev doktoritöö käsitleb võrguettevõtete majandusliku regulatsiooni tulemuslikkust Eestis. Võrgutööstused pakuvad ühiskonnas mitmeid esmavajalikke teenuseid, olulisi tootmissisendeid teistele majandussektoritele, ning annavad märgatava panuse riikide sisemajanduse kogutoodangusse. Võrgutööstuste tootmistehnoloogia oluliseks komponendiks on kapitalimahukas taristu, millel üldjuhul puudub samaväärne alternatiivne kasutusotstarve ning millesse tehtud kulud on pöördumatu iseloomuga. See tingib olulise mastaabisäästu ja koostootmissäästu ilmnemise ning tegevusmahu kasvades keskmiste tootmiskulude pideva alanemise ehk loomuliku monopoli kulufunktsiooni. Akadeemilises kirjanduses peetakse loomulikult monopoolseks taristuks tavapäraselt raudteetaristut, elektrienergia ülekande- ja jaotusvõrkusid, küttegaasi ülekande- ja jaotusvõrkusid, vee- ja kanalisatsioonivõrkusid ning keskküttevõrkusid.

Võrgutööstuste loomulikust monopoolsusest tulenev konkurentsisurve puudumine ja oluline turujõud toob kaasa nende allutamise majanduslikule regulatsioonile. Majanduslik regulatsioon piirab ühiskondlikke ressursse raiskavat horisontaalset konkurentsi võrgutööstuste taristu vahel ning sätestab diskrimineerimata juurdepääsu ja mõistlike hinnatingimuste reeglid operaatorite vaheliseks konkurentsiks taristul. Taoline regulatiivne raamistik piirab oluliselt võrgutööstuste omandiõiguse teostamist ning mõjutab oluliselt kõikide regulatsioonist puudutatud osapoolte tegutsemiskeskkonda.

Euroopa Liidu riikides on võrgutööstuste majanduslik reguleerimine laialdaselt levinud, kuid regulatiivne praktika ning institutsionaalsed lahendused on riigiti erinevad sõltudes paljudest majanduspoliitilistest ja ühiskondlikest teguritest. Euroopa Liidu tasemel on harmoneeritud majanduslik regulatsioon juurutatud raudtee- ja energeetikasektoris, kuivõrd nende valdkondade tehnoloogilised näitajad teevad võimalikuks üle-euroopalise sektori kujundamise.

Loomulike monopolide reguleerimise meetodeid on akadeemilises kirjanduses laialdaselt käsitatud, samuti leidub empiirilisi uuringuid erinevate võrgutööstuste majandusliku reguleerimise mõjudest. Kuivõrd võrgutööstuste tegutsemiskeskkond on sektorite ja riikide kaupa oluliselt erinev, siis on märkimisväärseks puuduseks selliste teadustööde kontekstispetsiifilisus ning puudub võimalus laiemalt kohalduvate järelduste tegemiseks. Eesti kontekstis on võrgutööstuste majanduslikku regulatsiooni puudutavate uurimistööde maht äärmiselt piiratud ning eksisteerib sellekohane teadmiste lünk.

Käesoleva doktoritöö eesmärgiks oli empiirilisel alusel välja selgitada võrgutööstuste majandusliku regulatsiooni tulemuslikkus tuginedes Eesti näitele. Uurimisülesanneteks olid:

- kirjeldada võrgutööstuste majandusliku regulatsiooni institutsionaalne raamistik Eestis, selgitades välja vastavate regulaatorasutuste ja õigusloome kujunemine;
- tuvastada turule juurdepääsu ja hinnaregulatsiooni meetmete kohaldamise praktika võrgutööstuste majanduslikul reguleerimisel Eestis;
- välja selgitada, kuidas toimub majandusliku regulatsiooni eesmärkide püstitamine ja tulemuste hindamine Eestis, hinnates valitud võrgutööstuste näitel, kas majandusliku regulatsiooni eesmärgid sektoris on saavutatud.

Käesolev doktoritöö on koostatud artiklite kogumikuna. Artiklis I kujundatakse kontseptuaalne raamistik võrgutööstuste majandusliku regulatsiooni kohta Eestis ja süstematiseeritakse selle praktika. Tuvastatud raamistiku alusel teostakse artiklites II ja II valitud Eesti võrgutööstuste juhtumianalüüsid. Artikkel II selgitab majandusliku regulatsiooni praktikat raudteeinfrastruktuuri majandamise valdkonnas. Tuvastatakse majandusliku regulatsiooni eesmärgid, pakutakse asjakohased indikaatorid ning hinnatakse eesmärkide täitmist. Artikkel III kaardistab põlevkivitootmise väärtusahela Eestis ning süstematiseerib väärtusahela osade majanduslikku regulatsiooni, selle eesmärke ja reguleerimise tulemusi. Ülevaateartiklis tuvastatakse Euroopa Liidu majandusliku regulatsiooni põhieesmärkide saavutamine Eesti raudteesektoris ning võrreldakse tehingukulude teooriast lähtuvalt regulatsiooni tulemuslikkust erinevate raudteetaristu valitsemismudelite kaupa.

Töö tulemusena selgitati välja, et võrguettevõtjate majanduslik regulatsioon juurutati Eestis süstemaatiliselt Euroopa Liidu ühinemisläbirääkimiste kontekstis ning meetmed lähtuvad valdavas osas Euroopa Liidu regulatsioonidest. Raamistik tugineb nn ebapiisava konkurentsiolukorra käsitusele, regulatiivsed meetmed on suunatud võrgutaristu opereerimisega seotud majanduslike huvide eraldamisele taristul toimuvast majandustegevusest ning võrgutaristule diskrimineerimata juurdepääsu tagamisele. Konkurentsiolukorra tugevdamist peaks toetama võrgutaristu majandamise vertikaalne eraldamine taristul toimuvast operaatortegevusest.

Majandusliku regulatsiooni printsiibid ja praktika Eesti võrgutööstuste valdkondades on kujunenud ühetaoliseks. Doktoritöös tuvastati, et Eestis puudub institutsionaalne praktika võrgutööstuste reguleerimise eesmärkide sätestamiseks ja tulemuste mõõtmiseks. Võrgutööstuste ühiskondlikku tähendust ja majandusliku regulatsiooni potentsiaalselt suurt mõju arvestades tuleb seda pidada oluliseks puuduseks.

Doktoritöös formuleeriti Eesti raudteetaristu kolm valitsemismudelit, mis erinevad üksteisest vertikaalse eraldatuse taseme poolest. Perioodi 2004-2019 kohta teostatud empiirilisest uuringust selgus, et raudteeturu avamisel tekkis konkurents eelkõige kaubavedudel, kuid see ei kasvatanud üldist kaubaveomahtu, vaid jagas seda veo-ettevõtete vahel ümber. Raudteetaristu püsiv- ja muutuvkulu tõhususe ühikunäitajad on perioodi jooksul jäänud ühtlasele tasemele või halvenenud, seega saab väita, et raudteetaristu ning kasutatav tehnoloogia ei ole kohandunud veomahtude olulise langusega. Raudteetranspordi osakaal kõikide veoliikide kogukäibes on samuti vähenenud.

Doktoritöö peamine teoreetiline panus on tõestuses, et Euroopa Liidus valitsev ebapiisava konkurentsi käsitusest lähtuv majandusliku regulatsiooni paradigma ei pruugi olla sobilik väikestes liikmesriikides. Võrgutaristu vertikaalne eraldamine võib soovitud konkurentsisurve asemel tekitada väärtusahela koordinatsiooniprobleeme ning tõsta selle tehingukulusid. Empiiriline panus on võrgutaristute majandusliku regulatsiooni süstemaatilise raamistiku koostamine ning praktilised soovitused poliitikakujundajatele ning regulaatorasutustele.

Appendix

Publication I

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SYSTEMATIC APPROACH TO ECONOMIC REGULATION OF NETWORK INDUSTRIES IN ESTONIA

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Abstract. Naturally monopolistic network industries such as railways, water and sewage, district heating and electricity infrastructure etc. are often subject to economic regulation in order to avoid wasteful duplication and to restrict monopolistic behaviour in the industry. A variety of different regulatory approaches have emerged as a result. The volume of empirical studies on the effects of economic regulation is increasing, yet the application of results to different environments is limited due to very context-based nature of regulatory instruments and interactions. In order to support more active analysis of local circumstances, this paper systematises and presents the institutional framework and practices of economic regulation of network industries in Estonia in a comprehensive manner. The authors analyse the composition of relevant industry sectors, the evolution of legislation and sector-specific regulators. Individual regulated services in different network industries are identified, detailed regulatory practices elaborated on, and volume of regulatory decisions is compiled accordingly.

Keywords: economic regulation, access to market regulation, price regulation, natural monopoly, network industry

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1. Introduction

Modern society is a regulated system where governments actively intervene in how various spheres of human life are organised. Regulations are put in place to shape and develop markets in a way society deems just and favourable. It is widely accepted that we live in an age of the 'regulatory state' and the R-word has penetrated ever more domains across countries (Baldwin et al. 2012:2).

The economics of regulation is a wide and diverse topic as government intervention in markets has been subject to extensive scholarly research and debate. The fundamental basis of such work is traditionally associated with the

dichotomy between public interest theory and public choice theory, and handling of the concept of market failure.

Public interest and public choice constitute two alternative explanations of how human behaviour and motivation impact the objectives and outcomes of regulation. Both theories have attracted a lot of scholarly attention. The idea that particular circumstances systematically cause price-market institutions to produce sub-optimal productive or allocative outcomes (i.e. the markets 'fail') was first introduced in regulatory economics by Bator (1958). A very comprehensive academic account about different types of market failures and corresponding regulation is provided in Breyer (1981). An outstanding discussion of public interest principles is available in Posner (1974), Hantke-Domas (2003) explains recent developments of the theory. Contradictory relationship between individual preferences and aggregated public values is explained in the seminal work of Arrow (1970). Stigler (1971) and Mueller (1976) both give an excellent overview on the earlier public choice literature; Light (2010) provides a good contemporary account.

Although different schools are at odds on a number of phenomena, Shepherd argues that the core of the scholarly debate on regulation comes down to the meaning of *effective competition.* Effective competition is the prime factor of efficiency, innovation and fairness of markets but its nature is debatable, and its concepts are frequently criticised by those who hold market power but wish to deny it (Shepherd 1990:454). It can be said that, as of the modern day, regulation has reached a state of maturity both in an intellectual and in a practical sense. Intellectually, theoretical perspectives have developed into an impressive body of scholarship and, in practice, a distinct and expanding 'regulatory community' has developed that shares similar languages, concepts and concerns (Baldwin et al. 2012:2)

The development of regulatory 'microcosm' has been ambiguous in the context of economic regulation. Economic regulation attracted more attention in the Anglo-Saxon tradition than in continental Europe because it was in the former where previously untested economic policy tools were pioneered on public utilities. Developments in continental European countries were slower and received gradually more focus due to economic regulatory initiatives taken by the European Union.

The evolution of economic regulation has produced a large variety of approaches and regulatory institutions in different countries, making it therefore critical to fully understand how regulation actually works. For that reason, empirical evaluation of economic regulation has become the mainstream of academic work during the last decade. Coglianese notes that recent years have also evidenced a number of governments establishing formal procedures to analyse new regulatory proposals before they are adopted. Nevertheless, there is still a relative lack of attention to analysing regulations after adopting or evaluating the impact of the whole regulatory process (Coglianese 2012:7).

One reason for that could be that the evaluation of the effects of a regulation is a complicated exercise due to complex interactions that are involved in regulatory processes. Rose argues that the impact of economic regulation depends critically upon its particular institutional form and the characteristics of the industry under evaluation. Measuring the impact of regulation requires as much attention to the details of how regulators operate as to the prescribed legal form of the regulation (Rose 2001:12957). An opportunity to apply same research designs or compare results of researches completed in different institutional and legal environments is therefore limited.

In Estonia, specific regulatory institutions emerged relatively recently and the lack of evaluation of regulatory development is obvious both on administrative and academic level. There are few authors who have addressed elements of economic regulation in Estonia. For example, Eerma and Sepp (2006) discuss the relationship between and complementarity of competition policy and sector-specific regulation with regard to market entry. Eerma (2013) takes that further by elaborating on different institutional arrangements of sector-specific regulation and competition regulation using certain industry examples in Estonia. Sepp and Eerma (2011) describe economic policy choices and developments in a bundle of Estonian industries that exhibit natural monopoly characteristics or universal service obligations, and Sepp and Ernits (2012) address liberalisation and promotion of competition in postal sector. A common characteristic of that research, however, is its attention to more general economic policy tools in monopolistic industries. Competition law and sector liberalisation (i.e deregulation) is the particular focus of the research, whereas economic regulation aspects get very limited attention both across different industries and regulatory practices. Moreover, the authors of this paper note that empirical evaluation of the effects of economic regulation in Estonia has been completely absent.

Thus, the objective of this paper is to open scholarly discussion on economic regulation in Estonia, systematise the existing knowledge on the topic, and prepare the ground for *ex post* analysis of the effects of economic regulation. The authors seek to explain institutional, legal and procedural interactions of economic regulation across different network industries in Estonia in a comprehensive manner. The analysis would serve as a robust cross-sectorial framework and support further studies of regulatory outcomes between time periods and more detailed subsets of legislative rules. The following objectives have been set:

- Firstly, the authors identify, conceptualise and explain institutional environment where economic regulation is delivered, and how relevant authorities and legislation of different network industries in Estonia have evolved to their current form.
- Secondly, the authors systematise individual regulatory processes and the output of regulatory decisions the institutional framework of economic regulation in Estonia has produced over the period of its existence.

The applied research methodology consists of periodisation, systematisation and analysis of relevant legal acts and documents (laws, decrees, administrative

guidelines, administrative directives etc.) accompanied by appropriate generalisations, discussion and conclusions. Archives of the Estonian Technical Regulatory Authority, the Estonian Competition Authority, and their preceding government authorities, government section of State Archives and Riigi Teataja database are the main sources of document material for the analysis.

2. Overview of literature on economic regulation of natural monopolies

2.1 The objectives and tools of economic regulation

The scope of regulations in a modern society is broad and delivered via a number of enforcement frameworks. This paper focuses on economic regulation that deals with regulating access to and prices in a naturally monopolistic industry or sector. The authors apply traditional distinction between economic and social regulation where the latter addresses issues such as protecting environment and human health, enhancing safety etc. Rose puts that economic regulation constitutes the most extreme form of government intervention in the markets. Competition, tax and trade policies, as well as most other regulations, shape but do not replace the market. In industries subject to economic regulation, government agencies exercise considerable control over firms' access, pricing, investment and product choice decisions. Market outcomes are replaced by administrative decisions (Rose: 12957).

Economic regulation framework is set by a combination of direct legislation and administrative rules, and it is imposed by certain sector-specific institutional arrangement (i.e. a 'regulator'). It should be noted that, contrary to some authors, for example Ogus (2004), this paper does not treat governance and ownership choices as economic regulation tools. Although such ideas usually imply that government or public administration can more easily impose certain thinking patterns on publicly owned companies, the authors believe that this is not necessarily true. Anti-competitive behaviour is not attributable to a particular form of ownership, be that public or private, but rather is driven by the ability to do so. Our observations from the Estonian publicly owned natural monopolies in several sectors do not suggest different behaviour patterns compared to privately owned ones.

Academic study offers a number of positive and normative theories by different schools in economics and political economy on whether economic regulation is justifiable and how it changes the market outcomes. Primary objectives of regulation are to promote competition and to enhance social welfare (Armstrong and Sappington 2006:4). Nevertheless, whether regulation is able to deliver such benefits in real life has always been heavily contested because phenomena such as vague property rights, regulatory capture and collusion, principal-agent problem etc. can substantially change the outcome of regulation. Although it is currently widely accepted by academic discourse that natural monopolies require regulatory oversight, normative theoretical aspects focusing solely on static efficiency argu-

ment are of little practical interest to this paper. Regulation indeed is a political act (Braeutigam 1989:1299), and is, therefore, implemented for reasons that appeal to those in power, be that the existence of natural monopoly or something else. It is our practical observation that governments in Europe extensively regulate non-competitive markets and Estonia is no exception to that pattern.

2.2. 'Natural monopoly' considerations in network industries

The need for economic regulation is primarily associated with the market failure of non-competitive markets where effective competition is by definition the scarcest. Gellhorn and Pierce explain that in theory such environment leads to socially sub-optimal prices, production volumes and income redistribution (Gellhorn and Pierce 1999:36–37). Non-competitive markets are, however, a wide category that includes market structures with different levels of market power consolidation. It should, therefore, be noted that a 'monopoly' is a rather generalised concept for describing evolution and outcomes of substantially different market processes that can last for different time periods. For example, a monopoly can be granted by legislation, be acquired through competitive or anti-competitive behaviour etc.

Baumol (1977) defines the so-called natural monopolies where, in contrast to an ordinary monopoly, competition would result in wasteful duplication of resources and higher costs. A natural monopoly involves an operation that requires a substantial infrastructure component with respective economies of scale and decreasing average costs, making it less costly for a society to have such market served by a single firm instead of many.

Economies of scale, however, do not satisfactorily describe natural monopoly in a multi-product environment. For this reason, Baumol, Panzar and Willig have proposed the concept of cost subadditivity. Subadditivity characterises industries where a single firm can supply the whole market with lower cost per production unit than any other combination of several companies (Baumol et al. 1977:352). Strict cost subadditivity requires both economies of scale and economies of joint production in a multi-product situation. The latter represents a situation where the total cost of producing individual products by separate firms is greater than the total cost of having them all produced by the same firm (Tirole 1988, in: Shughart 2003:15). Therefore, a natural monopoly relates to complexity of technology of supply in a particular industry and not to the actual number of companies in a market (Posner 1999, in Shughart 2003:14).

It is important that provision of goods and services through a naturally monopolistic technology may involve parts that are inherently competitive as the economies of scale phenomenon may only affect one part of a given process (Ogus 2004:31). For example, in the context of network industries, a transmission network is needed for enabling a service or a good to be consumed by connecting the point of production to the point of consumption. Such industries like electricity and gas transmission and distribution, water supply and sewage services, and district heating, especially satisfy the economic criteria for a natural monopoly.

Cogman argues that most transmission networks are natural monopolies due to the technical complexity of their operation (Cogman 2001:2). A production part of the same service or good, however, may inherently be competitive (e.g. generation of heat or electricity).

3. Institutional framework of economic regulation in network industries in Estonia

3.1 Establishment of institutionalised economic regulation in Estonia

The following chapter presents the evolution of legal norms and institutions of economic regulation in Estonian network industries as a single framework. For that purpose, the authors briefly discuss natural monopoly considerations of network utility's technology and then provide an overview of circumstances that existed before the economic regulation was introduced. Further, the authors elaborate on the key legislation and institutional setup in all network industries.

The authors consider the establishment of a sector-specific regulation, specifically a regulator, as being the primary factor for the coherent delivery of economic regulation that can be studied via scientific methods. Therefore, the following considerations must be noted. First, some sectors had institutional outside-the-company pricing mechanisms also during the period that the authors define as pre-regulation. The pricing principles during of the mentioned time, however, were of arbitrary and political nature, and often lacked substance of economic regulation. Arbitrarily and politically delivered economic regulation is out of scope for this study. Second, competition law includes general provisions that prohibit market dominating companies engaging in predatory pricing. Although such clauses in principle support similar objectives as sector-specific legislation on price regulation, its delivery mechanism and tools are completely different from an active implementation of economic regulation, and not included in this analysis.

Estonia chose the path of liberal economic and industrial policy soon after regaining independence in 1991, and established market forces in several network industries. State-owned enterprises were formed and many of them later privatised at a pace that was unprecedented in continental Europe. Infrastructure monopolies at a local scale (e.g. district heating and water utilities) were mostly transferred to municipal ownership.

Economic regulation in Estonia was introduced almost simultaneously in a number of different sectors by the start of accession negotiations with the European Union in 1997. The need to harmonise the Estonian legislation with the European Union directives was obvious for railway, gas and electricity sector where the European Union had adopted an active intervention policy. The European Union's requirements in railway, gas and energy sector were transposed in Estonia with Energy Act (1998) and Railway Act (1999).

In contrast, services of localised nature such as district heating and water and sewage do not have industry specific legislation established at the European Union level. Regulation in those sectors has always been a domestic matter and, as a result, development path and the level of regulation vary largely in different countries. Nonetheless, Estonia established economic regulation in district heating and water and sewage sector at the same time and in the same manner as in the utility sector where the European Union directives apply. District heating economic regulation was included in the Energy Act and water and sewage sector economic regulation was passed with the Water and Sewage Act (1999).

In the following sections the authors outline and provide commentary on the three distinct development patterns of legislation and institutions of economic regulation in Estonian network industries. The results are summarised in Appendix 1.

3.2. District heating, electricity and gas

The technology of electricity, gas and district heating transmission and distribution grids has obvious natural monopoly characteristics as a substantial infrastructure component is required that is unreasonable and costly to duplicate. Power generation or gas supply to the network has viable alternatives and is therefore competitive.

It should be noted that there is a significant difference between electricity, gas and district heating market characteristics. The potential to increase the size of interconnected European electricity and gas market by integrating additional areas is theoretically limited only by the total consumer base, whereas the size of district heating market is always very local. Heat generation in a district heating system can in principle be also competitive whereby alternative heating sources are utilised to supply the network. Therefore, the argument depends on whether a sufficient scale of a single district heating supply network is achieved that would justify such competition in heat generation.

Incumbent monopolies such as Eesti Energia (Estonian Energy) and Eesti Gaas (Estonian Gas) are the most important companies in this segment. Most of the network operated in electricity and gas sectors is either directly controlled or spun off from these monopolies during several phases of restructuring. Both Eesti Energia and Eesti Gaas were established as vertically integrated state-owned enterprises in 1992, however, their organisational structure changed in different ways during the subsequent years.

Eesti Energia, among the biggest companies in Estonia, has always been under the control of the state. Its organisational development from 1997 tracks closely the evolution of the European Union's regulation in the energy sector. Eesti Energia transmission and distribution businesses, as well as oil shale mining were separated from power generation into different group entities. The gradual separation of organisational structure and management responsibilities within Eesti Energia group of companies continued until the transmission network operator, now called Elering, became a fully independent business under different owner-

ship in 2010. Eesti Energia distribution network subsidiary, Elektrilevi, has a distribution monopoly in most of Estonia with a market share of 87% (Eesti Konkurentsiamet 2013:17). Both Elektrilevi and Eesti Energia's oil shale company, Eesti Energia Kaevandused, are organisationally separate but are part of the Eesti Energia group of companies.

In contrast to Eesti Energia, the privatisation of Eesti Gaas was gradually implemented during several phases between 1993 and 1999. The company became 100% privately owned in 1999. Its transmission and distribution networks were vertically integrated within the Eesti Gaas group until 2012, and later reorganised into separate independent limited companies. Eesti Gaas retains a monopoly of gas transmission network in Estonia but faces intermodal competition from alternative providers of energy sources.

From 1991 to 1998, the price setting system in district heating, electricity and gas sectors was mixed and prices were authorised by governmental or municipal decisions. There were no specific regulations on how such price setting should be conducted and no coherent economic regulation practices emerged. Decisions were based on incoherent grounds and considerations, and were often politically motivated. The authors characterise the period between 1991 and 1998 in those sectors as without economic regulation, because it is retrospectively impossible to study the argumentative basis of those pricing decisions in a systematic manner.

Economic regulations in district heating, electricity and gas sectors were introduced in 1998 with passing the Energy Act and the creation of Energy Market Inspectorate, the first sector-specific economic regulator in Estonia. The regulation was divided into the following subsector-specific laws in 2003: District Heating Act (2003), Electricity Market Act (2003) and Natural Gas Act (2003), and has been amended afterwards to incorporate the requirements of the European Union. The Estonian Energy Market Inspectorate was reorganised to form the Estonian Competition Authority later in 2008 but the framework of economic regulation and its implementation has remained essentially the same. Legislative provisions in district heating, electricity and gas address both the principles of entry to naturally monopolistic infrastructure market as well as price regulation.

3.3. Railway infrastructure

Railway infrastructure management has the textbook character of a naturally monopolistic network as it involves substantial capital investment and moderate variable cost resulting in decreasing average cost as output increases. Moreover, the management of important railway infrastructure in European countries has traditionally been publicly organised with considerations of public service provision, national security etc. often taking priority over pure economic performance. It is an institutionally conservative sector where change happens slowly and, although the provision of railway transport services is inherently a competitive sector, a substantial part of railway infrastructure and railway traffic operations is still controlled by incumbent state monopolies.

State-owned company Eesti Raudtee (Estonian Railways) was formed from a public agency at the beginning of 1992. It was reorganised to a company under full state ownership in 1997 and underwent several phases of restructure after that. As a result, Eesti Raudtee was transformed to a vertically integrated railway infrastructure and freight transportation business with the main economic focus on freight transit to Estonian ports. Other parts of the business that did not fit to that operating model were spun off and sold. South-west part of the railway infrastructure, approximately 25% of the total length of railway lines, was transferred to a separate railway company Edelaraudtee (South-West Railways), and privatised in 1999. About two-thirds of Eesti Raudtee was privatised in 2001. However, after years of disputes between the state and private investors over priorities and strategy of the company, the stake was bought back by the state in 2007. Both railway infrastructure companies have now achieved full organisational separation between the railway infrastructure management and railway transport operations.

As noted earlier, the start of Estonia's accession discussions with the European Union and gradual privatisation of Eesti Raudtee in 1997 triggered the establishment of economic regulation in Estonian railway sector. The first Railway Act that included provisions of economic regulation was passed in 1999. According to that, allocation of railway capacity and pricing was the responsibility of the railway infrastructure managers. The Estonian Railway Administration, the first independent regulator for railway sector in Estonia, was responsible for establishing a methodology for pricing the use of railway infrastructure and acted as a body of appeal in case of disputes. New economic regulation framework in this sector, however, did not change the *status quo* in the railway transport market. Pricing and access rules were vague and left railway infrastructure managers a lot of space for different interpretations of the rules. Incumbent monopolies *de facto* controlled the market and no access contracts were granted to new railway operators for a number of years.

A major change was introduced by the next version of the Railway Act effective from 2004. The principles of economic regulation remained largely similar, however, implementation and enforcement framework was substantially changed. Since then the railway infrastructure manager was no longer allowed to allocate capacity and determine pricing for the use of infrastructure if it had invested interest the traffic operations of the railway network. As stipulated in Railway Act (2004) article 63, capacity and pricing were determined by the regulator in these instances. Therefore, the new Estonian Railway Inspectorate received fully-fledged and active duties to implement economic regulation. The regulator did not follow the practices of how infrastructure managers had determined market access and pricing issues before and adopted a fundamentally different approach that resulted in years of legal disputes. Although the railway regulator was reorganised in 2008 and became part of the newly established Estonian Technical Regulatory Authority, and the Railway Act has been amended several times since it was introduced, economic regulation framework in Estonian

railway sector and the main provisions established by the Railway Act in 2004 have remained the same and remain in force today.

3.4. Water and sewage services

Water and sewage networks are closed supply systems with no technical interconnections between different infrastructures. The size of these markets is limited and natural monopoly aspects are similar to those in district heating sector. Distribution network of water and sewage industry is naturally monopolistic with decreasing average costs irrespective of the service area due to capital intensity of such infrastructure. The treatment of water and sewage could theoretically be set up as a competitive market if sufficient scale of service and consumer intensity is achieved on a network. This, however, is not the case in Estonia. Water and sewage is a 'local service' and most of the operating companies are owned by municipalities of respective service areas.

The evolution of economic regulation in Estonian water and sewage sector has been somewhat different from other network industries. General provisions of economic regulation in the form of authorising municipality councils to manage market access restrictions were first introduced with the Water and Sewage Act (1999) article 4. In contrast with other utility sectors outlined above, the Water and Sewage Act has been amended a number of times but never substituted with a comprehensive new piece of legislation since its inception.

Price regulation in the water and sewage sector attracts political meddling as it concerns most members of a community. Vague regulatory environment established with the first Water and Sewage Act in 1999 created a number of conflicts of interest in relation to the implementation of the framework. Pricing in water and sewage sector was particularly open to lobby and manipulation. Municipality councils were tasked to develop price setting methods and local governments were authorised to set prices based on these methods in their jurisdictions. This led to a myriad of different regulations and price setting practices in water and sewage sector throughout Estonia. Some municipal authorities kept the prices lower than the cost of providing these services to appeal to their electorate. This, however, undermined economic sustainability of water companies. Price regulation practices in water and sewage sector from 1999 to 2010 have large variations in terms of economic regulation merit with a lot of the weight on arbitrary agreements. For this reason, this paper classifies that period as a period without any economic regulation and excludes it from further review.

A big qualitative leap from the price regulation perspective occurred in 2010 when a comprehensive package of legislation amendments was passed. The Monopoly Price Restrictions Act amended laws on district heating, electricity market, water and sewage, and the penal code. It changed rules in many network industries, increased the authority of regulator and introduced new penalties for breaches. Water and sewage sector was influenced the most as the Estonian Competition Authority was given new sector-specific regulatory powers. The law limited that municipalities set prices only to water and sewage companies below

the threshold of 2,000 human equivalents and all operators above the threshold were to be regulated by the Estonian Competition Authority. As of 2014, the provision effectively means that approximately 60% of water and sewage companies in Estonia are regulated by municipalities and 40% by the Estonian Competition Authority.

4. Implementation of economic regulation in Estonian network industries

4.1 Access to market restrictions

The following systematises the implementation of economic regulation practices in Estonian network industries within the framework that was identified in the previous chapter. To provide for that, the authors analysed regulatory provisions of all relevant legislative and semi-legislative rules, identified individual regulated services and grouped corresponding regulatory decisions.

Theory prescribes that an entry to a naturally monopolistic market should be restricted to avoid the cost of infrastructure duplication. Restricting access to naturally monopolistic markets in Estonia is mostly implemented through standard provisions in sectorial legislation or municipal planning decisions without additional considerations or dynamic regulatory input from the regulator. For example, the District Heating Act (2003) articles 5 and 13 give municipality councils the authority to define district heating areas and assign monopolistic service providers. The Electricity Market Act (2003) article 26 section 4 and article 60 respectively allow to provide licence only to one electricity transmission network operator and give all distribution network operators a monopoly status in the service area of their infrastructure on the level of law. In the same manner, the Natural Gas Act (2003) article 301 section 2 allows to provide license only to one transmission network operator. In railway sector, Eesti Raudtee and Edelaraudtee railway networks were declared "public use railway infrastructures" by law already in 1999. The provision effectively refers to the infrastructure of national importance and covers approximately 2/3 of the total length of railways in Estonia. No additions or removals have been made in that category afterwards.

Consequently, the practices of access to market regulation in the sectors of interest have effectively been very static, and as a result lack necessary volume and variety of decisions that would warrant further analysis. Therefore, specific attention will be given to comparing price regulation practices.

4.2. Legal structure and economic principles of price regulation rules

The authors of this paper identified and analysed 10 individual services that have been subject to systematic price regulation in Estonia. The overview of the results is presented in Appendix 2. Those services are the following: access to public railway infrastructure, provision of heat to customers, provision of cogenerated heat to network, generation of electricity, production of oil shale,

provision of electricity to customers, electricity transmission and distribution, gas transmission and distribution, gas provision to residential customers (setting of sales margin only), provision of water and sewage services. The Estonian Competition Authority regulates prices of 9 of those services and the Estonian Technical Regulatory Authority is responsible for regulating prices of railway infrastructure service.

Fundamental framework of price regulation is stated on the level of law in all of the natural monopoly sectors. The Acts of Railway, District Heating, Electricity Market, Natural Gas, Water and Sewage articulate varying level of detail but the approach is essentially the same. Therefore, the reason for different use of terminology and wording in the above mentioned legal provisions remains unclear.

The laws set general principles that prices consist of allowable costs of production, depreciation costs and reasonable profit. This approach complies with what is referred to in academic literature as rate-of return type of price regulation. A more specific break-down of detailed rules on cost components are established by individual price setting methodologies.

Distinct differences between the sectors and services emerge on the legal status of price setting methodologies that vary from ministerial decree to administrative guideline. The overview of regulated services and corresponding rules is compiled in Appendix 2. The methodology for railway infrastructure pricing carries the highest level of legal standing as it is given by a decree of the minister of economic affairs and communications. Price methodologies for provision of electricity, electricity transmission and distribution, gas transmission and distribution, gas provision to residential customers, and provision of water and sewage services are set by a decree of the director general of the Estonian Competition Authority. Prices for provision of heat to customers, provision of cogenerated heat to network, generation of electricity and production of oil shale are based on administrative guidelines issued by the director general of the Estonian Competition Authority. Such a variety of legal tools can only be explained by the fact that price regulation of individual services in Estonia has been introduced during several phases over time. Furthermore, certain correlation can be noted between the legal status of a methodology and the level of authority the regulator has for intervention in the matters of a regulated enterprise.

Our review of ministerial decrees and sub-legislative acts on price setting methodologies also somewhat modifies what the authors defined in the previous chapter as the period of coherent price regulation in Estonia. Although price regulation framework was set up and regulator nominated on the level of law already in 1998, specific rules for district heating, electricity and gas services were introduced no earlier than 2002. Therefore, price setting decisions before 2002 were arbitrary according to our categorisation, and have been excluded from the scope of study. In the railway sector, similar treatment applies to the period before 2004 because it was then when the first ministerial decree on the price regulation

methodology was passed and no price setting decisions by the regulator had been made before that.

4.3. Implementation of price setting process

Both sector-specific regulators base their analysis and price setting decisions on the data provided by regulated companies but also have the authority to deviate from that if appropriate. The implementation of price setting process and its final result, however, exhibits two fundamentally different patterns. The Estonian Technical Regulatory Authority is responsible for actively setting the tariff of railway infrastructure services before a certain deadline once a year. The decision must be taken in any case, irrespective whether the regulator and a regulated company agree on the estimates or not. The outcome essentially fixes the budget of a regulated company for the following yearly period as it is not sensitive to fluctuations in the company's service volumes. Unit price of the service is only given as an indication.

In contrast to that, the Estonian Competition Authority normally launches a price regulation procedure upon receiving an application from a regulated company to change prices. There are no legal provisions on timing and frequency of such routine, therefore submission of applications for price review essentially happens *ad hoc* based on strategic and tactical considerations of a regulated company.

Although the principles that govern the economics of a regulated price are the same, the Estonian Competition Authority is strictly tied to the scope of price application and does not have legal authority or responsibility to set a new price by itself. After completing the review, the regulator in this case can agree and authorise a new price, demand amendments to the application or disapprove the application. A regulated company can modify service prices only after authorised by the Estonian Competition Authority and set prices always remain effective until changed.

4. Conclusions

The economic regulation of natural monopolies is a widely used tool of government intervention and various sophisticated systems have emerged both in the United States and Europe. Great emphasis is nowadays placed on evaluating and accounting for the effects of such regulation. Although there is plenty of empirical analysis being conducted on economic regulations in a number of countries, research designs are context based and enable only limited generalisation and comparison of results to other environments.

The objective of this paper was to systematise the existing knowledge on economic regulation in Estonia and, in a comprehensive manner, explain institutional, legal and procedural interactions of economic regulation across the Estonian network industries. To provide that, the authors analysed legal acts and

administrative documents on economic regulation from Riigi Teataja database, State archives and archives of sector-specific regulators. The following tasks were set and achieved:

- To conceptualise and explain the evolution and current state of affairs of the institutional environment of economic regulation in Estonia.

It was revealed that economic regulation in Estonia was introduced immediately after the start of accession negotiations with the European Union in 1997. The inception was quick and simultaneous in all network industries, provisions regarding access to market and price regulation were included in relevant laws and sector-specific regulators were formed. The Estonian approach of economic regulation in some network industries proved to be rather unique in Europe as it exceeded the relevant requirements of the European Union significantly. It appears, however, that a systematic and coherent implementation was delayed in all the sectors. Detailed sector-specific regulatory rules were not introduced until 2002 and sector-specific regulator in water and sewage sector was established as late as 2010. Over the recent years, institutional framework seems to have reached the phase of maturity and is expected to continue in a similar form. As of 2014, approximately 335 network infrastructure companies in Estonia are subject to economic regulation by two sector-specific regulators the Estonian Technical Regulatory Authority and the Estonian Competition Authority.

- To systematise individual regulatory processes and implications of regulatory decisions that the institutional framework of economic regulation in Estonia has produced over the period of its existence.

The analysis of the implementation of economic regulation in Estonia indicates that the interest for competitive entry to naturally monopolistic sectors has been low and has therefore not required sophisticated mechanisms of regulation. The emergence of such a static environment is understandable considering the capital intensive nature of naturally monopolistic network infrastructure and the low population density in Estonia.

In contrast, price regulation of network industries is an active segment in Estonia. There are a number of individual services which are regulated based on essentially identical principles, and the framework has accumulated more than 600 detailed price setting decisions combined. Regulatory routines, however, display an interesting dual approach to implementation by the Estonian Competition Authority and the Estonian Technical Regulatory Authority that is a rich environment for detailed comparative analysis in the future.

On a final note, it appears that coherent framework of economic regulation with a voluminous regulatory output has been in place in Estonia for more than a decade. Nevertheless, the implementation has drastically outpaced academic and administrative evaluation, and close to nothing is known about the actual impact economic regulation has had on Estonian network industries. The authors hope this paper will open scholarly discussion in this field and provide the basis for further studies on the effects of economic regulation of network industries in Estonia.

APPENDIX 1

Institutional system of economic regulation of network industries in Estonia

Industry	Industry technology	Pre-regulation in the industry	Economic regulation of the industry	Legal framework	Regulator	Subjects
Railways	Natural monopoly in infrastructure, competitive in transport services	1991–1999. State-owned vertically integrated monopoly Estonian Railways and gradual privatisation of spin-offs. No rules or oversight on prices and entry	1999 onwards. Price regulation of railway infrastructure service. General restrictions on entry	Railway Act and charging methodology	Railway Administration (2000–2004); Railway Inspectorate (2004–2007); Estonian Technical Regulatory Authority (2008–present)	2 railway infrastructure managers
District heating	Natural monopoly in transmission infrastructure, natural monopoly in heat generation when localised service	1991–1998. State-owned and municipal monopolies. Price setting by governmental/municipal decisions. No rules	1998 onwards. Price regulation of service; restriction of entry by establishing administrative regional/district monopolies	Energy Act, substituted by District Heating Act and charging methodology	Energy Market Inspectorate (1998–2007); Competition Authority (2008–present)	Approx. 200 district heating companies
Electricity	Natural monopoly in transmission and distribution, competitive in power generation	1991–1998. State-owned vertically integrated monopoly Eesti Energia. Price setting by governmental decisions. No rules	1998 onwards. Price regulation of service; restriction of market entry by establishing administrative regional/district monopolies	Energy Act, substituted by Electricity Market Act and charging methodology	Energy Market Inspectorate (1998–2007); Competition Authority (2008-present)	Approx. 25 distribution network companies and one transmission company

Industry	Industry technology	Pre-regulation in the industry	Economic regulation of the industry	Legal framework	Regulator	Subjects
Gas	Natural monopoly in transmission and distribution infrastructure, competitive in gas supply	1991–1998. State-owned vertically integrated monopoly Eesti Gaas was gradually privatised between 1993–1998. Price setting by governmental decisions. No rules	1998 onwards. Price regulation of service	Energy Act, substituted by Natural Gas Act and charging methodology	Energy Market Inspectorate (1998–2007); Competition Authority (2008-present)	Approx. 35 gas distribution companies and one transmission company
Water and sewage	Natural monopoly in transmission and distribution infrastructure, natural monopoly in water and sewage treatment	1991–1998. State-owned and municipal monopolies. Price setting by governmental/municipal decisions. No rules	Rules from 1999, regulator from 2010. Price regulation of service; restriction of market entry by establishing administrative regional/district monopolies	Water and Sewage Act, amended by Monopoly Price Restrictions Act and charging methodology	Competition Authority (2010–present)	Approx. 70 water and sewage companies

Source: compiled by the authors

APPENDIX 2

Price regulation of network industries in Estonia

Industry	Regulated services	Status of regulation	Effective period	Main principles	Scope of decision	Approx. number of decisions
Railways	Access to public railway infrastructure	Ministerial decree based on Railway Act art. 59	2004–present	Allowable operating costs, depreciation, reasonable business profit based on weighted average cost of capital	Regulator sets the fee for the next year	22
District heating	1. Provision of heat to customers 2. Provision of cogenerated heat to district heating network	Administrative guidelines by director general of the regulator	1. 2002–present 2. 2007–present	Same as above	Regulator authorises company's price application which can be filed at any time. No specific period, authorisation in force until changed.	1. 200 2. 20
Electricity	1. Generation of electricity 2. Production of oil shale 3. Provision of electricity to customers 4. Electricity transmission and distribution	1. Administrative guidelines as above 2. Administrative guidelines as above 3. Methodology by director general of the regulator based on Electricity Market Act art. 81 s. 3 4. Methodology as above based on Electricity Market Act art. 72 ¹ s. 4	1. 2002–2012 2. 2002–2012 3. 2002–2012 4. 2002–present	Same as above	Same as above	1. 2 2. 1 3. 120 4. 140

Industry	Regulated services	Status of regulation	Effective period	Main principles	Scope of decision	Approx. number of decisions
Gas	1. Gas transmission and distribution 2. Gas sales margin for residential customers	1. Natural Gas Act art. 23 and 23[2]. In addition methodology as above based on Natural Gas Act art.23 s. 41 and 42. 2. Methodology as above based on Natural Gas Act art. 10 s. 4	1. 2002–present 2. 2009–present	Same as above	Same as above	1. 55 2. 1
Water and sewage	Provision of water and sewage services	Methodology as above based on Water and Sewage Act art.14 s. 9	2011–present	Same as above	Same as above	45

Source: compiled by the authors

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ECONOMIC REGULATION ASSESSMENT OF NETWORK INDUSTRIES: RAILWAY INFRASTRUCTURE MANAGEMENT IN ESTONIA

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Abstract

Naturally monopolistic network industries are subject to regulation of access to market and charging in order to achieve optimal use of infrastructure and avoid the abuse of monopoly power. Relatively little is known what results does such regulation genrerate and whether it achieves objectives. Literature states that due to the context-specific nature of regulatory framework, *ex post* analysis and practical experiments are necessary to study the impact of economic regulation. In this paper, the authors provide analysis of the results of economic regulation of railway infrastructure management in Estonia. Regulatory objectives and targets from relevant policy sources are identified and indicators compiled to monitor results. This is followed by discussion and recommendations for further research.

Keywords: economic regulation assessment, network industries, public railway infrastructure, performance measurement
JEL Code: D42, L43, L92, R48

1. Introduction

Over the years, a vast amount of academic work has been done on the merits and shortcomings of regulation as a public policy tool. The theoretical discussion can be broadly divided into public-interest and private-interest categories. Public-interest approach bases its argument on the value-adding benevolent regulator that corrects market failure and, by doing that, improves social welfare. Private-interest theories disagree with the assumption of effective regulatory response due to numerous behavioural and informational flaws that benefit different interest-groups, and make it inefficient or impossible to achieve socially optimal outcome of a regulatory process. There is an ample of critique on both concepts, primarily relating to lack of ability to empirically test respective arguments. However, differences on the rationales and assumptions aside, there seems to be a widespread agreement in mainstream economic literature that the absence of a competitive market mechanism warrants certain level of regulatory intervention.

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It is well established concept that a company with monopoly power tends to produce less and charge a higher price than socially optimal. Therefore, exploitation of monopolistic dominance leads to welfare loss for a society. A government has a range of regulatory tools to tackle the monopolistic market structure and support effective competition in the industry. There are, however, certain industries where it would be impossible or feasible to enforce competition. Such industries, for example network utilities, are referred to as naturally monopolistic industries. Under the circumstances, economic regulation of market access and charging is imposed to reduce monopolistic behaviour and compensate for the absence of competition.

Economic regulation is complex and inherently costly, therefore, the results should be assessed with appropriate scrutiny, including whether they deliver the objectives of the regulation. Despite a wide range and long history of monopoly regulation in the developed countries, the number of empirical studies available is limited. Likewise, there are only few analysis that are relevant in Estonia's context. For example, Eerma (2013) focuses on institutional setups and sector specific regulation in certain industries in Estonia. Uukkivi *et al* (2014) provide an in-depth discussion on the institutional framework of five regulated network utility sectors (electricity, railways, water and sewage, gas, district heating) in Estonia, whereas Ots (2016) offers a commentary on price regulation practices in Estonian energy sector from the regulator's perspective.

In order to contribute to the discourse, the objective of this paper is to assess economic regulation of a utility sector in Estonia and to propose indicators to monitor the results of the regulation. The analysis builds on the framework established in Uukkivi *et al* (2014) and focuses on railway infrastructure sector as a case study. Railway infrastucture was chosen because the regulatory framework of railways in Europe is relatively standardised on the level of directives. Railway legislation, technical standard and the scope of the network in Estonia has not changed materially over the years and the number of regulated companies is small which reduces complexity.

Estonia as a country provides interesting context. It started its transformation towards market economy immediately after regaining independence in 1990 with a major overhaul of the former Soviet governance structures. The process was marked by very liberal economic policy, including extensive privatization of the state's assets in a short timeframe. Strategic infrastructure and utility companies were restructured within a decade and, in many instances, were privately owned. All those developments coincided with the country's accession to the European Union and harmonisation of domestic legislation with the *acquis communautaire* as well as with the European Union's own market liberalisation policies in a number of utility sectors. Due to these developments, Estonia was often among the early adopters of European Union's policies for market liberalisation and developed economic regulation in all network utility sectors with a wide range of regulatory interaction.

The approach of this paper is as follows. First, it discusses theoretical literature on economic regulation of natural monopolies and regulatory impact assessment. Secondly, the authors provide summary of the institutional setup and objectives of economic regulation of railway infrastructure management in Estonia. Finally, author's identify relevant policy objectives and establish corresponding indicators to monitor results of regulation.

2. Literature review

2.1 Discussion on economic regulation of a natural monopoly

The term *regulation* has been used loosely in academic literature and different taxonomies of the concept are proposed. This paper refers to *regulation* as a system of publicly mandated institutions and legally enforceable rules all operators in a sector are subject to. Therefore, the *regulation* covers both legislative domain (setting of the rules) and executive domain (enforcement of the rules) but does not include codes of conduct or other voluntary sector specific arrangements. The authors of this paper also subscribe to the widely used distinction between social and economic regulation (Viscusi, Vernon and Harrington 2005; Ogus 2004). Economic regulation is closely related to the concept of natural monopoly and adresses market access and charging in such industries *ex ante*. It should not be confused with competition or antitrust regulation that monitors market performance *ex post*.

The concept of competition is one of the important topics in academic debate of economic regulation. It is commonly assumed that the process of rivalry between informed and rational parties leads to the optimal efficiency of resources in terms of productivity and allocation. The perception of how competition affects market behaviours has evolved over time. Neoclassical approach to static market equilibriums required *perfect competition i.e.* a marketplace with perfectly informed buyers and sellers of homogenous products with perfectly free entry. Obiously such conditions do not exist in actual markets and an entirely satisfactory competitive standard – *effective competition* – has become a substitute to the pure theorist's textbook idea of perfect competition (Shepherd 1990: 305-306). Effective competition, however, has greater importance beyond productive and allocative efficiency. Kimmelmann and Cooper, for example, consider effective competition essential for *good market performance*, a cornerstone of fundamental values such as freedom of opportunity and proper function of democracy in a society (Kimmelmann and Cooper 2015: 406).

In some markets, effective competition is either absent or dysfunctional and needs to be supported through regulation or other alternatives. A market situation which particluarly requires for such public policy intervention is called „natural monopoly". According to the mainstream approach on natural monopolies, an industry is considered naturally monopolistic when its cost function is characterized by declining average costs per single output and cost subadditivity across multiple outputs. In order to deter market entry, economies of scale must also be associated with sunk costs.

(Baumol 1977: 809, Baumol *et al* 1977: 352) Therefore, a naturally monopolistic industry presents both economies of scale and economies of co-production. Under such circumstances, the most efficient arrangement for a society is to have such market served by a single firm *i.e.* a monopoly is maintained but an appropriate framework is set up to to challenge monopolistic behaviour.

Unlike a „standard" monopoly, naturally monopolistic industry is defined by the production technology and not the number of companies in the market. It is the capital intensity and sunk costs of investment that create natural barriers to entry to such industries. Moreover, regulatory barriers are often in place due to considerations for achieving better allocative and productive efficiency.

Mosca provides an excellent summary of academic discourse on natural monopolies. According to that, natural monopolies typically occur in two types of productions. The first is described by the need for a large infrastructure, such as transport networks and some public utilities. The second type of natural monopoly can be explained by the presence of network effects. (Mosca 2008: 324) Liebowitz and Margolis explain that positive network effects are very similar to conventional firm-level economies of scale. If larger networks have idefinitely increasing advantage over smaller networks then we have entered the realm of natural monopoly. (Liebowitz and Margolis1998: 672)

In general, network utilities like transmission and distribution of electricity and gas, disctrict heating, water and sewage, railway infrastructure etc. are commonly considered in academic literature as examples of natural monopolies. Moreover, some authors argue that such utilities are natural monopolies also due to essential importance to the functioning of society and influence they have on other economic sectors (Hertog 2010: 2) or due to the complexity of their operations (Cogman 2001: 2).

Regulation is foremost a political act (Braeutigam, 1989: 1299), thus the evolution of economic regulation of naturally monopolistic industries has been ambivalent. Governments used to provide utility services through own apparatus in order to achieve economies of scale and cross-subsidize between customer segments. There have been several shifts of deregulation and reregulation among the European Union and the OECD countries that have changed the institutional structure and the way industries operate. Pera explains that deregulation and privatization started in the end of 1970s by governments seeking more reliance on market forces and competition. In the United States, many industries with economic regulation (especially transport, energy, telecommunications) saw complexity of rules abolished and regulatory burden on companies reduced. In Europe, deregulation was accompanied with privatization of public enterprises. The reforms were focused on achieving more efficient charging mechanism, introduction of market based stimulae, and search for better ways of managing natural monopolies. (Pera 1989: 160, 165) Detailed overview of how policy intitiatives on restraining trade unions, reducing state subsidies,

supporting innovation and efficiency etc. reformed economic regulation landscape in the United States and Europe is provided by Hahn (1990), Kahn (1990), Newberry (2000) and Winston (1998). Today, economic regulation of network utilities is a common approach among the European Union and the OECD countries.

Economic regulation is a complicated interaction between stakeholders who have varying and sometimes conflicting interests. A regulated network utility strives to maximize profit in the short term whereas consumers demand high quality for low prices. Also regulators and politicians have their own agendas that are not always aligned. Leaver describes how regulators want to avoid public criticisms which occasionaly leads them to behave inefficiently in the price reviews (Leaver 2009: 573). Lim and Yurukoglu note the time-inconcistency problem as regulators promise a fair return on investments *ex ante*, but have no motivation to keep the promise after substantial investments have been made (Lim and Yurukoglu 2018: 2). As a result, changing political realities can systematically affect decisions that regulators make and influence productive and allocative efficiency in an industry.

Regulating an industry sets incentives and disincentives to companies affecting their behaviour. Rational actors will anticipate regulatory developments and adapt their decisions and activities accordingly (Kydland and Presscott 1977, Gilbert and Newberry 1994). For example, price regulation methodology, level of scrutiny that a regulator imposes on costs, or the rate of return it allows on investment will have effect on cost of capital of utilities, incentive to invest in new technologies etc.

Maintaining a regulatory framework incurs substantial costs for the society. A regulated company has to contribute time and resources, adjust internal structures and comply with operational and informational requirements. As the company tries to capitalize on the information assymetry it has over costs and technology, a regulator has to develop a corresponding approach of monitoring and enforcing compliance. Review of cost structures and determining rate levels is a time-consuming process that requires many resources.

2.2 Objectives of regulation and assessment of regulatory outcomes

The fact that a regulation seeks to change behaviour and entails a complex system of interactions makes it nearly impossible to foresee the impact of implementing a regulation *ex ante*. Therefore, assessment of policies *ex post* is particularly important to undestand what works and whether the objectives of regulation are met or not. Real reform of regulation requires promoting a culture of regulatory evaluation and experiments (Greenstone 2009: 123). The popular concept of „policy cycle“ that illustrates policy making in different phases is appropriate to explain this. Howlett, for example, divides policy cycle into five steps: setting agenda, formulating policy, decision making, implementing policy and assessing policy (Howlett *et al* 1995:12). Assessment as the last phase in policy making aims to establish how a policy has performed in terms of reducing the problem.

The European Union and the OECD have been promoting assessments of regulations and published several guidelines on best practices. Yet establishing such feedback loops is complicated and poses a challenge for many reasons. First, the difference between monitoring policy implementation and evaluation of policy impact should be noted. Monitoring relates to identification of what results a policy delivers whereas evaluation determines whether the policy is relevant, effective and efficient (Segone *et al* 2008: 7-8). Second, a number of varying taxonomies are proposed for analysis of policy impact in theoretical literature. The following figure (Figure 1) refers to the approach proposed by Coglianese (2012).

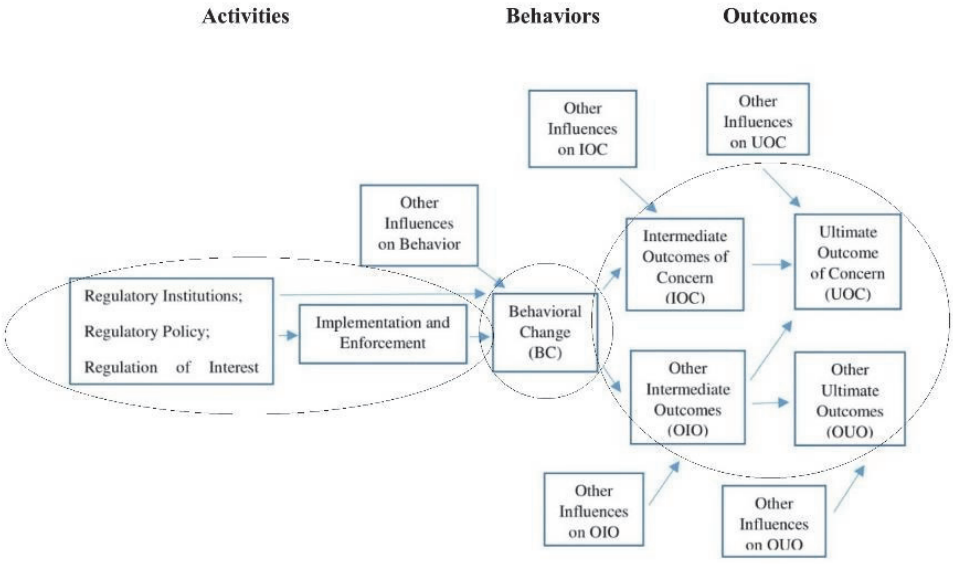

Figure 1. Causal map of regulation and its effects
Source: Authors' modification from Coglianese 2012: 21

Coglianese divides regulatory interaction into three core categories: regulation, behaviours and outcomes. The exercise of evaluation can be applied in the same manner across all categories: evaluation of how well a regulation is administered (activity); evaluation of compliance (behavior), and evaluation of outcomes. Outcome-based studies can additionally be differentiated based on the core features of outcome evaluation: a. indicators as empirical measures of outcomes and b. assessment of the extent to which the regulation has caused any of the observed changes in indicators (outcomes). To say that a regulation is effective is to attribute it to positive changes in indicators. (Coglianese 2012: 14-15)

A set of indicators is a tool for identifying the outcomes of regulation. Eurostat guidelines describe indicators as „road signs" of policy making that help to understand complex realities, assess where processes are heading and if goals are to be reached.

These are measures that condense relevant information on policy to facilitate assessment. (Eurostat 2017: 9-10) Indicators should provide „evidence“ that is expected to support conclusion (Oxman *et al* 2009: 3). Lomas also stresses the context-sensitive rather than scientific nature of evidence in social sciences. This means that any evidence has little meaning unless adapted to the circumstances of its application. (Lomas *et al* 2005: 4)

It is crucial to select appropriate set of indicators that are relevant to the regulatory matter and for which observable data is available. Coglianese puts that any selection of indicators must always be based on the purpose of the evaluation. When conducting evaluation, the selection of indicators will depend on regulatory objectives because defining something as a problem cannot be accomplished without reference to value choices. Because of this very reason, the evaluation of a specific regulation should be guided by the concerns or objectives of policy makers setting up that regulation. In the absence of a specific problem, the discussion of indicators for regulatory evaluation will be abstract. (Coglianese 2012: 17-20) Any assessment of a regulation should first identify the potential users of performance measures and then tailor those measures according to the users needs (Metzenbaum 1998: 53).

The context-specific nature of regulatory outcomes and indicators leads to a question whether particular objectives of economic regulation of network utilities could be formulated that apply in every context? Theory holds that economic regulation of a monopoly aims to contain monopolistic market failure and achieve the resource allocation and production efficiency similar to effective competitive market. Obviously more specific objectives will vary, however, since network industries are strategically important and support other economic sectors and society as a whole, operational sustainability of a regulated company is somewhat a universal goal that every regulation should consider. If the company is not able to function, there is no service to the consumers.

It is obvious that economic regulation is redistributive by nature and a range of trade-offs (in the form of financial, political, social, economical gains, pressures and constraints) take place between different interest-groups. Therefore, more specific goals and indicators for regulatory performance are likely to differ country by country. Investors seek to maximize profits, whereas consumers have obvious interersts in security of supply, quality of service and lower prices. Yet consumers are not homogenous and sometimes their interests contradict as some groups are cross-subsidized by others. Yarrow argues that certain objectives of regulation can relate to specific problems of an industry and change over time. For example, regulation may be initiated due to suboptimal efficiency and performance of a company when taxpayers or customers bear the burden of excessive costs. (Yarrow 2008: 6-7). Eventually, it is the regulator that must strike a right balance between the interests of customers and a company. After all, the conflict of objectives is a pervasive feature of policy debates (Helm 2006: 171), whereas both policy and politics affect regulation and change outcomes in the economy (Kimmelmann and Cooper 2015: 404).

3. Analysis of economic regulation of railways in Estonia

3.1 Institutions and legislation of railway sector in Estonia

In the following chapter, the authors of this paper assess the results of economic regulation with the sectoral case study of railway infrastructure management in Estonia. The regulatory framework for railway infrastructure management in question was established in Estonia in 2004 and has produced a reasonable volume of regulatory interaction inherent the analysis and this study. First, summary is provided on institutional design of relevant state institutions, regulated companies and main provisions from Estonian railway legislation. Comprehensive outline on the evolution of economic regulation and respective institutions in railway sector in Estonia is available in Uukkivi *et al* (2014). Then, country specific regulatory objectives in railway sector are identified from relevant legislation and other policy sources, and finally, appropriate indicators are proposed based on the objectives to assess impact of regulation.

Railway infrastructure management in Europe has traditionally been organised by state-owned or state controlled entities. Decades of monopolism without any threat of competition resulted in very low levels of productive and allocative efficiency of railway management, and accumulated huge deficits funded by the public budget. This proved the main impetus for sequential initiatives of economic regulation of railways in Europe. In order to increase the commercial viability of railway transport and promote modal shift from roads to railway, policies of the European Union have resulted in a gradual separation of the state administration and railway business, as well as vertical disintegration of monopolistic and inherently competitive railway operations. Although most of the railway network in Europe is still controlled by the former infrastructure monopolies, provision and charging of railway infrastructure management services in the European Union is more regulated than any other utility sector. Vertical unbundling is the central structural measure that allows for efficient use of existing railway infrastructure by providing access to it to all railway traffic operators for a fee payable to infrastructure manager.

European Union railway directives are an important source of regulation that Estonia must adhere to, principles and provisions laid down in Estonian railway act fully comply with the European Union railway policy. Estonian railway legislation considers main railway network as a natural monopoly and imposes restrictions on the property rights of public railway infrastructure in order to restrain monopolistic practices on access to the infrastructure and charging. After the adoption of European Union railway directives and opening up railway traffic operations to competition, Estonia required to vertically separate provision of railway transport services from infrastructure management.

There are two infrastructure managers of public railway network in Estonia: Eesti Raudtee AS (Estonian Railways) and Edelaraudtee Infrastruktuuri AS (South-West

Railways Infrastructure). Both companies operate railway network that has been nominated as public interest by law and are therefore subject to economic regulation of access to the network and charging. Whilst Eesti Raudtee is 100% owned by the state Edelaraudtee is owned by private investors. Eesti Raudtee and Edelaraudtee had affiliated entities operating railway traffic, therefore, functions of capacity allocation and setting of infrastructure fee have been transferred to the independent body, Estonian Technical Regulatory Authority. Due to that fact, Estonian Competition Board acts as the National Regulatory Authority as stipulated in the European Union directives. Ministry of Economic Affairs and Communications of Estonia (MoEAC) is responsible for setting railway policy and making infrastructure financing agreements with railway infrastructure managers.

The price that a railway infrastructure manager can charge from railway transport companies to fund its infrastructure is regulated in detail by a specific section of the legislation, railway infrastructure charging methodology. It is rate-of-return type of approach and it has been in place almost unchanged with limited number of minor modifications since 2004. In principle, the methodology regulates the level of costs (operating, overheads, depreciation) that can be passed on to customers and a return that a railway infrastructure manager can earn from its fixed assets. Methodological approach to railway infrastructure charging is similar to that of other network utility sectors in Estonia but the application of fee period is different. Estonian Technical Regulatory Authority is obliged to set an annual fee for railway infrastructure and renew it every year, whereas Estonian Competition Board sets fees that do not have a defined term. Those are valid until the new fee is set.

3.2 Regulatory objectives of economic regulation of railways

Ex post assessment of regulation requires to identify objectives *i.e.* the problem what the regulation should solve. After that, appropriate set of indicators should be chosen to monitor the outcomes of regulation. There are a number of sources in public policy that have the legitimacy to define and set such objectives: legislation, policy strategies, declarations by politicans or authorities responsible for particular domain (ministry, regulator). In order to identify regulatory objectives of railway regulation in Estonia, the authors of this paper analysed Estonian railway acts and railway infrastructure charging methodologies, National Transport Development Plan 2014-2020, fee decisions of Estonian Technical Regulatory Authority and infrastructure financing agreements between the MoEAC and railway infrastructure manager.

Railway act defines overall operational and financial objectives for railway infrastructure management. Those objectives are (a) provide railway transport operators non-discriminatory access to public railway infrastructure with regard to services, charges etc. (§ 7 pt 1), (b) ensure operational safety of the railway network, (c) keep the network operational for railway traffic to use (§ 34 pt 1), and (d) maintain the financial stability of a railway infrastructure manager by balancing revenues and

costs at least over the five-year period (§ 49^2 pt 5). It is noted that the act does not provide any specific targets.

Railway infrastructure charging methodology outlines detailed technical procedure around the calculation of railway infrastructure fee. The methodology scrutinises the allocation of costs and assets between services, elimination of waste etc, however, it does not set any specific targets to the company or regulator to meet. The authors of this paper studied regulatory decisions of the Estonian Railway Administration, the Estonian Railway Inspectorate and the Estonian Technical Regulatory Authority relating to the process of setting infrastructure charge based on the charging methodology since 2004. There is a distinctive pattern in the explanatory notes alluding that the regulator insists on strong cost discipline, however, no firm targets have been established for the regulated company to achieve.

National Transport Development Plan 2014-2020 outlines a number of declarations that can be considered objectives of the economic regulation of railway infrastructure management. It declares that railway freight transport cannot absorb the current level of railway infrastructure fees and they need to become more competitive, also the financial viability of Eesti Raudtee is under pressure. Railway passenger operations need to increase speeds up to 120 km/h and exceed road transport alternatives. Infrastructure investments should be directed to maintaining network capacity, safety and quality of operations. (National Transport Development Plan 2013: 53)

Infrastructure financing contracts have only been established between the MoEAC and Eesti Raudtee. The contracts in such format with the railway infrastructure manager were put in place in 2016 and renewed annually, they aim to balance the expenditure and revenue of railway infrastructure management under „normal business conditions“ over the five-year period. Importantly, the conctracts define clear areas of priority and establish targets. Contract pt 1.4.1 outlines these priorities as:

- operating speed of railway line, reliability of service and consumer satisfaction;
- capacity of the railway network;
- asset management;
- volume of operations;
- safety performance;
- environmental protection.

Annex of the contract identifies annual targets and is renewed every year. Comprehensive summary of regulatory objectives of railway infrastructure management is presented in Table 1.

Table 1. Regulatory objectives of railway infrastructure management in Estonia

Source	Objective	Target
Railway act	1. Non-discriminatory access to infrastructure 2. Railway safety 3. Service provision reliability 4. Financial stability	1. None 2. None 3. None 4. Balanced revenues and costs over 5 year periods
National Transport Development Plan 2014-2020	1. Competitive fee level for freight transport 2. Increase of passenger traffic service speeds 3. Safety performance, capacity and quality	1. Fee level should not increase 2. 120 km/h and exceed road alternatives 3. Current level should be maintained
Infrastructure charging methodology	1. Correct application of methodology and cost discipline	1. None
Infrastructure financing contract	1. Operational speeds on the network 2. Service provision capability 3. Network capacity 4. Asset management/cost discipline 5. Safety 6. Declares no objectives for customer satisfaction, volume of operations and environmental safety	1. Yes. Detailed 2. Yes. Number of breakdowns 3. Yes. Detailed 4. Yes. 5. Yes. Number of level-crossings to be upgraded 6. N/A
Fee decisions	1. Cost discipline	1. None

Source: authors' compilation

3.3 Discussion of regulatory outcomes of economic regulation of railways

3.3.1 Regulatory indicators

Previous section of this paper identified regulatory objectives of economic regulation of railway infrastructure management in Estonia. In order to collate evidence on whether those objectives have been met and what the outcomes are, a set of indicators needs to be compiled. The following discussion focuses only on Eesti Raudtee and scopes out Edelaraudtee. This is because the latter is solely used for passenger transport funded from public service obligation (PSO) contracts, also, the state has not signed an infrastructure financing contract with Edelaraudtee. Eesti Raudtee presents

a wider mix of freight and passenger traffic and also has the status of „railway administration“ with regard to the non-EU countries.

Stenström proposes a system for performance measurement of railway infrastructure management that differentiates between two groups of indicators: managerial group and condition group. Managerial group constist of technical indicators, organisational indicators, economic indicators and HSE (health, safety and environment) indicators, whereas condition group displays the status of different technical subsystems of railway infrastructure. (Stenström *et al.* 2012: 6-8) Current analysis focuses on managerial indicators as those are relevant for the purpose of monitoring regulatory outcomes. When defining regulatory objectives, policy makers and regulators usually focus on high level overall performance of a regulated company as opposed to detailed technical characteristics of infrastructure. Moreover, if infrastructure technical systems fail then performance levels are also affected. One can thus argue that condition level aspects are included in the managerial indicators.

Indicators for economic regulation of railway infrastructure management in Estonia are presented in Table 2. Indicators and targets for specific infrastructure management domains were sourced from infrastructure financing contracts or other sources of regulatory objectives. In the absence of predefined indicators, the authors propose them provided that relevant data is available. The analysis of this paper covers the period from 2013 onwards when the business concern structure of Eesti Raudtee was abolished and vertical separation between railway infrastructure management and railway transport operations was finalised. It should be mentioned, however, that the state has set clear targets for railway infrastructure manager only for the last two years.

Table 2. Regulatory indicators of railway infrastructure management on Eesti Raudtee infrastructure 2013-2017

	2013	2014	2015	2016		2017	
	actual	actual	actual	target	actual	target	actual
Network speed (km/share with 120 km/h)	500 (74%)	529 (78%)	529 (78%)	541 (80%)	556 (82%)	556 (82%)	571 (84%)
Network capacity (train pairs/day)[3]	160	160	160	160	160	160	160

[3] Railway capacity is calculated for each individual line. The table indicates maximum capacity of Tapa-Lagedi-Ülemiste which is the most heavily used railway segment in Estonia. The actual capacity allocated on the mentioned segment for 2017/2018 traffic period is 38 train pairs/day (Eesti Raudtee web-site).

Number of breakdowns	405	418	258	320	257	320	258
Total expenditure (million EUR)	55,08	54,43	54,13	less than 53,91[4]	53,43	less than 56,11[5]	53,04
Volume of operations (million train-km; million freight tonnes)	5, 97 (24,4)	6, 45 (19,3)	5, 94 (15,4)	N/A	5, 71 (12,5)	N/A	5, 66 (12,4)
Work safety (number of incidents; working days lost)	1 (24)	5 (224)	1 (0)	N/A	3 (35)	N/A	4 (91)

Source: authors' analysis

3.3.2 Technical and organisational indicators

Technical and organisational indicators are related to reliability, availability and maintainability of railway infrastructure management (Stenström et al. 2012: 6-7). With reference to the regulatory objectives of railways in Estonia, service provision reliability and operational speed on railway network fall into this category.

Proportion of railway main lines with maximum operational speed (120 km/h) is a proxy indicator of the technical condition of railway because maintenance deficiencies usually translate to speed restrictions. One can note that targets and levels of the indicator have steadily increased over the past five years. The second indicator measures the flexibility of railway capacity. Level of capacity demanded by the state and respectively provided by railway infrastructure manager has remained flat. Railway capacity on Eesti Raudtee, however, is abundant as available capacity on the most heavily used main line exceeds actual utilization by a factor of four. Number of breakdowns affecting train schedule is the third indicator in this segment. Overall, the number of breakdowns has been falling and targets for the last two years have been achieved by the infrastructure manager. The state does not set objectives on customer satisfaction about the infrastructure service and respective indicators cannot be defined in this paper due to the lack of relevant data.

3.3.3 Economic indicators

Economic indicators address cost-efficiency and financial viability of railway infrastructure management. Although all policy sources of railway regulation in

[4] Less than CPI–0,5% from previous year
[5] Less than 5% increase from previous year

Estonia stress the need for cost discipline and financial stability of the regulated company, total expenditure[6] of railway infrastructure management is the only indicator defined in infrastructure financing contracts. Total expenditure levels of Eesti Raudtee have been falling moderately over years in nominal terms, but set targets are not challenging considering the objectives and allow for up to 5% annual increase. The state has not set objectives or targets on the volume of operations on the railway infrastructure. The authors therefore provide an indicator based on train-kilometers and total freight volume which is considered an appropriate metric reflecting both the intensity of passenger and freight traffic. One can note that while freight volume has more than halved over the past five years, the amount of train-kilometres has decreased marginally. Therefore, passenger traffic has substituted freight in this metric. Also, cost efficiency of infrastructure management relative to the volume of railway traffic has somewhat deteriorated. Due to the fact that railway infrastructure manager's total budget is set by the regulator, variation between the forecasted and actual expenditure could also be considered as regulatory indicator in future.

3.3.4 Health, safety and environment (HSE) indicators

HSE indicators are an important perspective to railway infrastructure management as poor record in this domain can have serious implications to reliability of supply and performance. For that reason, general HSE requirements are usually set on the level of legislation. All sources of regulatory objectives of railway infrastructure management in Estonia state the importance of HSE but only infrastructure financing contract sets clear targets. In the contract, the MoEAC and Eesti Raudtee agree on the number of level crossings and pedestrian crossings to be upgraded every year. While Eesti Raudtee has achieved targets 2016 and 2017, it is difficult to estimate the impact such investments have on safety. In principle, accidents on railway level crossings are caused by the breach of traffic code by road traffic or pedestrians. Therefore, improvement of safety on level crossings depends on a variety of technical, social and behavioural aspects well beyond the domain of railway infrastructure management. The state has not set regulatory objectives on occupational safety thus the authors provide an aggregate indicator on the number of incidents and working days lost because occupational safety is a domain where the regulated company can directly impact outcomes. One can note that the overall level of incidents over the five years has been low and fluctuations year on year are inconclusive.

4. Conclusions

The objective of this paper is to assess economic regulation of naturally monopolistic network utility sector using railway infrastructure management in Estonia as a case study. Any regulation must be evaluated relative to its objectives. Therefore, in order

[6] Total expenditure consist of operating expenditure and capital expenditure. Reasonable business profit is not included.

to identify the objectives of economic regulation of railway infrastructure management, the authors analysed railway legislation, policy and strategy documents, and practical implementation of economic regulation in Estonia. The study reveals that although the framework of economic regulation of railway infrastructure management has been in place since 2004 and has not changed much over the years, there is no institutionalised mechanism in place to monitor how the regulation works. Objectives of economic regulation of railway infrastructure management in Estonia are difficult to identify and are mostly conceptual or vague. Cost discipline, safety, network capacity and quality of service are stated in a number of policy documents over the years but absence of clear targets does not allow the measurement and assessment of outcomes of the regulation.

It was only in 2016, when specific objectives and targets of economic regulation were introduced in railway infrastructure financing contracts between the MoEAC and Eesti Raudtee with 8 areas identified as priorities. This paper allocates these objectives into technical-organisational, economic and health-safety-environmental categories, and proposes indicators to monitor performance against targets for the five year period 2013-2017. Analysis demonstrates that most of the regulatory objectives address safety and quality of railway infrastructure, there is one objective on economic performance and one on safety performance. Currently no objectives or targets have been set on the volume of operations, customer satisfaction and environmental safety of railway infrastructure management.

Technical indicators monitor the extent of speed restrictions on the infrastructure, network capacity and number of breakdowns that affect train schedule. All targets have been achieved by Eesti Raudtee and it is noted that the quality indicators have been improving. However, the relevance of setting targets for maximum network capacity is questionable because only a fraction of available capacity is utilized on Eesti Raudtee infrastructure.

Economic viability of railway infrastructure management and reducing costs for customers is an important consideration of economic regulation in railway policy documents. Clear objectives are still few and targets for total expenditure rather unambitious. The authors propose indicators for safety and volume of operations on infrastructure, whilst noting that the cost efficiency of infrastructure management has deteriorated over the last five years.

Finally, the authors highlight the need for further research towards a more holistic approach to measuring the effectiveness of economic regulation of railway infrastructure management in Estonia. A more comprehensive mechanism of objectives, targets and indicators is needed to achieve this. The approach should be agile and responsive to industry developments, cover all important aspects of the economic activity and enable benchmarking railway infrastructure managers and network utilities from other sectors.

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VÕRGUETTEVÕTJATE MAJANDUSLIKU REGULATSIOONI TULEMUSLIKKUSE MÕÕTMINE: EESTI AVALIKU RAUDTEEINFRASTRUKTUURI NÄIDE[7]

Raigo Uukkivi[8], Ott Koppel[9]

1. Sissejuhatus

Majandusteaduses on laialdane konsensus, et monopolistlik turukäitumine pärsib konkurentsi ja innovatsiooni ning halvendab ühiskonna heaolu. Riikidel on üldjuhul valik meetmeid, mida on võimalik kasutada konkurentsi toetamiseks ja monopoolse seisundi kuritarvitamise vältimiseks. Siiski on teatud majandussektorid, kus konkurentsi soodustamine ei pruugi olla praktiliselt võimalik ega ka teatud juhtudel soovitav. Selliseid majandussektoreid kutsutakse loomulikeks monopolideks. Võrguettevõtjad on näide loomulikest monopolidest ning sellistes sektorites on tavapärane majandusliku regulatsiooni rakendamine monopoolse käitumise takistamiseks, teisisõnu monopolisti hindade ja teenuse kvaliteedi reguleerimine.

Majanduslikul regulatsioonil on keeruline raamistik, kus informatsioon jaotub asümmeetriliselt ja osapooltel on oma erihuvid. Reguleeritav ettevõtja soovib maksimeerida kasumit, tarbijad soovivad kõrget kvaliteeti ja madalaid hindu. Poliitikud ja riiklikud regulaatorid soovivad vältida avalikkuse kriitikat ja võivad seetõttu otsuseid kohandada moel, mis muudab ressursside jaotust ühiskonnas. Majanduslik regulatsioon muudab reguleeritava ettevõtja ajendeid ja käitumist, samuti on regulatsiooni kohaldamine ühiskonnale kulukas. Reguleeritav ettevõtja peab üles ehitama nõutava organisatsioonistruktuuri ning kulutama aega ja ressursse, et talle pandud kohustusi täita. Riiklik regulaator omakorda peab korraldama samaväärse mehhanismi kontrolliks ning vajadusel sunni rakendamiseks.

Eelnevast tulenevalt tuleb pöörata rohkem tähelepanu, kuidas sellised regulatsioonid töötavad ja kas tulemused vastavad ootustele, mis viisid regulatsiooni juurutamisele. Artikli autorid nendivad, et kuigi loomulike monopolide majanduslikust regulatsioonist on kirjutatud väga laiapõhjalisi teoreetilisi käsitlusi, siis sarnaste empiiriliste tööde arv on suhteliselt väike. Arusaadavatel põhjustel on Eestit puudutav analüüside arv piiratud. Näiteks Eerma (2013) analüüsis teatud sektorite valdkonnapõhist regulatsiooni ja institutsionaalset korraldust. Uukkivi jt (2014) andsid põhjaliku sissevaate kuue valdkonna võrguettevõtjate majanduslikku

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regulatsiooni Eestis, Ots (2016) kommenteeris energeetikavaldkonna hinnaregulatsiooni riikliku regulaatori vaatepunktist.

Käesoleva artikli eesmärk on välja selgitada võrguinfrastruktuuri ettevõtjate majandusliku regulatsiooni rakendamise tulemused raudteeinfrastruktuuri majandamise näitel. Raudteesektori valiku põhjuseks on see, et valdkond on üle kogu Euroopa Liidu ühetaoliselt direktiivide tasemel reguleeritud. Lisaks on Eesti raudteeõigus ja -sektor olnud aastate vältel stabiilsed. Eesti riik pakub analüüsiks väga huvitava konteksti, kuivõrd ta võttis Euroopa Liidu nõuded üle ning juurutas majandusliku regulatsiooni raudteesektoris väga kiiresti.

2. Kirjanduse ülevaade

Majanduslik regulatsioon on tihedalt seotud loomuliku monopoli kontseptsiooniga. Loomulikult monopoolseteks peetakse turge, mille kulufunktsiooni iseloomustavad pidevalt alanevad keskmised kulud ning mitme teenuse korral nn mitmekülgsussääst. Seega on ühiskonna jaoks kõige efektiivsem lahendus, kui sellisel turul tegutseb ainult üks ettevõte (Baumol jt 1977; Baumol 1977), kuid samaaegselt on kasutusele võetud asjakohased meetmed monopolistliku käitumise ärahoidmiseks.

Erinevalt tavapärasest monopolist tingivad loomuliku monopoli tootmistehnoloogia iseärasused, mitte ettevõtete arv turul. Mosca esitab põhjaliku kokkuvõtte erinevatest akadeemilistest käsitustest loomulike monopolide kohta. Selliseid valdkondi iseloomustavad eelkõige vajadus suure ja kapitalimahuka infrastruktuuri järele ning investeeringute pöördumatus. (Mosca 2008: 324) Tavapärased näited on transpordiinfrastruktuur, elektri ja küttegaasi ülekande- ning jaotusvõrgud, kanalisatsioonivõrgud, kaugküttevõrgud jms. Osad autorid väidavad, et võrguettevõtted on loomulikud monopolid tulenevalt nende suurest olulisusest teistele majandussektoritele (Hertog: 2010: 2), või tehnoloogilise protsessi keerukuse tõttu (Cogman 2001: 2).

Coglianese jagab reguleerimise kui protsessi kolmeks etapiks: regulatsiooni kujundamine ja rakendamine; regulatsioonist tulenevad muudatused turuosaliste tegevuses; regulatsiooni tulemused. Regulatsioonide hindamine saab lähtuda samalaadsest jaotusest käsitledes regulaatori tegevuse aspekte, regulatsioonist lähtuvaid ettevõtete majandusotsuste muutusi ning reguleerimise tulemusi. (Coglianese 2012: 14-15, 21)

Reguleerimise tulemuste väljaselgitamiseks on vajalikud sobivad näitajad (indikaatorid). Eurostat käsitab neid kui „teeviitasid“, mis võimaldavad mõista komplekseid olukordi, hinnata protsesside suunda ja eesmärkide saavutamist (Eurostat 2017: 9-10). Indikaatorite ülesanne on pakkuda tõendusmaterjali, mis võib toetada või mitte toetada järeldusi (Oxman jt 2009: 3). Indikaatorite valikul on eelkõige olulised praktilised kaalutlused nagu nende sisuline seos regulatsiooni poolt

lahendatava probleemiga ning vastavate andmete kättesaadavus. Coglianese rõhutab lisaks, et indikaatorite puhul tuleb lähtuda regulatsiooni eesmärkidest, kuivõrd igasuguse probleemi määratlemine, mida regulatsioon lahendama peaks, sisaldab alati poliitikakujundajate väärtusotsust.

3. Raudteeinfrastruktuuri majandamise majandusliku reguleerimise tulemustest Eestis

Raudteesektori majanduslik regulatsioon on Eestis aktiivselt toimunud alates 2004. aastast ning Euroopa Liidu raudteedirektiivid on oluline komponent Eesti raudteeõiguses. Avalikku raudteed Eestis käsitatakse loomuliku monopolina, avaliku raudtee majandaja otsustusõigus võrgule ligipääsu ja teenuste hinnastamise osas on õigusaktidega oluliselt kitsendatud.

Avalikku raudteed majandavad AS Eesti Raudtee ja Edelaraudtee Infrastruktuuri AS, nendest esimene kuulub 100% riigile ja teine erainvestoritele. Raudteeinfrastruktuuri-ettevõtjad on vertikaalselt eraldatud raudteeveoteenuse pakkujatest. Transpordi-poliitika väljatöötamist korraldab Majandus- ja kommunikatsiooniministeerium (MKM), kes sõlmib infrastruktuuri finantseerimislepingud raudteeinfrastruktuuri majandaja(te)ga. Raudtee kasutustasu määramise eest vastutab Tehnilise Järelevalve Amet. Käesolev analüüs keskendub Eesti Raudtee näitele, kuivõrd Edelaraudtee Infrastruktuuri AS võrku kasutab ainult avaliku reisijateveo lepingutega finantseeritud veo-ettevõtja. Vaatluse all on periood alates 2013. aastast, kui senine Eesti Raudtee valdusettevõte korraldati ümber ning raudteeveo-ettevõtja AS EVR Cargo tegevus eraldati raudteeinfrastruktuuri majandamisest täielikult.

Raudteeinfrastruktuuri majandusliku reguleerimise eesmärkide tuvastamiseks analüüsisid autorid raudteeseaduste ja raudteeinfrastruktuuri kasutustasu määramise metoodikate redaktsioone koos seletuskirjadega, Transpordi Arengukava 2014-2020, Tehnilise Järelevalve Ameti otsuseid raudteeinfrastruktuuri kasutustasu määramiseks ning raudteeinfrastruktuuri finantseerimise lepinguid MKMi ja Eesti Raudtee vahel.

Raudteeseadus sätestab üldised tegevus- ja finantseesmärgid. Nende kohaselt peab olema tagatud diskrimineerimata juurdepääs kõikidele raudteeveo-ettevõtjatele (§7 lg 1), raudteeohutuse ja raudteeinfrastruktuurile juurdepääsu teenuse toimivus (§34 lg 1) ning raudteeinfrastruktuuri-ettevõtja tulude ja kulude tasakaal (§ 49^2 lg 5). Raudteeseadus ei sätesta nende eesmärkide juurde konkreetsemaid sihttasemeid, sellegipoolest tuleb eeldada, et raudteeinfrastruktuuri majanduslikku regulatsiooni on vajalik rakendada nimetatud printsiipe eesmärgiks võttes.

Raudteeinfrastruktuuri kasutustasu metoodika sätestab detailsed alused ja protseduuri kasutustasu määramiseks. Metoodika rõhutab kulude kokkuhoidu ja korrektset jaotust teenuste kaupa, kuid ei sätesta konkreetseid eesmärke nagu ka kasutustasude määramise otsused. Transpordi arengukava 2014-2020 loetleb mitmeid prioriteete

nagu raudteeinfrastruktuuri konkurentsivõime tõstmine ja kulude vähendamine, sõidukiiruste tõstmine raudteel, võrgu läbilaskevõime, ohutustaseme ja kvaliteeditaseme säilitamine.

Infrastruktuuri finantseerimise lepingutes sätestatakse konkreetsed eelisvaldkonnad ja sihttasemed, mille saavutamise vastu eraldatakse riigi poolt rahalised vahendid. Prioriteetsete valdkondadena on nimetatud:

- rongiliikluse tulemuslikkus rongiliini kiiruse ja töökindluse seisukohast ning tarbijate rahulolu;
- varahaldus;
- tegevuse maht;
- ohutus;
- keskkonnakaitse.

Tabel 1. Raudteeinfrastruktuuri majandusliku regulatsiooni eesmärgid Eestis

Allikas	Eesmärk	Sihttase
Raudteeseadus	1. Diskrimineerimata juurdepääs võrgustikule 2. Raudteeohutus 3. Infrastruktuuri toimepidevus 4. Finantsstabiilsus	1. Puudub 2. Puudub 3. Puudub 4. Tulude-kulude tasakaal viieaastase perioodi jooksul
Transpordi arengukava 2014-2020	1. Konkurentsivõimeline kasutustasu kaubavedudele 2. Reisivedude sõidukiiruste kasv 3. Raudteeinfrastruktuuri ohutus, läbilaskevõime ja kvaliteet	1. Kasutustasud ei tõuse 2. 120 km/t ja kiirem maanteetranspordist 3. Olemasoleva taseme hoidmine
Infrastruktuuri kasutustasu metoodika	1. Kulude kokkuhoid, metoodika korrektne kohaldamine	1. Puudub
Infrastruktuuri finantseerimise leping	1. Kiiruspiirangute maht 2. Infrastruktuuri toimepidevus 3. Infrastruktuuri läbilaskevõime 4. Varahaldus/kulude kokkuhoid 5. Ohutus 6. Tarbijate rahulolule, tegevuse mahule ja keskkonnakaitsele eesmärke ei seata	1. Jah. Detailne jaotus 2. Jah. Liiklusgraafikut muutvate rikete arv 3. Jah. Detailne jaotus 4. Jah 5. Jah. Rekonstrueeritavate ülekäikude ja ülesõitude arv

		6. Puudub
Kasutustasu määramise otsused	1. Kulude kokkuhoid	1. Puudub

Allikas: koostatud autorite poolt

Stentström (2012) alusel jagavad autorid eespoolkoondatud raudteeinfrastruktuuri majandusliku regulatsiooni eesmärgid kolme kategooriasse: tehnilised-organisatsioonilised; majanduslikud; ohutus- ja keskkonnaalased. Kõikide kategooriate puhul tuvastakse infrastruktuuri finantseerimislepingutest või muudest regulatsioonidest sobivad indikaatorid seisundi tuvastamiseks.

Tabel 2. Raudteeinfrastruktuuri majandusliku regulatsiooni näitajad Eesti Raudtee kohta 2013-2017

	2013	2014	2015	2016		2017	
	tegelik	tegelik	tegelik	siht	tegelik	siht	tegelik
Lubatud kiirused (km/osa 120 km/t)	500 (74%)	529 (78%)	529 (78%)	541 (80%)	556 (82%)	556 (82%)	571 (84%)
Läbilaske-võime (rongipaare päevas)[10]	160	160	160	160	160	160	160
Rikete arv	405	418	258	320	257	320	258
Ärikulu (miljon EUR)	55,08	54,43	54,13	Vähem kui 53,91[11]	53,43	Vähem kui 56,11[12]	53,04
Tegevus-maht (miljon rong-km; miljon kaubatonni)	5, 97 (24,4)	6, 45 (19,3)	5, 94 (15,4)	N/A	5, 71 (12,5)	N/A	5, 66 (12,4)
Tööohutus	1	5	1	N/A	3	N/A	4

[10] Läbilaskevõime arvestatakse iga lõigu kohta eraldi. Tabelis on esitatud maksimaalne läbilaskevõime Tapa-Lagedi-Ülemiste kohta, mis on kõige intensiivsema kasutusega raudteelõik Eestis. Tegelik läbilaskevõime kasutus nimetatud lõigul on 38 rongipaari päevas (Eesti Raudtee veebileht).

[11] Vähem kui THI–0,5% eelmisest aastast

[12] Vähem kui 5% kasvu eelmisest aastast

(intsidente; kaotatud tööpäevad)	(24)	(224)	(0)		(35)		(91)

Allikas: koostatud autorite poolt

4. Kokkuvõte

Analüüsi põhjal jõudsid autorid järeldusele, et Eestis puudub institutsionaliseeritud lahendus raudteeinfrastruktuuri majandusliku regulatsiooni tulemuste mõõtmiseks. Seega ei ole teada, millised on sellise reguleerimise tagajärjed olnud ning kas need on vastanud regulatsiooni juurutamise eesmärkidele. Sarnaselt on keeruline ühetaoliselt tuvastada võrguettevõtete majandusliku reguleerimise eesmärke. Autorid koondasid regulatsiooni eesmärkidena käsitatavad seisukohad raudteevaldkonna õigusaktidest, strateegiadokumentidest, haldusaktidest ja lepingutest ning pakkusid asjakohased indikaatorid eesmärkidega seotud seisundi tuvastamiseks viieaastasele perioodil 2013-2017.

Regulatsiooni eesmärkide puhul on tuvastatav, et need on enamjaolt abstraktsel tasemel, taotlevad „kõike“ ning ei arvesta raudteeinfrastruktuuri majandamise muutuva tegevuskeskkonnaga. Riik on seadnud raudteeinfrastruktuuri regulatsiooni eesmärkidele konkreetseid sihttasemed alates 2016. aastast. Raudteeinfrastruktuuri tehnilise seisukorra ja kvaliteedi osas on sihttasemed sätestatud sõidukiirustele, läbilaskevõime mahule ja liiklusgraafikut mõjutavate rikete arvule. Majanduslike eesmärkide osas on sätestatud raudteeinfrastruktuuri majandamise ärikulude sihttase ning ohutuse osas rekonstrueeritavate raudteeülekäigukohtade ja –ülesõidukohtade arv. Eesmärke ega sihttasemeid ei sätestata tegevuse mahu, kliendirahulolu ja keskkonnakaitse osas.

Raudteeinfrastruktuuri majandusliku regulatsiooni indikaatorite järgi on viimasel kahel aastal on Eesti Raudtee infrastruktuuri finantseerimislepingutega kehtestatud sihttasemed saavutanud kõikides valdkondades. Kuigi kiirusepiirangute maht on sobiv agregeeritud indikaator raudteeinfrastruktuuri kvaliteedi mõõtmiseks, on siiski küsitav, kuivõrd asjakohane on praeguses raudteeturu olukorras eraldi eesmärgina sätestada läbilaskevõime mahtusid. Tegelik läbilaskevõime kasutus on mitmeid aastaid olnud teoreetilisest läbilaskevõimest kordades madalam.

Mitmed raudteevaldkonna arengudokumendid nimetavad oluliseks raudtee-infrastruktuuri kulutaseme alandamist ja Eesti Raudtee finantsilist jätkusuutlikust. Regulatsiooni majandusliku eesmärgina on sätestatud Eesti Raudtee ärikulude tase, kuid sihttasemena on riik viimastel aastatel lubanud ärikulude mahu inflatsioonist kiiremat kasvu. Ettevõtte raudteeinfrastruktuuri kulude määr on jäänud sisuliselt samaks, aga arvestades tegevusmahtude mõõdukat langust rongikilomeetrite ja olulist vähenemist kaubamahtude osas, on teenuse kuluefektiivsus tegelikult halvenenud.

Keskkonna- ja ohutusalased kaalutlused raudteeinfrastruktuuri majandusliku regulatsiooni eesmärkide osas on suuresti katmata. Finantseerimislepingus on ministeeriumi ja Eesti Raudtee vahel mõõdikuna kokku lepitud rekonstrueeritavate ülesõitude ja -kohtade arv, kuid see ei anna sisulist indikatsiooni ohutustaseme muutumisest või tegelikest kitsaskohtadest.

Autorid osundavad edasise uurimistöö vajadusele arendamaks välja süsteemne raamistik raudteeinfrastruktuuri majandusliku regulatsiooni eesmärkide ja indikaatorite osas. See võimaldab hinnata, kas ja kuidas majanduslik regulatsioon toimib ning loob eeldused regulatsiooni efektiivsuse ja mõjususe kasvuks. Lisaks saaks võrguettevõtja selgemad signaalid investeeringute planeerimiseks, oleks võimalik sisuliselt hinnata eesmärkide täitmist ja võrrelda võrguettevõtjaid siseriiklikult või teiste Euroopa Liidu riikidega. Eesmärgid ja indikaatorid peavad katma kõik raudteeinfrastruktuuri majandamise olulised osad (sh. keskkonnakaitse, infrastruktuuri kasutamine, raudteeohutus ja tööohutus). Kuivõrd võrguettevõtjate majanduslik regulatsioon toimib Eestis ka mitmetes teistes valdkondades, võib osutuda võimalikuks parimate praktikate ülekandmine valdkondade vahel.

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Assessment of the economic regulation of network industries: oil shale value chain in Estonia

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Abstract. *Naturally monopolistic network industries are subject to economic regulation to achieve an optimal use of infrastructure and avoid the abuse of monopolistic power. In theory, such intervention leads to a higher allocative and productive efficiency in the industry. Relatively little is known about the results the economic regulation gives in practice and whether it achieves the objectives set. Literature states that due to the context-specific nature of regulatory framework, ex post analysis and practical experiments are necessary to be performed to study the impact of economic regulation on the performance of industries. In this paper, analysis of the impact of economic regulation on the oil shale value chain in Estonia is performed and the results are provided. Based on relevant policy documents, regulatory objectives and targets are identified and indicators compiled to monitor the results. The discussion is presented and recommendations for further research are given.*

Keywords: *oil shale value chain, economic regulation, network industries, ex post analysis.*

1. Introduction

Network utilities like railways, district heating, water and sewage, electricity transmission and distribution produce services that are important intermediate inputs for the overall economy and largely non-discretionary to consumers and the society as a whole. Such industries are all associated with capital intensive infrastructure and sunk costs that create a substantial barrier to new entry. Moreover, due to the naturally monopolistic character of production technology, legal monopolies are established to avoid unnecessary duplication of utility infrastructure. Thus, a framework of economic regulation needs to be established to provide approriate incentives for the industry and balance a spectrum of interest pursued by different stakeholders. For example, exploitation of monopoly market power by a network utility must be prohibited. On the other hand, important considerations like sustainability of operations, affordability of service, safety of supply, etc., must be ensured.

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The concept of economic regulation and its implications for the productive and allocative efficiency in an industry have been extensively discussed in theoretical literature, however, empirical studies on the subject are rare. The latter can be attributed to the context-specific nature and variety of regulatory systems across industries and countries. Therefore, theoretical models often fail to convey the actual regulatory dynamic between stakeholders and the impact of regulation cannot be meaningfully predicted ex ante and should rather be evaluated ex post. As put by Jacobs [1], the most important aspect for the quality of government decisions is not the precision of calculations but asking right questions, understanding real-world impacts and exploring assumptions. Even though the European Union (EU) has been labelled "a regulatory state", it is more advanced in initiating regulations than measuring regulatory performance [2].

The objective of this paper is to assess the impact of economic regulation on the Estonian oil shale sector. Oil shale related industries have been the cornerstone of Estonia's energy independence and contribute an important share to the national economy. The competitiveness of the sector, however, is undermined by the EU's climate policies. The oil shale sector in Estonia presents a value chain of industries that are subject to varying economic regulations enforced by multiple regulators. Although the value chain involves industries with monopolistic and competitive market structures, firm inter-linkages between these industries create vertically integrated industrial conglomerates that have network utility characteristics.

There are only few analyses of the economic regulation of network utilities in Estonia. Eerma [3] discusses sector-specific regulation in selected industries, Uukkivi et al. [4] propose a comprehensive framework of the economic regulation of five network utility sectors in Estonia, and Ots [5] analyses price regulation practices from a regulator's perspective in the energy sector. More recently, Uukkivi and Koppel [6] present a sector-specific study on the results of the economic regulation of railway infrastructure management. With regard to the oil shale sector, there are few academic works that address regulatory issues of industries within the Estonian oil shale value chain. Kearns [7] provides commentaries on the trends in oil shale utilisation in Estonia: electricity generation, shale oil production, and heating. Kallemets [8] discusses the sustainability potential of Estonian shale oil production until 2030 and regulatory developments both at the national and EU level. Additionally, the National Audit Office of Estonia conducted an assessment of the effectiveness of implementation of strategic policies in the Estonian oil shale sector [9] and the Ministry of the Environment of Estonia published the first progress report on the implementation of the National Development Plan (NDP) for the Use of Oil Shale 2016–2030 for the years 2016 and 2017 [10].

The paper is structured as follows. First, an overview of theoretical literature is presented and the methodology used in the paper is described. Secondly, a summary of the institutional setup and framework of the economic regulation

of oil shale value chain in Estonia is provided, objectives to be achieved are set and indicators to monitor the outcome of the regulation are compiled. Then a discussion is presented and conclusions are provided.

2. Overview of theoretical literature

Porter [11] puts forward a concept of value chain to distunguish different stages of the supply process as well as the support services within a company which are necessary to deliver a product to the market. In a similar manner, the term value system proposed by the reseacher describes the set of activities between inter-industry linkages and includes suppliers who provide inputs (raw materials, purchased services, etc.) to the firm's value chain. Both concepts are used to address strategies in terms of relationships between relevant counterparts, including firms, regulators and the government [11]. In this sense, the value chain and the value system are similar to what has also been labelled as "industrial complex" formed around the core firm [12]. This paper treats the terms as synonyms.

Transaction cost economics explains the economizing, organizational and contractual aspects associated with the value chain phenomenon whereas transactions involving assets with specific physical, human or location characteristics are of relevance to the topic of this paper. As argued by Williamson [13], large investments in asset-specific transactions lead to non-marketability issues and substantially increase governance costs of parties involved in the transaction. According to the author, a greater vertical integration of the value chain is therefore seen as a way to optimize governance costs when it is not possible to benefit from the economies of scale on the market.

There are specific industries, the so-called natural monopolies, where competition leads to a wasteful duplication of resources. In such cases economic regulation is needed to restrict entry but also to avoid exploitation of monopoly power by the incumbent that does not face the competitive pressure. More specifically, regulation is designed to improve the unregulated performance and address market failures and achieve optimal outcomes for society. Economic regulation therefore addresses a variety of objectives like asymmetry of information, market power, investment and operating efficiency, tariff structures and levels, viability of the regulated firm, etc. [14, 15].

The most widely accepted definition of natural monopoly in contemporary academic discourse stems from the seminal works of Baumol [16] and Baumol et al. [17]. According to this definition, a natural monopoly is presented in an industry with declining average costs per single product and cost subadditivity of multiple products. In such cases, the production technology of the industry is usually associated with some combination of economies of scale, economies of scope and economies of density, which makes it most efficient to have a single definite produce for the whole market [18].

Joskow [18] argues that besides economies of significant scale and scope, sunk costs in an industry are the most important linkage between behavioral parameters and economic performance problems thought to arise from unregulated natural monopolies. According to the investigator, most of the industries regulated based on natural monopoly arguments have a large fraction of their total costs as sunk capital costs which create potential opportunities for a strategic behavior of monopoly pricing or discouraging entry by the incumbent The literature discusses several other considerations of the natural monopoly approach, for example, technological complexity of operations [19] and societal importance of the industry [20]. It is important to note, however, that industry characteristics may change over time. For example, innovations in technology can disrupt capital intensive naturally monopolistic production infrastructure or political priorities may require the economic regulation of inherently competitive industry. Joskow [18] therefore stresses that there is no definite distinction between "naturally monopolistic" and "competitive" industries, while in reality, the judgement depends on what is considered a relevant product market and what are substitute products in a particular environment.

Regulated infrastructure monopoly may be vertically integrated with network services that are inherently competitive and do not have the properties of a natural monopoly properties. For example, vertical integration between complementary services used to be the mainstream approach with network industries in telecommunications, railways, electricity, etc., where the process of production and distribution of the product were organised by the same entity or concern. Vertical integration between regulated and non-regulated industries upstream or downstream within a value chain may also be the case. As a vertically integrated monopoly will have a rationale to utilise differentiated regulation across industries for strategic gain, the regulatory framework must be designed accordingly. Knieps [21, 22] summarizes that subparts of a production chain characterized by a natural monopoly in combination with sunk costs lead to network-specific market power and can be exploited for monopolistic charges or inadequate access conditions. Therefore, if the network infrastructure is a monopoly (i.e. there is a "monopoly bottleneck"), non-discriminatory access to service providers has to be solved by the regulatory access regime. Competitive subparts can be regulated ex post under the general competition law.

3. Methodology

The empirical analysis performed in this paper is based on the process tracing approach and addresses the design, implementation and outcomes of the regulatory framework of industries in Estonian oil shale sector. The paper refers to regulation as a combination of both legislative domain (composition

of the rules) and executive domain (enforcement of the rules). Although not directly enforcable, legally mandated strategy documents are considered an inherent part of regulation. This is because such strategies trigger future legislative intervention and guide on the discretion of regulatory authorities when they enforce compulsory regulation. The period of interest for the study is set from 2008 to 2018. Such a timeframe allows inclusion of two subsequent strategy periods in the analysis. Moreover, the period is sufficiently long for regulated companies to adjust capital investment programs in order to cope with regulation.

The authors define the system of the oil shale value chain in Estonia, address the composition of vertically linked industries and discuss the natural monopoly parameters of the combined system. All industries included in the value chain are mapped for operational performance and trends, mutual interdependencies, stakeholding company groups, regulatory institutions and instrumental economic regulation provisions.

Regulations under review in this paper have been in force for a relatively long period of time, therefore the main reference to ex post evaluation is provided by the problem definition that these regulations should solve. Although elected politicians, bureaucrats and economists often have different views on what a "good regulation" is, as stated by Radaelli and De Francesco [23], the direction of a policy is always guided by regulatory objectives. As put by Coglianese [24], regulatory objectives also define the selection of indicators for evaluation because defining something as a problem cannot be accomplished without reference to value choices. In the absence of a specific problem, the discussion of indicators for regulatory evaluation will be abstract.

In order to identify regulatory objectives across the oil shale value chain, the authors trace the legislation of associated industries and applicable strategic plans in the oil shale and energy policy domain. The objectives are summarized and matched with the corresponding indicators on the industry or company level. The actual values of regulatory indicators are benchmarked against targets and outcomes are discussed with reference to the regulatory activities and interventions. The discussion concludes with recommendations for further research.

It is important to note that this paper has no intention to make a normative case for regulatory objectives or regulatory indicators for the oil shale value chain but to analyse what incentives are set for regulated companies and whether the regulatory framework achieves the objectives. As put by Arndt et al. [25], regulatory effectiveness is based on the extent to which a regulatory system pursues its underlying objectives on policy, efficiency and governance. While the implementation of the measures aims to meet wider public policy objectives with a positive impact on the economy and society, the indicators themselves do not necessarily assess the achievement of such objectives.

4. Economic regulation of oil shale value chain in Estonia

4.1. Mapping of the oil shale value chain

Extensive use of oil shale is the unique and defining quality of the Estonian energy system [7]. In 2017, about 76% of electricity and 8% of heat produced in Estonia was based on oil shale [26]. Although Estonian oil shale deposits are insignificant compared to the world resources, even "small" deposits can be huge related to the country's energy needs and Estonia is among the few countries where oil shale is in commercial use [27]. Oil shale serves as a raw material for a number of industries in Estonia which account for about 4–6% of its GDP and about 2.5% of total employment [28]. Due to the concentration of deposits, oil shale is particularly important for the economy and livelihoods of eastern Estonia.

The oil shale sector in Estonia presents an ecosystem of vertically linked industries that form the oil shale value chain (Fig. 1). For the purpose of this paper, the authors differentiate between the following industries within the oil shale value chain: mining of oil shale, utilisation of oil shale for electricity and shale oil, and cogeneration of heat. Oil shale utilisation for cement production in Estonia is marginal and is therefore left outside the scope of this paper. Horizontal supporting functions like transport and logistics, construction, warehousing, cleanup, etc., are considered as an inherent part of each industrial phase.

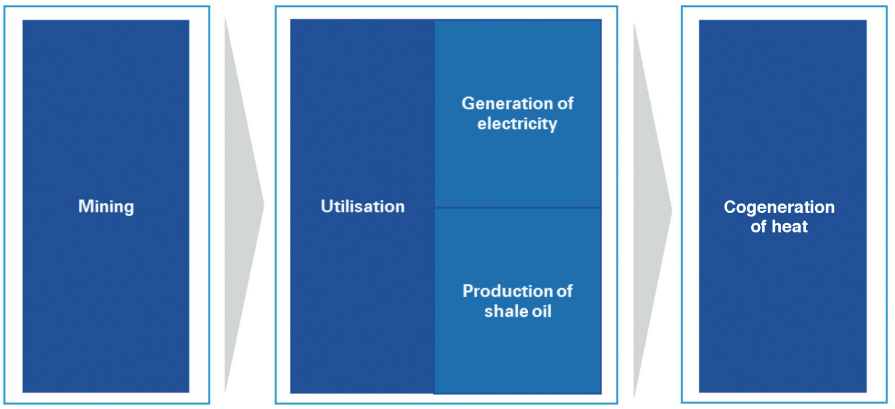

Fig. 1. Oil shale value chain in Estonia.

The properties of Estonian oil shale deposits largely define industry links within the value chain. First, the mineral utilisation involves a high amount of ballast, making the export of oil shale uneconomical due to the low energy value of the stock. The utilisation technology is proprietary and there is no competition between oil shale utilisation alternatives but with substitute

products on the marketplace (e.g. eletricity, oil and heat from oil shale are substitutes for similar products from other resources). The physical limit of oil shale value chain is legally set by the maximum volume of the mineral that is available. Similarly, the volume of economic operations of the companies is limited by the access to the mineral as the supply needs to be secured in downstream industries. For those reasons, access to the oil shale mineral effectively presents a monopolistic bottleneck across the whole oil shale value chain regardless of the production technology.

Oil shale mining operations and processing facilities must be located within a logistically efficient range as the trading in the mineral between vertically integrated groups is marginal. Therefore, a natural monopoly's arguments for economies of scope, economies of scale and economies of density apply to utility scale oil shale energy production due to the geographical irreversibility of infrastructure and subadditivity within the value chain. Competitition or contestability within the value chain is not a viable option. Oil shale mining and utilisation require capital intensive infrastructure with an asset life span over several decades and specific parametres for each mining-utilisation complex. Therefore, investments in both the physical and human capital related to oil shale mining and utilisation are to a high degree sunk with no practical alternative uses.

The asset-specificity of location, and physical and human assets in oil shale related industries has led to a high degree of consolidation of the oil shale value chain. As a result, practically all of the oil shale in Estonia is mined and processed by three groups of companies: Eesti Energia AS, Viru Keemia Grupp and Alexela Grupp (Table 1). All these companies are vertically integrated and provide support services mostly within the concern companies.

Table 1. Corporate groups in Estonian oil shale sector

Parent company	Mining	Electricity/ shale oil production	Cogenerated district heating
Eesti Energia AS	Enefit Kaevandused AS	Enefit Energiatootmine AS	Enefit Energiatootmine AS/ Narva Soojusvõrk
Viru Keemia Grupp	VKG Kaevandused OÜ	VKG Oil AS, VKG Energia OÜ	VKG Soojus AS
Alexela Grupp	Kiviõli Keemiatööstuse OÜ	Kiviõli Keemiatööstuse OÜ	Kiviõli Keemiatööstuse OÜ

Compiled by authors.

4.2. Oil shale mining

Access to Estonian oil shale resource is economically regulated through a scheme of mining licences. Mining licenses are issued by the Estonian Environmental Board and effectively create a legal monopoly on a particular deposit for a period of up to 30 years. The long mining permit validity period allows the complete mining of the resource and recouping of sunk investments in capital intensive infrastructure.

The National Development Plan for the Utilization of Oil Shale 2008–2015 introduced the maximum mining limit of 20 million tonnes of oil shale reserves per annum that was later also incorporated into the law [29]. Annual mining allowances per license are set by a decree of the Minister of the Environment.

The government collects revenue and incentivises the achievement of regulatory objectives through a combination of resource fees and environmental charges. There is no universal price regulation for third parties besides general ex post competition rules as most of the mineral for utilisation is provided by affiliated miners within the vertically integrated groups. Resource fees are set by a governmental decree, the rationale of which has changed during the recent years. Formerly, the mining companies were charged a fixed tonnage rate irrespective of the market conditions but from 2016 onwards, a fluctuating rate has been applied based on the world market price for fuel oil with a sulfur content of 1%. Due to the fluctuations in downstream demand, a

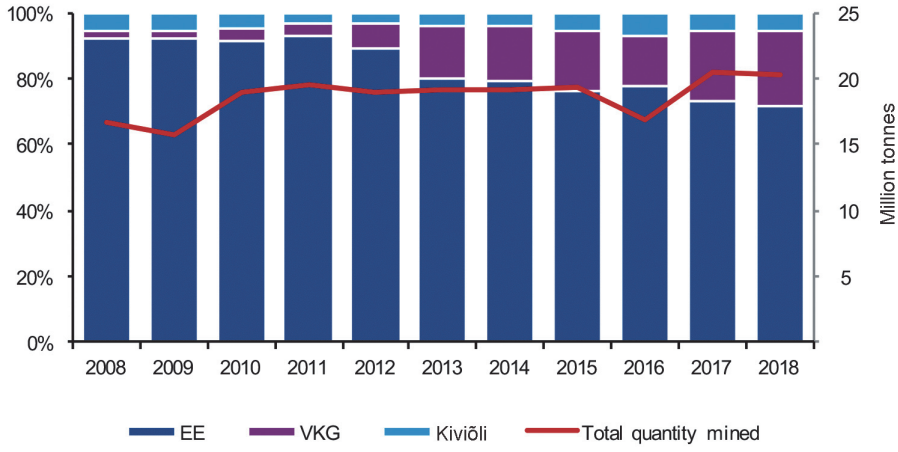

Fig. 2. Oil shale mining volumes in Estonia 2008–2018, million tonnes. Compiled by authors, data from [30]. (Abbreviations: EE – Eesti Energia, VKG – Viru Keemia Grupp, Kiviõli – Kiviõli Keemiatööstus.)

compensation mechanism was introduced in 2015 that allows a retrospective mining of unused quota. Also, the trading in the annual mining allowance is possible within the 20 million tonne maximum mining limit.

With regard to the economic operators, Eesti Energia is the biggest miner of oil shale in Estonia, accounting for more than 90% of the mining volume in 2008 and 71% in 2018. In 2018, Viru Keemia Grupp peaked at 22% and Kiviõli Keemiatööstus mined around 7% of the total volume (Fig. 2).

4.3. Oil shale utilisation

Oil shale in Estonia is mostly utilised to generate electricity and produce shale oil (Fig. 3). Both products compete on the marketplace with a number of substitutes from other energetic sources. It is important to note that the economics of oil shale electricity and shale oil is sensitive to the regulation of the oil shale value chain. The production technology is viable only with large scale operations, therefore mining activities must be coordinated with the utilisation. Oil shale utilisation is also subject to a set of environmental charges that are imposed by the Estonian Environmental Board and are aimed to incentivise efficient and innovative production practices.

Most of oil shale electricity is generated in Eesti Energia's Eesti and Balti power plants, also Auvere Power Plant can be operated on oil shale. The volume of shale oil production in Estonia is sensitive to changes of crude oil prices in the world market. All of the vertically integrated groups that operate in the oil shale value chain produce shale oil and have developed proprietary technological solutions.

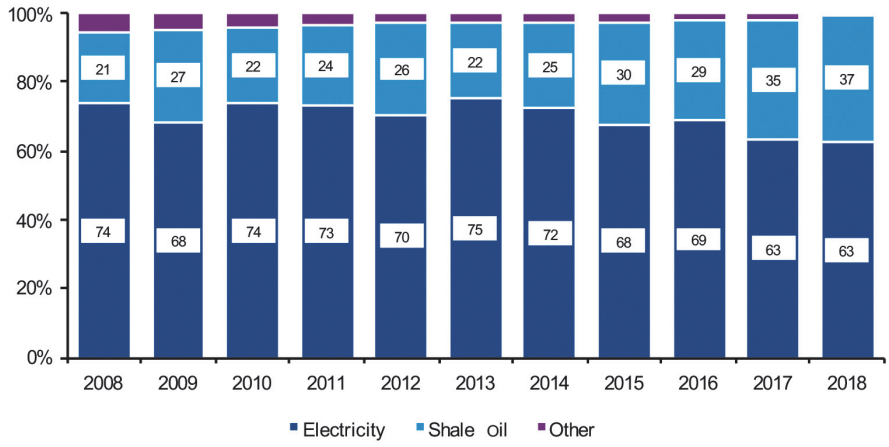

Fig. 3. Utilisation of mined oil shale in Estonia 2008–2018. Compiled by authors, data from [26, 31].

In total, about 70% of oil shale mined in Estonia was consumed for electricity generation during the period 2008–2018, the respective figure for shale oil production was around 25% [26, 31]. The shift of the EU's policy towards the use of renewables and the "cap-and-trade" principle-based emissions trading scheme have been posing a major regulatory threat to oil shale electricity. For example, the price of carbon dioxide emission quota increased threefold in 2018 [32], which has drastically undermined the competitiveness of oil shale electricity and favoured shale oil production as according to the emissions trading scheme, the latter is classified as less carbon dioxide intensive [33]. The domestic energy policy foresees a gradual decline of oil shale electricity portfolio and a strong impetus to utilise the mineral for the production of shale oil of higher value added [34]. The strategy of the state-owned Eesti Energia is in line with the mentioned objectives.

Both oil shale utilisation methods allow co-production of heat that requires capital investment in the associated production and distribution infrastructure. The commercialisation of heating, however, must take place in the vicinity of production facilities due to the absence of viable technologies for heat storage and transport. Heat is distributed to residential areas through district heating networks in the vicinity of production facilities in Narva, Kohtla-Järve, Jõhvi and Kiviõli and subsidiary companies have been established in the vertically integrated groups to manage the operations. District heating is a typical network utility domain that is subject to ex ante economic regulation relating to access to market and setting of tariffs by the Estonian Competition Authority.

5. Discussion

5.1. Regulatory objectives of the oil shale value chain in Estonia

In order to identify regulatory objectives of the oil shale sector value chain in Estonia, the authors traced the most important legislative acts and strategic policy documents of the oil shale domain. The Earth's Crust Act, the National Development Plan for the Utilization of Oil Shale 2008–2015 (NDP 2008–2015), the National Development Plan for the Use of Oil Shale 2016–2030 (NDP 2016–2030) and the National Development Plan of the Energy Sector until 2030 (EMDP 2030) were studied for this purpose. While certain overarching regulatory principles can be drawn from the Earth Crust's Act and EMDP 2030, NDP 2008–2015 and NDP 2016–2030 set very concrete policy objectives that can be scrutinized in practice. The results are summarized in Table 2.

Table 2. Regulatory objectives and indicators of the oil shale value chain in Estonia

	NDP 2008–2015	NDP 2016–2030
Objectives	1. Securing sufficient reserves of oil shale energy and safeguarding Estonia's energetic independence 2. Increasing the efficiency and reducing the environmental impact of oil shale mining 3. Increasing the efficiency and reducing the environmental impact of oil shale utilisation	1. Increasing the efficiency and reducing the environmental impact of oil shale mining 2. Increasing the efficiency and reducing the environmental impact of oil shale utilisation 3. Developing education and research activities in the field
Indicators and targets	Mostly activity based indicators and no numerical targets	Mostly outcome based indicators and detailed numerical targets

Compiled by authors, data from [35, 36].

NDP 2008–2015 stipulates 12 different measures in order to achieve the objectives [35]. NDP 2016–2030 sets three strategic objectives with eight respective measures for the oil shale sector but with somewhat different composition. The strategic objectives are: increasing the efficiency and reducing the environmental impact of oil shale mining; increasing the efficiency and reducing the environmental impact of oil shale utilisation; developing education and research activities in the field of oil shale [36]. NDP 2008–2015 and NDP 2016–2030 stress the importance of oil shale as a strategic resource of national importance but the composition of objectives has changed. The objective to secure energy independence through oil shale energy was dropped from the current strategy and replaced with initiatives on education and research activities in the sector. This change was necessary because consumers are free to choose between alternatives in an open energy market and oil shale based energy cannot have any preference. As a result, increasing the efficiency and reducing the environmental impact of the oil shale value chain have been the overarching objectives of the regulatory policy throughout several strategy cycles.

5.2. Regulatory indicators and outcomes of the regulatory framework

Regulatory indicators provide reference to the status of regulatory objectives compared to targets and reflect on the outcomes of policy implementation. Implementation of NDPs is supported by regular progress reports to be submitted to the government for approval. While NDP 2008–2015 was of general character and contained no numerical targets, NDP 2016–2030 sets

specific values for every indicator to be achieved and requires updating the target levels every five years.

Compiled by the authors, the summary of regulatory oil shale mining and utilisation indicators is presented in Table 3. The indicators listed in the table are matched with target and actual values for the period 2008–2018 and are numbered for easier reference in the discussion. The average indicator values are calculated because the respective annual figures may fluctuate substantially due to exogenous factors. It should be noted that although conceptually elaborate, the calculated oil shale utilisation indicators (indicators 4–5, 7–9) are highly dependent on the consistent approach towards and format of input data and calculation methodology. Target values for calculated indicators in NDP 2016–2030 are based on an expert opinion commissioned by the Ministry of the Environment of Estonia but there is no common data series or calculation methodology. Moreover, the NDP 2016–2030 progress report retrospectively revises base indicator values by up to 40%. The authors are therefore unable to calculate or verify oil shale utilisation efficiency indicator values and refer directly to the data from the NDP 2016–2030 progress report for the period 2013–2017.

NDP 2016–2030 sets three indicators (indicators 1–3) to monitor the efficiency and environmental impact of oil shale mining in Estonia. The underground mining loss, waste rock recovery and pumped-out water volume indicators are a function of mining technology and mining intensity combined with geological and environmental conditions at mining locations. The values are aggregated from measurable parameters that are reported by the companies. The set of indicators reflecting on the regulatory objective of increasing the efficiency and reducing the environmental impact of oil shale utilisation is more complex. This set consists of six indicators, of which only one (indicator 6) is measurable based on the data reported by the companies. Other indicators are calculated aggregates which reflect technological efficiency ratios of shale oil (indicator 4) and oil shale electricity (indicator 5) production and economic efficiency ratios of oil shale value chain per various key parametres (indicators 7–9). Economic efficiency ratios are also descriptive of energy products pricing conditions on the marketplace.

The analysis of the data shows that in the years 2008–2018, the underground mining loss was mostly above the target level, 29.2%, averaging 30.4%. Considering that during the same period, the underground oil shale mining accounted for 2/3 of total mining volume and has been increasing especially in recent years, extended mining loss has led to substantial inefficiencies in and negative environmental impact of mining. This problem has been repeatedly acknowledged in various progress reports and explanatories, yet the research pipeline does not indicate mature projects on the domain. As capital investments in new technologies have prolonged incubation periods, it is unlikely that substantial progress will be achieved in this measure during the NDP 2016–2030 period.

Table 3. Economic regulation indicators of oil shale value chain in Estonia

Category	Indicator	Base value	Target value	Actual value
Mining efficiency and environmental impact	1. Percentage of the underground mining loss from oil shale reserves already mined and rendered unfit for use, %	29.2	Up to 29.2 (2020)	32.2 (2008); 29 (2018); 30.4 (2008–2018 avg)
	2. Recovery of waste rock, %	40	Not less than 40 (2020)	17 (2008); 57 (2018); 50 (2008–2018 avg)
	3. Volume of water pumped out for each tonne of oil shale reserve extracted from the Earth's crust, m^3	15 m^3	14 m^3 (2020)	8.91 (2008); 5.74 (2018); 6.9 (2008–2018 avg)
Utilisation efficiency and environmental impact	4. Energy efficiency of shale oil production, %	76	Over 76 (2020)	76 (2013); 78 (2017); 78.2 (2013–2017 avg)
	5. CO_2-specific emissions emitted in relation to total electricity and thermal energy in the case of cogeneration, tCO2/GWhe+th	1186	Below 1186 (2020)	1186 (2013); 1204 (2017); 1210 (2013–2017 avg)
	6. Percentage of recovered oil shale ash from the total formation, %	4.5	At least 4.5 (2020)	4.7 (2008); 1.92 (2018); 3.7 (2008–2018 avg)
	7. Indicator of economic efficiency of producing energy from oil shale, €/t per trade oil shale	34.55 (adjusted to 24.37)	No degradation of value (2020)	24.37 (2013); 25.13 (2017); 24.87 (2013–2017 avg)
	8. Value added created by producing energy from oil shale in relation to the oil shale reserve mined and made unusable, €/t	29.78 (adjusted to 19.61)	No degradation of value (2020)	19.61 (2013); 16.37 (2017); 17.83 (2013–2017 avg)
	9. Value added created by producing energy from oil shale in relation to th e deposited waste, €/t	71.04 (adjusted to 43.17)	No degradation of value (2020)	43.17 (2013); 32.76 (2017); 38.06 (2013–2017 avg)

Compiled and calculated by authors, data from [10, 30, 35–37].

The target for recovery of mining waste rock (40%) was exceeded in 2018 (57%) and the average achieved during 2008–2018 (50%), whereas the oil shale ash recovery has underperformed the target in both comparisons. It must be noted that the yearly values for both indicators fluctuate substantially as the recovery depends both on mining and utilisation volumes as well as on recycled water pipeline projects within the logistical range. As the waste to mineral ratio in the mining and utilisation process is largely fixed, better prospects of recovery are associated either with utilising the material in the construction industry (Rail Baltic railway, etc.) or with the regulatory redefinition of the recycling criteria. The indicator of pumped-out water volume per mined oil shale tonne was in positive territory both in 2018 and during 2008–2018. The lack of a coherent methodology, however, presents problems as alternative approaches to data series handling lead to unreliable calculation results.

The summary of oil shale utilisation performance indicators is ambiguous. The technological efficiency of shale oil production has somewhat increased but that of electricity production decreased due to recent major production facility upgrades or lack thereof. The growth of oil and electricity market prices over the recent years has caused the indicator of aggregated net sales per trade shale oil to exceed the target whereas the same measure per used oil shale reserves and deposited waste falls short due to the use of lower energy value mineral.

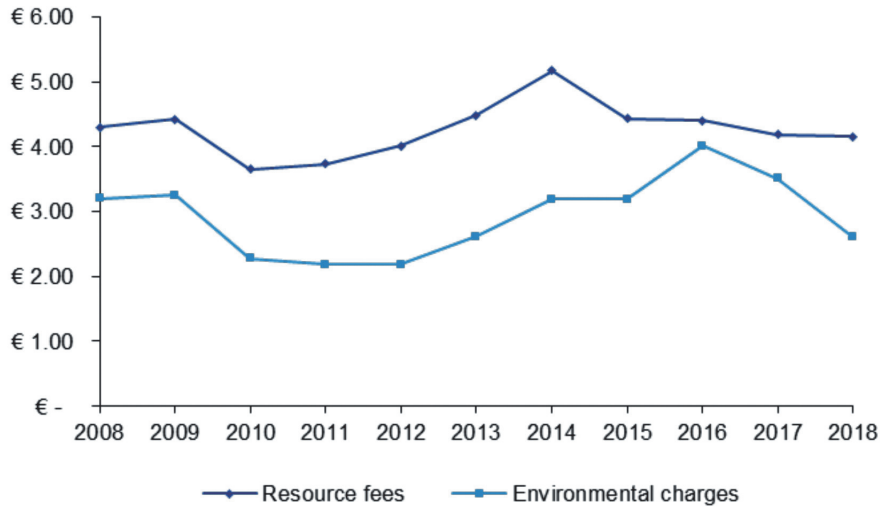

Fig. 4. Resource fees and environmental charges of oil shale value chain in Estonia 2008–2018, €/mined oil shale tonne, inflation adjusted. Compiled by authors, data from [38].

The authors note that the economic regulation of the oil shale value chain in Estonia is differentiated between industries without uniform technical or operational requirements. Incentives to abide by the regulatory objectives are set in two ways. First, the state sponsors a pipeline of applied research related to oil shale industries and disseminates the know-how. Second, there is a system of resource and environmental charges to increase the efficiency of the oil shale industry and mitigate its environmental impact (Fig. 4). The companies are charged for mined oil shale and mining loss, used and contaminated water, air pollution and deposited waste generated by oil shale operations. It is therefore rational to assume that any investment in technological upgrades is weighed against the level of charges that would be saved by making such invesment.

Based on the charges paid by the oil shale industries, the authors calculated the inflation adjusted level of annual resource and environmental charges per mined oil shale tonne for the period 2008–2018. This level presents input that is available for value adding operations in downstream industries.

The analysis shows the inflation adjusted level of resource fees to have been relatively stable over the period 2008–2018, averaging 4.3 €/tonne. During the whole period, environmental charges accounted for about 2/3 of total charges. This appears to support the conclusion that either operational measures fall short to impact on regulatory indicators that have had no sustained improvement over the period, or it was economically more beneficial to pay charges rather than invest in technological upgrades. In such case, the tariff system effectively amounts to an implicit taxation regime. Introduction of composite regulatory indicators [39] would be warranted for additional clarity how sectoral trend and company level performance contribute to the outcomes.

6. Conclusions

The objective of this paper is to present an ex post analysis of the impact of economic regulation of the oil shale value chain in Estonia. Oil shale value chain is a system of vertically linked industries with competitive and monopolistic market structures and varying regulatory regimes and regulators. Fixed investments have a high degree of asset-specificity with regard to physical and human assets and location. The combined value chain in Estonia has natural monopoly characteristics of economies of scope, economies of scale and economies of density, and is dominated by three concerns of integrated companies.

The industries in the oil shale value chain were mapped for operational performance and trends, regulatory institutions and provisions of economic regulation. Legislative acts and policy documents were studied for regulatory objectives and regulatory indicators. The analysis demonstrates that the

regulatory framework of oil shale value chain in Estonia over several strategy cycles has aimed to increase the efficiency of oil shale mining and utilisation and reduce its environmental impact.

The implementation of regulatory oil shale mining and utilisation policies in Estonia is monitored by annual progress reports which are submitted to the government for approval. A set of indicators is established to survey the status of regulatory objectives. However, there has been a significant time lag between observation of indicators and the authorities' regulatory reaction to the findings. The empirical analysis of regulatory indicators and targets shows the impact of economic regulation during the period 2008–2018 to have been ambivalent. In oil shale mining, underground mining loss was continously in excess of the target but objectives of waste rock and pumped-out water recovery in relation to oil shale mining were met. In oil shale utilisation, targets to increase the energy and economic efficiency of oil shale-based production were reached. The calculated CO_2 emissions, oil shale ash recovery and oil shale utilisation added value remained below the target levels.

Analysis of the design of regulatory indicators leads to the following conclusions. First, there is no common methodology for collecting data and calculating indicator values. Furthermore, the base values of several indicators have been revised but cannot be scrutinized or replicated as the revisions are based solely on expert opinions. Second, the application of many regulatory indicators is limited due to geological and hydrological conditions, regulatory discretion or macroeconomic trends that are beyond the control of companies. For example, the legal waste recycle and pipeline classification applied to infrastructure construction projects significantly influences the values of relevant indicators. Third, regulatory indicators are calculated on an aggregate level for the combined oil shale value chain and the performance of individual companies that mine and utilise oil shale is not measured or benchmarked. The impact of companies' technological upgrades or operational performance on achieving regulatory objectives is therefore unclear.

Incentives for companies to comply with regulatory objectives are mostly provided by a system of resource tariffs and environmental charges. It is shown that combined inflation adjusted charges paid by the oil shale value chain were relatively stable in 2008–2018, however, this did not lead to a sustained improvement of regulatory indicators.

Composite regulatory indicators of oil shale value chain industries, which aggregate sectoral and company level performance, monitor parameters the economic operators can affect and allow benchmarking, will require further research. Also, access to oil shale mineral that presents a monopolistic bottleneck for the whole value chain is based on legacy market conditions. The economic regulation of oil shale mining and the tariff system of oil shale value chain industries merit further study to enable using the mineral in operations that generate higher value added.

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