Developing an explanatory model for the firm investments in submarine optic telecommunication cables: A case study of the investment behavior to the Netherlands and Spain

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Abstract

Interconnection with the internet is important for the business climate in a country. Therefore it is relevant for governments to understand the factors that influence the investments in submarine communication cables. However there is no singly comprehensive theory that explains the investments in this industry. Therefore the research question in this paper is: What factors explain the investment decisions in submarine communication cables? A pluralistic research framework is create based on three theories; resource-based view, transaction cost economics and transaction cost regulation. Analysis with help of this framework results in a list of factors that can explain the investments in submarine cables. These factors are used in a comparative qualitative case study between the Netherlands and Spain. In this way a first step is made to develop and validate an explanatory model for firm investment behaviour in submarine communication cables. Outcome of the analysis show that content and application providers and telecom operators have different investment strategies. Content and application providers invest in diverse connections between their datacentres as part of a vertical integration. Telecom providers connect regions which have high data transit demands.

Keywords: Submarine optic fibers, investments, explanatory model, the Netherlands, Spain

1. Introduction

"The world continues to consume ever increasing amounts of data, with bandwidth demand project to almost double every two years for the foreseeable future. This demand – largely driven by a continued explosion of mobile device usage – provided numerous opportunities for the submarine fibre industry" (Submarine Telecoms Forum, 2018, p. 17). Companies in the submarine fibre industry invest in the submarine optic fibres that allow transit of data between all the countries in the world. For countries it is important to be well-interconnected in this network. "ICT continues to have strong impacts on the performance (of countries)"(OECD, 2003, p. 9). The OECD also states that: "businesses, governments, consumers and key infrastructures increasingly rely on the use of information

networks, which are often interconnected at the global level" (OECD, 2003, p. 91). Therefore it is important for countries to be interconnected in the global infrastructure of the internet through submarine optic fibres. However there is no single comprehensive theory available that can explain the allocation of submarine communication cables. This paper explains how an explanatory model was created to explain firm behaviour of the investments in submarine communication cables.

The research question of the paper is: **What factors explain the investment decisions in submarine communication cables?**

2.1 How to create a research framework?

In order to be able to explain the investments in submarine communication cables a framework has to be developed. This research framework consists of different theories. A framework is ´ "…the most general forms of theoretical analysis" (Ostrom, 2011, pag. 8) As start of the development of the research framework the framework of de Vaan (2012) is taken. The framework is developed to understand the investment behavior the small field upstream gas industry in the Netherlands. It is a logical start to begin with this framework because it also analyses investments in a network industry with government interference. In the framework the Resource-based view (Barney, 1991), Transaction cost theory (Williamson, 1979) and the Five force's theory of Porter (Porter, 1979) are combined. In this way the investment behavior of investors can be analyzed based on multiple theories. The fundamental assumption here is theoretic pluralism. According to Groenewegen and Vromen (1996): "formulating an all-embracing, all condition theory is infeasible … If some theories can be assumed to be applicable under different conditions, they can be said to be complementary. In combination these theories then can be said to give us a riches understanding of some set op phenomena". The basic assumption in this study is that the used theories can be used next to each other. In this way different perspectives on the same problem can be obtained. This will enrich the understanding of the research problem. The relevancy of every theory that is used in the framework is identified with help of interviews with different stakeholders. Factors that explain the investment behaviour are first extracted from the interviews. Then, the selection of the theories is conducted based on these relevant factors.

2.2 Interviews

The interviews were conducted with investors in submarine communication cables to the Netherlands and Spain and with other stakeholders such as government bodies of both countries and interest groups of the submarine communication industry. Interviewees from the Netherlands and Spain were chosen because the framework is validated with a comparative study between the Netherlands and Spain. The list of the interviewees can be found in Appendix A. The interview methodology is semi-structured. In this way the researcher can understand "how the interviewee frames and understands issues and events—that is, what the interviewee views as important in explaining and understanding events,

patterns, and forms of behaviour" (Bryman, 2012, p. 471). The outcome of the interviews is a list with different issues which, according to the interviewees, have an effect on the investment decisions. The factors can be found in Appendix B. This list of factors gave direction to the choice of theories.

2.3 Choice of the theories and the creation of the framework

First the theories that were used in the research of de Vaan (2012) were contrasted with the factors obtained from the interviews. Could the resource-based view, transaction cost theory and Porter's five forces theory be used in the framework to explain the investments in submarine communication cables? To give answer to this question the issues and assumptions of the theories were discussed. Porter's five forces theory was rejected. Underlying assumptions of this theory are; resources are divided homogeneous over the firms, the structure of the market determines the investment behaviour and methodological holism. (Barney, 1991; Porter, 1979). These assumptions are not in accordance with the characteristics of submarine communication industry, which is characterized by network effects and government interference. Therefore Porter's five forces theory was not used in the framework.

The resource-based view was accepted since its assumptions are in line with submarine communication industry. Assumptions of the resource-based view are; resource heterogeneity, immobility of resources and methodological individualism. The theory can explain the behaviour of companies based on the individual resources and capabilities of companies (Barney, 1991). The interviews showed the large differences between the network assets of companies.

The transaction cost economic theory was also accepted. The theory also assumes methodological individualism and takes the transaction as unit of analysis. (Williamson, 1998). Transaction cost theory can be used to analyse the investment behaviour of investors by focussing on the contracts. Besides the resource based view and the transaction cost theory an extra framework was introduced. The reason is that both the resource-based view and transaction cost theory cannot explain the influence of governments on the investment behaviour. However interviewees indicated that this was the case. The transaction cost regulation framework is based on transaction cost theory (Spiller, 2013). This is the reason that it has the same underlying assumptions. The transaction cost regulation theory can explain the influence of regulations on the investment behaviour of firms. The three theories together form the research framework which is used to explain the investments behaviour of firms to the Netherlands. In appendix C the research framework is displayed. The resource based view is the basis to understand the business models of the individual investors by analysing their resources, the transaction cost theory analyses the contracts between telecom carriers and content and application providers. Transaction cost regulation explains the influence of the Dutch regulations on the investment decisions of investors.

2.4 From the analysis to an explanatory model for the qualitative comparison of countries

In the end of all three analysis chapter the factors that influence the investments to a country are formulated. These factors are based on the theories and the application of the theory. These factors are merged and double factors are removed. The list of factors forms an explanatory model for investments to a country. This model was applied to make a qualitative comparison between the Netherlands and Spain. This comparative qualitative study is used as a first validation of the framework.

3. Most important outcomes of the analyses

3.1 Resource-based view

The analysis of the resource-based view showed that the business cases of telecom carriers and content and application providers are different. Telecom operators are usually already for a longer time in the industry. They have extensive global networks which they use to sell transit services. Data transit is the service of creating a data connection from one place to another. Most telecom operators are involved in large consortia with over ten participants. These consortia have built submarine cables which connect the economic centers of the world. Since the crash of the 'Dotcom Bubble' the prices of data transit are low due to the high availability of capacity. Therefore the current investment of telecom carriers is mostly focused on upgrades of current cables. Although most of the telecom providers have similar business case their investment strategy can be different due to the differences in network assets they have. For example Telxius, a telecom operator, has already large network in South America. Therefore their strategy will focus on adding value with these South American connections. Verizon has a very dense global network. Their future investments will be influenced by these assets.

The analyzed large content and application providers, which are Facebook and Microsoft have datacenters all around the world. Since their business model is focused on their platform product their investment strategy is different. Instead of investing in the connection between economic centers they invest in a low risk diverse transit infrastructure between their data centers. These datacenters do not necessarily locate in an economic center. The requirements for these cables depend on the services they want to sell now and in the future. Content and application providers tend to invest in small consortia with at least one operator to 'run' the cable. Parties like Facebook and Microsoft can do this because they have the financial resources (The Economist, 2017). In a small consortium they can keep control over their supply chain. Another advantage of a small consortium is that they have less complex organization structures which allow more technical control.

3.2 Transaction cost economics

The analysis with the transaction cost theory showed that short term transit contracts and some long term contracts are less attractive than co-buy and co-building of a new submarine communication cables in a small consortium for large CAPs. Contracting can

lead to opportunistic behavior of the telecom operators. There is a risk for underinvestment in the infrastructure, the extraction of quasi rents by the telecom operator and corresponding technological uncertainty. This underinvestment and technological uncertainty can limit the possibilities for new platform products. This could lead less competitive products, which could lower the amount of costumers and profit. Large content and application providers can mitigate these risks by co-building or co-investing in a submarine cable with a few other investors. In this way they have more control about the technology and the long term costs for data transit. New products can then be designed with the certainty of available data capacity for a fixed price.

3.3 Transaction cost regulation

The case study of the Netherlands with the transaction cost regulation framework created insights in the possible effects of government regulations of the investments in submarine communication cables. In the North Sea in the Netherlands the shore of Amsterdam there is increasingly used for the generation of energy. This might lead to 'governmental opportunism', which can create lower investments. When investors make large investments can get 'locked-in'. Governments can change regulations which disadvantage the locked-in investor. Possible cases of governmental opportunism were identified in the analysis of the Netherlands. Due to the energy transition to sustainable energy a large number of windfarms at sea are planned for construction. Energy infrastructures have priority of telecom cables since they are regarded of 'national interest' (Waterwet, 2009). In this way future cables might be forced to take more risky routes. Furthermore the maintenance zones around cables are reduced to below the international standard of 750m on both sides if there is scarcity of space (Ministerie van Infrastructuur en Milieu, Ministerie van Economische Zaken, 2015). According to Deutsche Telekom and British Telecom this lead to the situation where some cables cannot be repaired anymore in case of a cable cut. (Energieprojecten, 2015). However the reduction of the maintenance zone can also provide an incentive to submarine communication owners to be more compact.

Table 1 – Factors which explain the investments in submarine optic fibers to a country

Name of the criterion
Factors that cannot be directly influenced by a government
Price level of data transit
Number cables owned by CAPs
Non-used supply
Digital economic centers
Number of CDNs of CAPs
Increase in diversity of existing networks
Quality of terrestrial backhaul
Number of landing cables
Number of cables that were constructed before 2003
Convenience of the geographical location of the country
Factors that can be directly influenced by a government
Liberalization of the telecom market
Risk of cable failures
(Regulated) space for future cables
Degree of cable protection
Guaranteed maintenance zone
Government investment

4. Factors that can explain the investments in submarine cables to a country

The factors that were identified to have an impact on the investment behavior of investors in submarine communication cables were merged and listed. This list of factors was used used in qualitative comparative study between the Netherlands and Spain in regard to the submarine cable investments. Table 1 shows the list of factors that were identified. The list of factors is divided in factors that cannot (or hardly) be influenced by the government and factors that can directly be influenced by the government. In this way policy options for governments can be extracted from the comparative study.

5. Case study: a qualitative comparison of submarine optic investments to the Netherlands and Spain

The case study in Appendix D shows the comparison between the Netherland and Spain based on the factors from table 1. There are a substantial amount of differences between the investment behaviour to these countries. In the Netherlands there are three datacentres of large content and application providers and in Spain there are none. Nonetheless Facebook and Microsoft invested in the MAREA cable towards Bilbao in the North of Spain (Microsoft, 2017). This can be explained by a number of differences. First of all there are already a large number of transatlantic cables that connect the United States and the North of Europe. Therefore a new cable on this route cannot increase the diversity of the global submarine infrastructure. Content and application providers want to invest in connections between the datacentres in the United States and Europe that add diversity. For example MAREA increased the diversity of their transatlantic transit infrastructure. Therefore the geographical location of Spain was an advantage.

The location of Spain with shores with the Mediterranean makes it also an attractive landing site for cables to the middle-east, Africa and South America. Secondly the risks of cables failures are lower in Spain due to the deeper seas and the higher availability of space (Violari, 2017). This is why Spain an attractive cable landing spot. In the Netherlands the sea is shallower. High intensity fishing and shipping have also a negative effect on the cable reliability in the North-sea (Booi. de, 2017) (Dinkelman, 2017). According to Telecom operators is the fact the Netherlands does not guarantee the 750m maintenance zone around submarine cables can have a negative effect on the investments (Energieprojecten, 2015). Content and application operators can access their data centres easily through the high quality terrestrial trans-European backhaul network and therefore will prefer cable landing locations with low risks for cable failure. Telecom carriers will have no incentive to invest in new cables to the Netherlands and Spain. In both the North-sea and transatlantic route there is a large share of non-used supply (Booi. de, 2017) Therefore there is currently no reason to invest in new cables to connect the Netherlands and Spain with other economic centres. For now, telecom carriers are likely to prefer upgrading current submarine cable

systems since this is more cost effective. However nearly all submarine cables to the Netherlands were constructed before 2003. This means that in the future existing cables might be replaced with new ones. About half of the cables that land in Spain were constructed before 2003.

7. Conclusion

The research question of the paper is: **What factors explain the investment decisions in submarine communication cables?** First a research framework was constructed which consists of the resource-based view, transaction cost economics and the transaction cost regulations framework. Table 1 shows the list of factors that were identified to have an effect on the investment behaviour of investors to a country. The identified factors were used in a comparative case study between Spain and the Netherlands. An overview of the outcome of the case study is displayed in appendix D.

6. Policy Implications

The set of factors which explain investment behavior and the analysis resulted in three policy implications for the government of the Netherlands. The first policy option is to consider to restore the minimum maintenance zone around telecom cables from 500m to 750m on both sides. Table 1 shows that the amount of free space has an effect on the investments. However the effect of this policy can have two effects. On one hand the increase in maintenance zone could increase the investments to the Netherlands. However a disadvantage is that the sea would be less efficiently. The reduction of the minimum maintenance zone might also be a good incentive for submarine communication owners to work more compact, which could result in more efficient use of space. The second policy option is to force different stakeholders of the sea to cooperate. An example of such cooperation is the construction of a cable corridor through new windfarms at sea. This could protect submarine cables from fishing and shipping activity. Benefits of these policies are that it could lead to more efficient spatial planning. However there is a risk that forced cooperation will lead to more conflicts and less efficient permit procedures. The third policy option is to improve the business climate for datacenters in the Netherlands. Datacenters can increase the data transit demand. Ultimately this can 'pull' interconnectivity infrastructure to the Netherlands. This study did not identify policy options to improve the business climate of datacenters.

8. Discussion

During this research some knowledge gaps were identified. First of all it became clear that multi-sided platform market theory might increase the understanding of the investment behavior of platform companies. Future studies can include this theory to use the platform perspective to explain the investments. Secondly the factors that were identified in this study can be applied to more countries. Only then can the explanatory model be improved and further validated. Thirdly, more detailed information is required about the availability of room for new cables in the North Sea.

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Appendix A

Company name:	Cables that land in Netherlands:	Cables that land in Spain:	Type:	Contact:
British Telecom	*Farland North,* *TAT14* *UK-NL 14*		ISP (Former Incumbant)	*G. Rea*
KPN	*TAT14* *UK-NL 14*		ISP (Former Incumbant)	*M. van der Paard* *P. Knol* *R. Dinkelman*
Telefonica/ Telxius	*TAT14*	*Pencan-6* *Pencan-7* *Pencan-8* *Pencan-9* *Columbus III* *Estepona-Tetouan* *PENBAL-5* *BARSAV* *MAREA*	ISP (Former Incumbant)	*A. Moreno Rebollo* *J.A. García Cabrera*
Verizon	*TAT14* *Ulysses 2*	*Columbus III*	ISP	*P. Booi*
Microsoft		*MAREA*	CPA	*J. de Groot* *D. Crowley*
Facebook		*MAREA*	CPA	*M. Violari*
Relined	*COBRAcable*		Public Fibre Carrier	*R. Weijers*

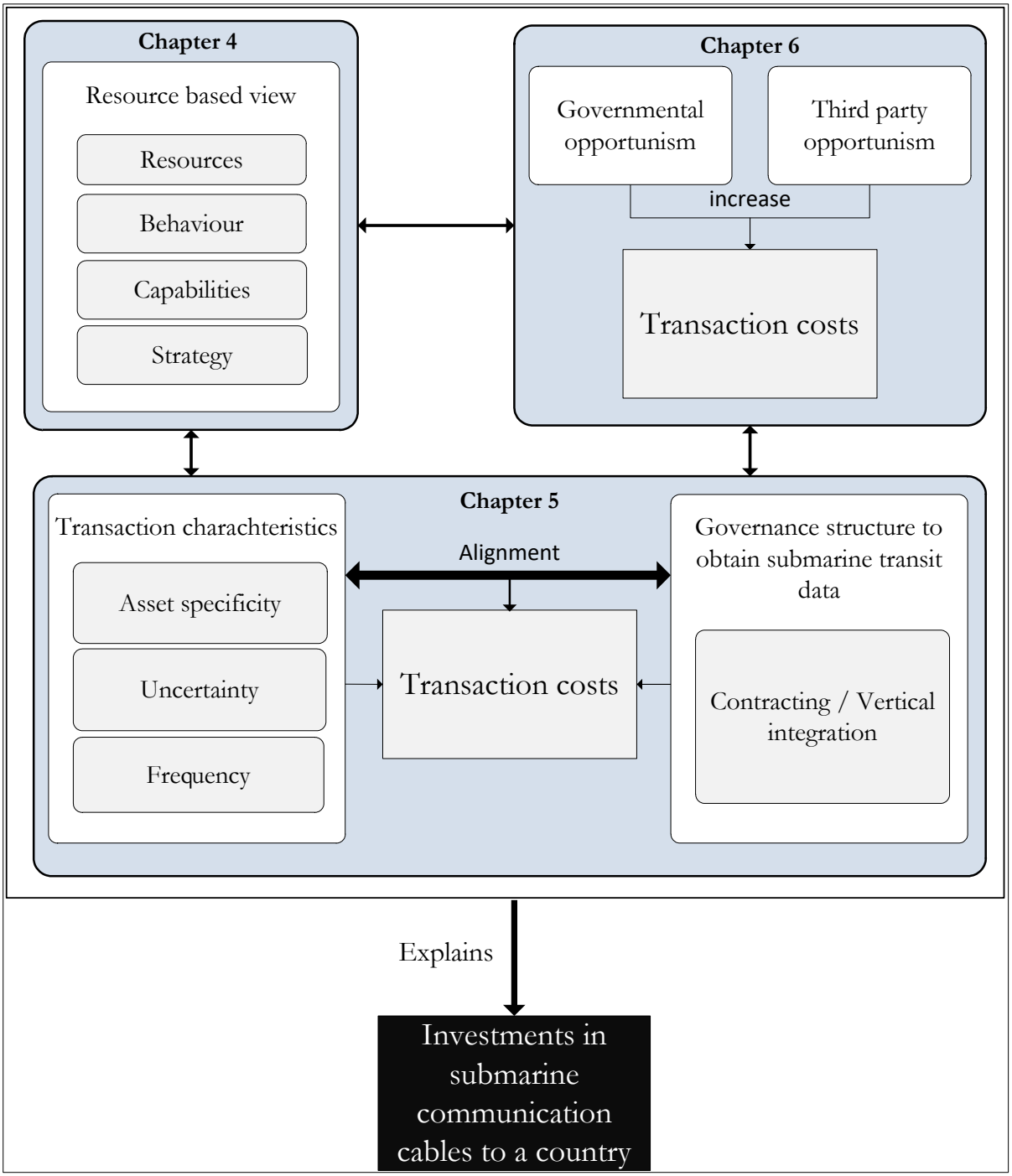
Name of organization:	Type of institution:	Contact:
European Subsea Cables Association (ESCA) / Palagian	*Interest group / Consultant*	*T. Fisk*
Fibre Carrier Association NL|DC	*Interest group*	*R. van Fucht*
Saba Statia Cable System B.V	*Government of the Netherlands*	*W. de Haan*
Ministry of Economic Affairs and Climate Policy	*Government of the Netherlands*	*M. Botman* *J. Vermeulen*
Rijkswaterstaat	*Government of the Netherlands*	*R. Duijts*

Appendix B

Verizon	Telefónica/Telxius
Risk of cable failure on a route	Estimations of data demand in an area
The location of wind farms at sea	Availability of investment partners
Latency of a route	CAPEX funds of the company
Number of datacenters in a country	Agreement with a consortium
Available space in the sea for new cables	Latency of a cable
Easiness of maintenance for cables	Availability of backhaul connections close to the shore
ESCA/ ICPC/ NASCA recommendation compliance of a country	Number of datacenters in a region
Geographical location	Reliable energy supply
Existing backhaul network	Shore characteristics
Influence by politics (e.g. Effects Brexit)	Shape of the ocean floor on a route
Access of the market	Risks due to environmental factors (hurricane/tsunami)
Amount of economic activity in an area	Permit application procedure in a country
Shore characteristics	Capacity of a new submarine fiber
Fishing activity	Shared strategy of Telefónica and Telxius
Availability of backhaul connections close to the shore	Developments in the digital landscape
Number of inhabitants of a country	Co-opetition' with other market players
Number of exiting cables on the same route	Environmental protection legislation
Geological activity in an area	Internal regulations
Shipping activity in an area	
Business strategy of Verizon	
Existing data capacity on a route	
Regionalization of the internet	
Repair time of a cable in an area	
Diversity strategy, make network resilient	
British Telecom	**Microsoft**
Current network assets of British Telecom	Location of the own datacenters
Economic and financial importance of a region	Current submarine cables of Microsoft
Risks of a cable cut on a route	Reliability of the connections between the databases
Shore characteristics	Estimation of future data capacity requirements
Backhaul connections in the region	Location of landing station
Costs to maintain the cables	Availability of partners for investments
ESCA/ ICPC/ NASCA recommendation compliance of a country	Low cost high capacity in the future
Wind farms at sea which are a barrier	Geography of the country
Total costs of a new submarine system	Interconnectivity of a country in the global network
Length of the route	Latency on a route
Latency on a route	Shipping activity on a route
Easiness to reach the shore	Seabed properties
Capacity demand in a region	History of uptime of existing cables on a route
Tax breaks regulations	Existing submarine connections to a region
Existing infrastructure of other owners on a route	Environmental regulations
Strategy of British Telecom	
Geographical location of a country	

Facebook	KPN
Future data demand of the Facebook products	Estimation of the demand in international data transit
Location of the current cables of Facebook	Latency on a route
Location and backhaul connections to Facebook datacenters	Geographical location of a country
Current capacity between data centers	Risks of cable failure
Availability of terrestrial backhaul close to the shore	Fishing activity
Seabed properties	Shipping activity
Fishing activity	Availability of a consortium
Existing cables on a route	Location of windfarms at sea
Risk for cable failure on a route	
Scalability of cable systems	
Availability of carrier that can operate a Facebook cable	
Existing commercial relationships telecom operators	
Relined	
Governmental regulations	
Investment decisions regarding submarine electricity cables	
Data demand between Amsterdam and Denmark	
Capacity requirements for control systems for windfarms at sea	
Latency on a route	
Price to add an optic fiber to a submarine electricity cable	
Growing data transit demand	
Existing backhaul networks	

Appendix C


Chapter 4
Resource based view
Resources
Behaviour
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Strategy
Chapter 6
Governmental opportunism
Third party opportunism
increase
Transaction costs
Chapter 5
Transaction charachteristics
Asset specificity
Uncertainty
Frequency
Alignment
Transaction costs
Governance structure to obtain submarine transit data
Contracting / Vertical integration
Explains
Investments in submarine communication cables to a country

Appendix D

Name of the factor	The Netherlands	Spain
Factor that cannot be influenced by governments		
Price level of data transit	Low prices	Low prices
Number cables owned by CAPs	No cables of CAPs land in the Netherlands	There is one cable of CAPs, which is the MAREA cable
Non-used supply	There is a lot of non-used supply both in the North-Sea and Transatlantic	There are fewer connections between the south of Europe and the Americas
Digital economic centers	High demand for data transit	There is a medium demand in Spain
Number of CDNs of CAPs	Three CAPs invested lately in datacentres in the Netherlands	No datacentres are located in Spain
Increase in diversity of existing networks	Low, there are already a lot of cables in the North of Europe	High, there are few cables between the American continent and the South of Europe
Quality of terrestrial backhaul	High quality fine-meshed network	Medium quality network, which is a bit more coarse
Number of landing cables	There are seven cable landing locations	There are eight cable landing locations
Number of cables that were constructed before 2003	Eleven cables were constructed before 2003	Eight cables were constructed before 2003
Geographical location	The country is 'hidden' behind Great Britain. Therefore it is less attractive for direct transatlantic cables. However the Netherlands is useful as 'gate' to the mainland of Europe	The location of Spain is good for cables from Africa, middle-East and transatlantic cables
Factors that can be influenced by governments		
Liberalization of the telecom market	The market is liberalized	The market is liberalized
Risk of cable failures	Due to the shallow waters and intensive use of the sea there is a high risk of cable failure for cables to the Netherlands	There is a relatively low risk for cable failure to the Netherlands because of the deep waters and large waters
(Regulated) space for future cables	Because of the construction of windfarms at sea, sand mining and protected areas there is little space for new cables	Due to the deep sea and size of the country there is enough space for future cables
Degree of cable protection	Cables are protected	Cables are protected
Guaranteed maintenance zone	The maintenance zone around submarine cables was reduced from 750m to 500m in some cases	--

Government investment	There is low government investment. The only public cable to the main land of the Netherlands is the COBRA cable of Relined, a public enterprise	There are ten cables that are regulated by the CNMC to the Islands. Spain does not invest in new public cables