

Ph.D. thesis summary

**THE TRANSACTION COST-BASED APPROACH TO
STANDARDIZATION**

Introducing the connection between network industries, transaction costs and standardization through the experiences of the standardization of mobile telephone systems

István KOVÁCS

Supervisor: Dr. Judit KAPÁS



UNIVERSITY OF DEBRECEN
Doctoral School of Economics

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Motivation of the research

Standards play an essential role in our everyday life. They play a part in almost every transaction, making it easier to exchange, to measure, to inform, etc. We become aware of how important they are when some problem arises in connection with them. The most common problems, which can be observed by an average user, stem from the lack of compatibility. The question of incompatibility is addressed by several papers (e.g. Matutes-Regibeau 1998), but the literature on standardization has not really paid attention to an examination of how standards come into existence. However, my interest focuses on the questions: *What can economic theory tell us about the birth of standards? What determines which coordination mechanism is used to evolve a standard?* These questions are based on a puzzle that emerged from the analysis of the standardization of mobile phones, namely: *Why are the standards created by committee-based standardization mechanisms more successful than the standards created by market standardization mechanisms?*

To answer these research questions, I believe, the theory of standardization must be based on a view that was not inherent in the previous papers. Many publications deal with the issue of standardization, from the numerous technology-oriented papers written by engineers, through sociological research to articles by legal academics. Fortunately, there are an increasing number of studies from the field of economics. Studying this enormous literature I noticed that the theoretical foundation of the economics of standardization is insufficiently developed. Of course, I do not mean to say that a completely new theory must be constructed, but rather that the existing concepts should be seen from viewpoints which – at first glance – seem far from obvious. In my dissertation I show that analyzing standardization with *an approach based on transaction cost economics contributes to the deepening of our knowledge of standards.*

The methodology and structure of the dissertation

The dissertation was written within the framework of economics. Farkas Heller, one of the greatest Hungarian economists, wrote in the Editorial Preface of *Közgazdasági Szemle*: “Those who neglect theory, saying it is just theory without practical significance, are mistaken. The benefits of theory are not always obvious because it lightens the depths, but only strong theoretical thinking enables us to judge the phenomena of life seriously and thoroughly instead of relying on shallow prejudices. Therefore, we must not shrink from the depth of theory if we want to give our words more weight.” (Heller 1925:208). Identifying with this advice – now 80 years old – I attempt to set up a conception with sufficiently deep theoretical foundations.

In the 20th century a serious debate evolved over the nature of economics (Móczár 2008, 2009), which was coupled with another discussion on methodological issues (Csaba 2008). Ronald Coase, undoubtedly one of the world’s most influential economists, expressed his opinion on methodological issues several times (Szakadát 1995). Unfortunately, this debate does not provide proper guidance to students of economic science on how to establish their own theoretical concepts.

Babbie (2008) summarizes the criteria that have to be considered during research in the social sciences field. On this basis, the steps listed below have been followed in the dissertation. I have first defined the main topic of the dissertation: the economics of standards. Then I have narrowed the scope of the research to the specifically analyzed area - to standardization. Within this narrower issue, however, there is still a very large number of papers, so further screening is necessary. I have focused on the theoretical foundation of the issue, therefore the most important task is to identify and define the main concepts. During this time-consuming research I had to identify not only the concepts, but also their connections and our current knowledge of the interconnections and relationships between the concepts. Setting up my own conception was only possible following these steps.

The identification of the concepts is based on the critical exploration of the available literature. This means that the papers and monographs have been summarized and systematized (as far as the space limitations allowed), and I have critically analyzed the conceptions as well. This analysis made it clear that for a deeper understanding of standards I have had to step outside the framework of the economics of standards and extend the research in two directions: (i) network industries and network effects, and (ii) transaction cost

economics. Both fields would be far more than enough to fill numerous dissertations, so the list of the relevant and analyzed papers is inevitably subjectively selected. Instead of automatically adopting the conceptions during the whole research I have tried to analyze them and confront the theories with each other. Studying and interpreting the relevant literature in this way enabled me not only to identify the concepts but also to continuously expand the research, incorporating the interrelations discovered in the meantime, while at the same time supporting the thesis.

The dissertation follows the structure outlined above. The second chapter deals with the economics of standards. I have summarized the most frequently cited works which are considered to be the main literature of this topic. There are also some deficiencies that can be traced back to the definition of standards. I have reviewed the most important functions of standards using the classification provided in Swann's (1999, 2000) reports. Subsequently, I have showed how standards influence the economy and what economic effects they have. I have concluded that a new approach is necessary to define standards, which enables a deeper understanding of the process of standardization.

In the third chapter I have turned to the topic of network industries and network effects. The brief review of the articles dealing with networks reveals a misconception which seems to be insignificant at first sight: many authors treat industries with positive network externalities – where only one actor supplies the whole market – as natural monopolies. This is an annoying mistake because internal economies stand in the background of natural monopolies, while the network effects stem from the consumption process (external economies). These anomalies within the conceptions can be partly traced back to the interpretation of the phenomena (path-dependency and lock-in) arising from network effects.

The theory of transaction cost economics (TCE) is treated in chapter 4. TCE is a widespread theory; it cannot therefore be dealt with in full detail here. In this chapter only those parts are discussed which play a major role in the new standardization approach. Two closely linked directions are followed in this chapter. First, I have discussed the governance structures (market-hybrid-hierarchy) – that were first introduced by Oliver Williamson – aiming to show what transaction costs they can reduce and how they can do this. Williamson's theoretical framework serves as the basis of my conception. The other direction is the definition of a transaction. The unit of analysis in TCE is the transaction, so an elaboration of the earlier concepts of transaction is needed to set up my own conception. Not only does TCE benefit from the treating of the notion of transaction but it also enables the development of the 'transaction cost based' approach to standardization.

Chapter 5 shows the connection between the three theories discussed in the earlier chapters. During the creation of a standard the actors share their own knowledge with each other, which assumes that this knowledge can be articulated and transmitted. The codification of tacit knowledge is necessary to assign the right of usage, a transfer which stands for the transaction itself. Under certain circumstances the cost of this transfer is lowest when the transaction is coordinated under hierarchy (e.g. formal committees, a national standardization authority). In other cases hybrid forms (e.g. standard-setting consortia, cooperation) have advantages in coordinating this transaction. If the specificity of the knowledge is low, a market-based mechanism will minimize transaction costs.

The sixth chapter brings some empirical evidence to the theoretical conception of chapter 5 by studying the innovation waves of mobile communication. In the last 50 years many standards have existed in parallel in the different regions of the world – which complicates the interpretation – therefore I have decided to summarize the evolution of mobile standards first in historical then in geographical order. The standardization of mobile communication underpins the predictions of my theoretical model. Before creating the first generation (1G) systems the standardization process had been coordinated in hierarchies – standards had been created in national contexts under the supervision of states and their authorities. During the 1G standardization in some cases (especially when creating the NMT standard in the Nordic countries) the hierarchy was combined with market-based mechanisms. This hybrid form (committee-based standardization with numerous participants from the market) proved to be a successful solution: those standards (NMT and AMPS) which were created by hybrid mechanisms were chosen worldwide. In both 2G and 3G standardization hierarchy was combined with even more market-based incentives.

Theses

In the second chapter I introduced the theoretical background of the main questions of the dissertation. This short review of standards' literature has made it clear that the theory of standardization should be expanded in two directions. Firstly, I studied the widespread literature of network effects followed by the literature on transaction costs economics. There is a widespread agreement among economists that network effects emerge in the consumption process (Kiss 2010). When external economies are significant, demand forms an inverted U-function so the demand function has an upward slope section. It means that users are willing to buy more even at a higher price (Rohlf's 1974). All in all, the more people consume the

good the more valuable it becomes to the individual. The market for such goods should be handled as a network. In most cases there is a physical network (e.g. telephone services) in the industry that makes direct network effects stronger. If a network does not exist physically, but indirect network effects are strong, users form a virtual network (e.g. the group of consumers that use the same standard).

Although economists are agreed upon the source of network effects, there are some questions that have to be clarified. One can explore some misconceptions and serious debates about the network effects and related phenomena (Lewin 2001a, 2001b). These debates can be traced back to terminological issues. In early works authors spoke of network externalities. Using this phrase encouraged research into the issue of networks but as a side effect it also set back the theoretical clarification of the phenomenon. Liebowitz and Margolis (1994) drew attention to the separation of the notions: according to them network effects should not be treated in all cases as externalities. Situations are externalities when an individual benefits (or bears costs) from an interaction between two other parties and these benefits (or costs) are not compensated. Therefore, we can talk about externality only if the parties cannot internalize the effects they have on each other, in other words, if they do not perceive how their activities and decisions affect the others. When the actors constitute a network and this external effect emerges in the consumption process, then this effect is a network effect (Economides 1996). However, in most cases the consumers of the given good are not at all, or only slightly, able to internalize the network effects while the sponsor of the network – if it exists – can benefit from the growth of the network. When there is at least one actor who is able to internalize the effects of the network then we cannot talk about externality, so there is no market failure. Let us imagine an industry where the sponsors can internalize the network effects. It is possible that only one huge network with one sponsor survives the war of networks (or standards) but there are no externalities because network effects are internalized by the sponsor. This situation is not market failure because social wealth is maximized. All in all, not every case where network effects are significant proves to be a market failure, so the expressions (network effects and network externalities) should be separated.

The issue of network effects and network externalities raises two further questions. On the one hand, authors dealing with network externalities see this notion as a market failure; they therefore claim that the outcome is not socially optimal. When the notion of network externality is used in a study, it is in fact assumed (explicitly or implicitly) that not all costs and/or benefits were taken into account when decisions were made. These studies implicitly state that wealth would have been increased if every incurred effect were taken into account.

The only reason to use the notion of externality in the analyses is to study the questions of internalization of costs and/or benefits or to examine whether there is a market failure. On the other hand, those studies that treat network effects as market failures, state that those networks which are born from network effects, are inferior from the viewpoint of welfare economics. Brian Arthur and Paul David are the most cited authors, who describe the phenomenon of lock-in as market failure. According to them, the benefits of networks that actually have come into existence can be lower than the benefits of networks that have not come into existence (Arthur 1989, David 1985). They base their theory on the fact that the small, maybe insignificant, events of history have influenced the actors' decisions. This phenomenon is also called path-dependency. As an example, they use standards that rule the market and are inferior as compared to others that are available to the actors. However, some authors (e.g. Liebowitz–Margolis 1994) questioned the soundness of these examples, which gave rise to heated debates.

These debates are the results of differing opinions regarding sub-optimality. I have pointed out that the debating authors view normative and positive economics, and also the issue of market failures, differently. The classification of path-dependency by Liebowitz–Margolis (1995) could have easily resolved these debates by analyzing the degree of path-dependency based on the level of information held by the actors. Unfortunately, this classification has not been widely accepted and the debates have continued. Paul David draws attention to some definition problems in Liebowitz–Margolis's approach. At the same time Liebowitz–Margolis state that in industries with increasing returns lock-in and path-dependency do not necessarily lead to market failure. So far none of the empirical examples have demonstrated an undeniable inferiority in the winning technology.

Thesis 1: There is a heated debate between authors dealing with network effects because of differing opinions regarding sub-optimality: they view normative and positive economics and also the issue of market failures (especially failures stemming from the level of information held by the actors) differently. This endless debate hinders the clarification of the concept and also the objective analysis of certain cases and market situations.

The terminology used by the literature concerning externalities is rather blurred, and there are important confusions regarding the use of increasing returns and natural monopolies as well. The inconsistent use of terminology can potentially lead to interventions which would not have been applied in the case of a clearly clarified theory (e.g. the Microsoft case). One

can find similar inconsistency in the case of related phenomena because of the imprecise use of the notion of network effects and network externalities.

Arthur (1990) names the network externalities as one source of increasing returns. On the contrary, mainstream economics studies the role of the returns in relation to the production function in the area of economies of scale. The above is especially important, because the positive feedback of network effects is often mixed with the phenomenon of natural monopoly. In chapter 3 I have shown several examples of such cases.

One of the examples is the QWERTY keyboard. Those studies that handle standards as natural monopolies are based on misconceptions (Liebowitz-Margolis 1990), because they are not sound enough. Through the QWERTY example one can see the importance of theoretical clarity. Those who regard winning standards and their sponsors as natural monopolies make several mistakes. On one hand, the notion of a natural monopoly relates to subadditivity (one feature of cost functions), and this assumes internal economies (Kiss 2009). In actual fact, a natural monopoly derives from production functions. On the contrary, the winning of a standard can be linked to external economies: users will increasingly choose the given standard as a result of positive feedback. On the other hand, the cases of QWERTY and video formats show that many producers use the standard and supply the market although there is only one standard remaining on the market. In this way, neither the case of QWERTY, nor the case of video formats can be referred to as a natural monopoly. Thirdly, using the term natural monopoly in relation to standards might cause confusion not only among scholars, but also among authorities. This might lead to situation in which standards and their sponsors are regulated similarly to natural monopolies. This might result in social losses in the case of *de facto* standards. In order to avoid this, one must consider the following: i) is it actually a network, ii) are there any network effects, iii) are there any economies of scale in the production process?

Thesis 2: In the literature, the case of a winning standard is often confused with a natural monopoly. This confusion might drive policy makers to regulate de facto standards and their sponsors in a similar way to natural monopolies resulting in potential social losses. While de facto standards stem from external economies, natural monopolies stem from internal economies, therefore regulation demands differing instruments in the different situations. To define these instruments we have to make a distinction between a monopoly situation (resulting from economies of scale), networks, and network industries based on network effects.

The basic unit of analysis in transaction cost economics is a transaction. “Transactions are the alienation and acquisition, between individuals, of the *rights* of future ownership of physical things, as determined by collective working rules of society.” Commons (1934:58). Williamson (1981) refers to transactions when products or services are transferred between two technologically separable areas, where one stage of activity ends and another stage begins. In my view a transaction is carried out, as I have showed in chapter 4, when the rights to use goods are transferred between two technologically separable areas. I think this definition will bring us closer to clarifying the role of transaction costs with regard to standardization.

By analyzing transactions in detail, I have been able to highlight two characteristics that have so far been neglected by other authors. I have shown that the occurrence of network effects is a feature of transactions. When an actor, not directly involved in the given transaction, benefits from the transaction, then there is a positive network effect related to the given transaction. The internalization of these benefits is crucial: if actors outside the transaction benefit from the transaction, then these gains should be made visible to everybody.

This is the reason why some transactions are standardized, while others are not. When there is no positive network effect in relation to a transaction, then there is no use in standardizing the transaction. In this case it does not matter to outsiders whether the transaction takes place or not. If there are no external benefits of the transaction, there is no use in standardizing it. At the same time, when there are strong network effects of a transaction, then there is an urgent need to standardize, because this internalizes the benefits of network effects for each actor.

By applying standards, the complexity of, and the risks involved in, transactions decrease; this simplifies transactions. Further, the parties make sure that each actor is fully aware of the following: what is exchanged, in what way the transaction is carried out, what rights and obligations are created, etc. In this way, each element of the transaction becomes specified for each party; therefore each actor enjoys the benefits.

During standardization, the parties participating in the transactions transfer the use of accumulated knowledge. Polányi (1966) divides knowledge into two types: codified knowledge and tacit knowledge. It is widely accepted that tacit knowledge should be articulated in order to be transferred. The articulation of tacit knowledge entails some degree of codification that ensures the transfer of knowledge. During standardization, this process is carried out the following way: the accumulated knowledge of the parties is codified and

shared with each other. This can happen within a formal standardization body (SDO), where hierarchical governance structures are used to transfer knowledge. People can access the codified knowledge via the formal standardization body. Another method of knowledge transfer is when the actors codify the knowledge themselves and people can buy it from them (market based governance structure). The mixture of the two extremes results in hybrid forms, which are more and more popular nowadays in standardization.

In the dissertation I have showed that TCE is an appropriate framework for modeling standardization. Williamson's Market-Hybrid-Hierarchy model can answer the questions raised in the introductory chapter. When the asset specificity is high and/or uncertainty is significant and/or the number of the standards is low, then it is worth standardizing within a hierarchy (e.g. within an approved formal body). If asset specificity was decreasing and the number of standards was increasing, it would be beneficial to use market-based mechanisms in order to lower transaction costs. When the number of standards is increasing, while the knowledge needed for the standardization is available from several sources, according to Williamson it is beneficial to move to the market-based governance structures. This can partly answer why the number of different types of cooperation between firms (such as consortia, fora, etc.) has increased.

Thesis 3: There is a transaction when the rights to use goods are transferred between two technologically separable areas. This definition makes it possible to analyze standardization by a transaction cost based approach; namely the Market-Hybrid-Hierarchy model by Williamson. This model clarifies what determines which coordination mechanism is used to evolve a standard. When the asset specificity is high and/or uncertainty is significant, standardization requires hierarchy (e.g. a formal committee), while low asset specificity calls for market mechanisms (de facto standards). In most cases hybrid forms (consortia, fora, alliances, etc) provide the framework for standardization.

I think for the theory of standardization, the application of the Williamson model contributes to resolving some of the current challenges. One of these challenges is the study of the relationships between states, public and private standard developing organizations. Another is the analysis of welfare effects of the *de facto* standards which are created by market mechanisms.

My approach provides arguments (supported by a theoretical model) for states, policy makers and authorities that standardization in private organizations should be supported in

certain situations. The standardization in these private organizations is dominated by market mechanisms, and this is the reason why these hybrid forms can standardize with lower transaction costs when asset specificity is moderate. Standardization as a transaction always requires specific assets, because the knowledge which is codified is always linked to one or more actors. The more actors have the same tacit knowledge, the lower the asset specificity is, although it can never be zero. As such, standardization based purely on the market or purely on hierarchy might result in higher transaction costs than in the case of hybrid forms.

The primary goal of authorities is to increase the wealth of society. Accordingly, one should not focus only on the benefits of standards, but should also consider the costs of standardization. In my view, standardization (similarly to all other transactions) has its own transaction costs. The Williamson model provides guidelines for the use of governance structures in order to minimize these transaction costs. If the ultimate goal is to maximize the wealth of society, then not only the benefits of standardization, but also the transaction costs should be considered. In certain cases, this means that hybrid forms should be preferred.

Based on the above reasoning, it is worth reconsidering the previously well-studied cases. As I mentioned earlier, there are many examples of standards dominating an industry that are said to be inferior as compared to other standards not being applied (e.g. keyboard layouts or video formats). Some authors argue that applying other standards could have increased the benefits to society. By using a TCE approach, not only the benefits, but also the transaction costs are considered in the analysis of the use of alternative standards. This implies that intervening in standardization could result in proportionally higher transaction costs than benefits. However, it is beyond the scope of my thesis to estimate the costs and benefits of these well-known cases.

Thesis 4: The transaction cost based approach provides further unpublished arguments for the evaluation of the role of regulators in standardization. The earlier papers focused on the benefits of standardization but regulators (aiming to maximize the wealth of society) should take into consideration the transaction costs of standardization. This implies that hybrid forms (consortia, fora, etc) should be preferred because they lower transaction costs more than market or hierarchical mechanisms.

Before 1st generation (1G) standards, mobile communication was a marginal industry with high uncertainty in telephone services and in the process of standardization as well. Only a few actors possessed the knowledge required for standardization, which meant that

standardization at that time required highly specific assets. Standardization in such a situation (high uncertainty, high asset specificity, infrequent standardization) requires hierarchy according to the TCE. This is exactly what we have noticed in each region analyzed. Standardization of mobile communication was carried out within a national framework.

1st generation standards were created in hierarchical structures, mostly within a national framework. The Japanese, Germans and Italians decided to have national standards and continued to use hierarchical structures in 1G standardization. In their decision making processes regarding 1G standards they did not consider the question of compatibility (the benefits deriving from compatible standards). In terms of the lack of market based incentives applied in the standardization of 1G standards the disadvantages of incompatibility are not recognized. In contrast, regions which tried to exploit the opportunities of the new industry applied market structures in standardization.

When the opportunities of mobile communication were recognized, FCC tried to centralize the standardization of AMPS; however, AT&T and Motorola were invited to the standardization in order to create an open standard. This openness lured foreign equipment manufacturers into the US mobile market to make products compatible to AMPS. This was the main reason for the domination of AMPS among 1G standards. This mixture of market and hierarchical mechanisms (namely the invitation of firms and manufacturers, and centralized decision-making) speeded up standardization and made the standard more successful. This success was partly based on the market-based incentives of the participants who did not allow technological aspects to dominate economic ones. During the 1G standardization it became obvious that demand was much higher than it had been before. This fact lowered uncertainty, while more and more actors gained knowledge which was necessary for standardization. These changes caused the emergence of hybrid forms during the 1G standardization.

Similar processes could be observed in the Nordic countries. The specification of the elements of the NMT system was carried out in subgroups in which international companies, national service providers and research groups from several authorities participated. The involvement of manufacturers and service providers was a proper step in order to bring some market mechanism into the committee-based hierarchical standardization. This step allowed manufacturers to keep up with the specifications immediately and to start development of equipment. The competition appeared in the patent creation of firms involved in standardization. NMT also enjoyed success, based on hybrid standardization.

These experiences were applied in the 2G standardization. In Europe it was a widely established fact that a single standard was necessary in order to gain the benefits of network effects. This is the reason why GSM became the most successful 2G standard. Similarly to NMT, GSM was created by committee-based mechanisms which were combined with market mechanisms as well. The early successes made GSM so popular that the participants of mobile market signed agreements (e.g. MoU) aiming at better coordination of further developments.

These agreements were sometimes embodied in organizations such as consortia. The further development of mobile standards was carried out in consortia or fora. These organizations have many participants so the decision-making needs hierarchical coordination, but the relations between firms are mainly based on voluntary cooperation.

Thesis 5: There are strong network effects in mobile communication services thus the role of standardization is significant in this market because standards reduce opportunism. Standards created by purely hierarchic structures cannot be successful in the mobile market: actors are not interested in quick and wide diffusion because of the lack of market incentives that restricts the benefits arising from increasing network effects. The costs of coordinating mobile market actors in the standardization process would be too high if it were governed by pure market structures. The uncertainty inherent in the industry has been decreasing and an increasing number of actors have acquired the knowledge (necessary for the standardization); thus hybrid forms in mobile standardization are spreading: there is a continuous shift from hierarchy to market.

Further research fields

The contribution of the transaction cost-based approach of standardization to theory is twofold: some questions can be answered with a strict theoretical base and many other questions can be raised. It can answer what determines which governance structure should be used in a certain standardization. Further questions can be linked to the role of the state.

It is quite obvious that the role of the international standard development organizations has changed in the last 30 years. Nowadays standardization is mainly carried out within industrial consortia and alliances of firms. This means that SDOs only need to approve the standard of the consortium instead of creating a brand new one. If this tendency continues, it

will be worth rethinking the primary task of SDOs, and change this from “creating standards” to “approving standards”. The economic effects of such a change in tasks should be analyzed by further theoretical and empirical research.

Another research field is the relationship between public and private standard development organizations. If it is reasonable that the spread of consortia continues, states should promote its foundation and operation not only on a national but also on an international level. These organizations play a crucial role in the international coordination of knowledge. Therefore, it should be analyzed whether states have any means to promote the foundation of consortia. Although some authors anticipate this, it is far from obvious that states can help in any way in the inter-firm cooperation of an industry.

As I have shown in the dissertation, patents play a crucial role in standardization. In the standard creation process and also in the application phase a patent owner can behave opportunistically because its knowledge is a specific asset. When the patent owner does not permit other actors to use its patents for standardization, or even for production, then buying-up emerges as a solution. Integrating a firm with many patents could provide significant market power for the integrator. This fusion calls for some intervention from the competition authorities, but they should intervene only if the classical criteria are fulfilled. Therefore, it is quite plausible that they do not intervene, because in the viewpoint of the earlier approaches it is not necessary. The research should be expanded in this direction in order to contribute to theory and to draw some conclusions from empirical analysis.

The points discussed above prove that the research is not finished; on the contrary, only the basis for further steps has been created.

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Notes