

**Summary:**

# The Norwegian Substitution Study for Electronic Communication

TØI report 1823/2021

Authors: Rasmus Bøgh Holmen, Christian S. Mjosund, Harald Wium Lie, Mikael Christiansson and Stefan Flügel  
Oslo 2021, 99 pages, Norwegian language

*In this study, we map substitution patterns between services for electronic communication over sectors in case of service outage. Furthermore, we map each sector's dependence of own and others usage of electronic communication. Our study builds on a comprehensive information collection, inter alia involving a web survey to all Norwegian firm branches. We find that fixed broadband constitutes the most important service for electronic communication, both in case of personal and non-personal communication. For both communication goods, we find that mobile broadband is the most important service for substitution during service outages in electronic communication. Our information collection also reveal that firms and households hold high growth expectations across sectors of the economy in the coming years.*

## Background

In this study, we map substitution patterns between means of electronic communication over sectors and communication goods. Furthermore, we investigate how patterns of usage and dependence of electronic communication vary across sectors, and the associated ripple effects. In connection to our study, we have conducted a comprehensive information collection to shed light on these topics, including a web survey, interviews, quantitative statistical analyses and literature surveys.

The objective of our study is to improve the parametric quality in the Norwegian Communications Authority's (Nkom) model for estimation of economic impacts of network outages, 'Network Outage COMunication model', abbreviated the 'NOCOM'-model. This model has been developed by the Institute of Transport Economics and Analysys Mason on behalf of the agency during earlier assignments (see Holmen et al. 2018) The study was carried out in the period from September 2020 to February 2021.

In our mapping, we distinguish between two basic goods of electronic communication – personal and non-personal communication. Personal communication comprises direct communication between two or a limited amount of people through sound, pictures, video or text. Non-personal communication includes electronic communication beyond one-way communication and personal communication. It comprises usage of internet or intranet through downloading and uploading of data to other purposes than personal communication, such as surfing and usage of online programs, cloud solution, usage of bank and legitimation apps (e.g. Bank ID), GPS navigation services, payment solutions, alarms and more.

## Information Collection

The pre-existing knowledge foundation for the topics focused upon in this study is both fragmented and incomplete. This is particularly the case for substitution between electronic communication services under network outages. It also largely applies for use and dependence of electronic communication services and the associated ripple effects.

Accordingly, we have found it expedient to carry out a comprehensive information collection in our study. A questionnaire directed towards all active firm branches in Norway has constituted the most important and extensive part of this collection. In principle, it covers all parts of the business sector, the public sector and the voluntary sector. To provide improved information basis for households as well, we have interviewed nine respondents throughout different municipalities in Norway, which during recent years have been object to substantial service outages in electronic communication. These informants have answered on behalf of six different age groups. In addition, we have conducted ten interviews with respondents from the sector for emergency and preparedness.

Altogether, our primary information collection contains 3,910 answers, distributed over the business sector, the public sector, the household sector and the voluntary sector with 32 underlying subsectors. The collection involving firm branches covers 3,856 respondents, which each represents a firm branch and combined employ 198,369 full-time equivalents. This corresponds to 1.9 percent of active Norwegian firm branches (with a least one employee) and 8.1 percent of total employment. The nine municipalities with interviewed informants represented 58,589 inhabitants in 2019. This corresponds to 2.5 percent of the municipalities and 1.1 percent of the population in Norway.

Beyond the web survey and the interviews, we have addressed the topics of this study by literature reviews and statistical analyses. The literature reviews provide overviews over central studies on a field and important develop patterns not addressed in other parts of our study. In the statistical analyses, we investigate the topics of our study based on available quantitative information. Important sources include national statistics from Statistics Norway and international statistics from '*Analysys Mason Data Hub*'. Admittedly, the scope and the magnitude of this project have involved certain restrictions on how far we have been able to go in our second-hand information collection. Nonetheless, they have served as useful references to our first-hand information collection.

## **Results**

In the following, we present our main findings for the study's three main themes - usage of and dependence on electronic communication, substitution between services for electronic communication and ripple effects associated with electronic communication.

### **Usage of and Dependence on Electronic Communication**

All parts of the Norwegian economy spend considerable time on electronic communication every day. For personal communication, the daily time spent per person varies from one hour to four and a half hours across sub-sectors. For non-personal communication, the daily time use per person varies from one hour and a quarter to five hours. In many instances, high consumption in a sector will reflect high dependence of electronic communication. Combined, telecommunication services account for 1.2 percent of total intermediate input either applied in the Norwegian economy or exported abroad.

Producers of infrastructure services and business-to-business services tend to involve the highest consumption of telecommunication services, while services suppliers directed towards households and the public sector, as well as the primary industries, tend to involve the lowest consumption.

There are also examples of sub-sectors with low consumption, where electronic communication is still critical for production, including ICT-dependent transportation and

the electricity industry. Consumption of some services may be more expensive for small units due to absence of scale advantages, as well as for businesses operating at remote locations where electronic communication is less accessible and more expensive.

Our respondents consider wired broadband as the most important electronic communication service for personal communication, followed by voice, broadband and SMS over commercial mobile networks, respectively. Broadband over the wired network also constitutes the most important service for non-personal communication, closely followed by broadband over commercial mobile networks.

The usage of electronic communication is dominated by conventional services such as voice, SMS and data over commercial mobile and the wired network. Yet, 8.9 and 7.2 percent of our respondents report that they apply other services for personal and non-personal communication respectively, where among services over open radio network are the most common service for both communication goods. The national emergency network and other non-conventional communication services are particularly important for the emergency and preparedness sector.

While the use of voice and SMS over mobile phones and broadband with fixed connections were on the rise around the turn of the millennium, mobile internet services have been subject to substantial growth in recent years. The use of cloud services is becoming more widespread, especially in high-income countries and large companies.

Weighted by size, our respondents expect relatively high annual growth rates for personal and non-personal communication of 4.2 and 2.9 percent respectively. Furthermore, they report that their use of electronic communication has increased by 45 percent for personal communication and 16.1 percent for non-personal communication, as a response to the corona pandemic. As we have not made any attempt to weight the sub-sectors of the economy by size, these growth rates will not be fully representative of the entire Norwegian economy. Consistent high growth figures in most parts of the economy nevertheless witness of strong growth in the usage of electronic communication during the pandemic. Our primary information collection also expresses expectation of strong growth in usage of electronic communication in the years to come.

## **Substitution between Electronic Communication Services**

The previous knowledge base for assessing substitution patterns between electronic communication services in the event of a network outage has been rather limited, especially in a Norwegian context. The scientific literature on substitution between electronic communication services primarily focuses on responses to price changes and to a certain extent supplier and technology change, but not network outages. The substitution between electronic communication services depends on how the demand for one service responds to the loss of another, as well as the prevailing distribution of market shares over services. Between 2009 and 2019, the marked shares (measured as revenue shares) for voice in the wired and commercial mobile networks in Norway fell by 13.8 and 6.7 percent annually. The market share for SMS and MMS services fell annually by 11.7 percent over the same period. Much of the declines in market shares for these services are obviously related to the transition towards OTT-services,<sup>3</sup> in addition to the transition from wired to mobile services. Also in period from 2009 to 2019, the market shares of mobile and wired data

---

<sup>3</sup> OTT services is an abbreviation for over-the-top services and inter alia include Facebook Messenger, Skype, Teams, Whatsapp and Zoom.

transmission in Norway increased by 10.1 and 4.4 percent annually, respectively. Similar development patterns can be seen in other European countries.

Today, wired broadband constitutes the service with highest market shares (based on our respondents subjective assessment of utility contribution) for personal and non-personal communication of 25.2 and 42.9 percent respectively, provide the composition of our sample. For personal communication, voice, broadband and SMS over the commercial mobile networks and voice over the wired network follows with market shares of 22, 20.2 and 14.8 and 6.8 percent respectively.

For non-personal communication, mobile broadband occupies a clear second place with a market share of 35.1 percent, followed by SMS-based services<sup>4</sup> over the commercial mobile networks with a market share of 18.6 percent. Services related to emergency networks and other electronic communication services have low market shares for most industries. Yet, they are important for the emergency and preparedness industries and some industries within provision of public, energy and infrastructure services.

If we weight all electronic communication services according to their market shares, we find that 67.2 percent of the personal communication will be replaced in case of a complete outage in a service. During an outage, mobile broadband and wired broadband are the most important services for replacing other electronic communications services with weighted market shares for substitution of 15.6 and 14.8 percent, respectively. Thereafter follows voice and SMS over commercial mobile networks and voice over the wired network with weighted market shares of 13.1, 10.4 and 5.1 percent, respectively. Services over the emergency network and other electronic communication services hold weighted market shares for personal communication of 3.9 and 4.3 percent respectively, but play an important role in replacing each other.

If we by the same token weight electronic communication services for non-personal communication according to their market shares, 53.3 percent of the communication will be replaced in case of an outage. Thus, the substitution is weaker for non-personal than for personal communication services, which probably relates to fewer available substitutes. Again, mobile broadband constitutes the most important service for substitution with a weighted market share of 20.7 percent, closely followed by wired broadband, which holds a market share of 18 percent. Furthermore, SMS over commercial mobile network holds a weighted market share of 11.9 percent for non-personal communication and is relatively hard to substitute. SMS over the emergency network and other electronic communications services hold weighted market shares for substitution of 0.7 and 1.9 percent respectively, but constitutes close substitutes.

## **Ripple Effects from Service Outages in Electronic Communication**

In our study, we have mapped the ripple effects of electronic communication outages beyond the direct effects in the markets for telecommunications. The literature on economic impacts of outcomes in electronic communication is relatively thin. Some consultant reports and research articles discuss various economic consequences of loss of service, while others go further and make rough estimates of the overall economic costs. The magnitude of the supplies to – and to a certain extent from – the telecommunication

---

<sup>4</sup> Non-personal communication over SMS includes usage of bank and legitimation apps (e.g. Bank ID in case of Norway), certain alarm services and back up-solutions for GPS navigation services and payment services.

industry provides a rough picture of which value chain are vulnerable to ripple effects from outages in electronic communication.

Of the telecommunications' own intermediate inputs in 2017, input from other Norwegian industries accounted for 37.1 percent and intra-industrial deliveries accounted for 33.3 percent. Gross investments in fixed capital and imports then follows with 20.5 and 11 percent respectively. Except for the industry itself, construction and IT services constitute by far the most important supplier industries for the telecommunication industry with intermediate deliveries of 8.3 and 6.2 percent of total deliveries respectively.

Households consume 33.1 percent of the Norwegian telecommunication consumption, while 31.5 percent are applied as intermediates in the business sector, the public sector and the voluntary sector. Furthermore, the internal deliveries in the telecommunication industries makes up for 22.1 percent, 9.9 percent is export to abroad and 3.5 percent is related to gross investments in fixed capital and changes in the inventory stock. The largest customer industries for the telecommunication industry is the seaways industry, architectural and engineering services, wholesale and agency trade and land transportation and pipelines. The emergency and preparedness sector and the infrastructure service industries constitute examples of industries that are dependent on electronic communication, without the dependence being reflected in the corresponding consumption level. Besides, relative expensive electronic communication services may contribute to higher consumption measured by value, exemplified by absence of scale advantages for households and higher prices outside the mainland for the seaways industry.

In the web survey and in the interviews, most of our respondents focused on ripple effects through the value chains, both in the consumer and in the supplier direction. Specific ripple effects that recur among our respondents include impulses on financial transactions, knowledge sharing, sales of telecommunication services, advertising revenues, travel, postal deliveries and reporting to the public sector.

From our previous work with the NOCOM model, we have also mapped ripple effects that our respondents did not focus on. These include difficulties in reaching other people in close relationships, distortion costs from tax financing, weakened security of the population, weakened strategic control for the authorities, district policy effects, the need for reinvestments in infrastructure and effects on other electronic communications networks.

## **Further Development of the NOCOM Model**

Our findings contribute to Improve the empirical basis and document the determination of the Norwegian Communications estimation model for economic consequences of network outages, the 'Network Outage COMunication model' (NOCOM).

## **Update of the NOCOM model**

Based on the updated information basis on economic importance of electronic communication, we have updated the NOCOM model. This knowledge base further contributes to documenting the parameter determination in NOCOM and can be followed up in future updates of the parameters in the model.

The most comprehensive update of the model involves sectorial overviews for each communication goods (i.e. personal and non-personal communication) over substitution

patterns between electronic communication services in case of outages. This adjustment led to considerable lower value estimate than in the earlier version of the model. The reasons is that our updated information basis suggest stronger substitution than we originally had assumed in the model.

Another update concern growth in usage of electronic communication across communication goods and sectors. This update has less significance for the model results, as the current version of the NOCOM model primarily value impacts of service outages per hour spent and the corresponding value coefficient are left unchanged.

In addition, our mapping has revealed some new types of net ripple effects, where the most considerable has been added to the NOCOM model's checklist for assessment of non-monetized effects. Ripple effects that have been added to this list include impacts on tourism activities, postal services and reporting duties to the public administration. In addition, we have added ripple effects through the value chain to the checklist. This kind of impacts has nonetheless been discussed in connection with previous model work.

## **Recommendation for Further Development of the NOCOM Model**

Through this study, we have improved the parameter quality of the NOCOM model considerably, particularly in connection to substitution between electronic communication services. Nevertheless, there are several topics that should be improved in later development projects in connection with the model.

First, there are considerable uncertainty associated with substitution between electronic communications services in the household sector. Interviews with representatives from municipalities exposed to service outages in electronic communication raise the parameter quality somewhat, but do not ensure parameter quality close to what could have been obtained from a web survey with a larger number of respondents. Accordingly, we recommend that substitution patterns within the household sector is followed up in a later project. Some parts of the other institutional sectors can also be improved by raising the number of respondents and thus the significance of the results, including ICT-dependent transport, petroleum extraction and possibly the emergency and preparedness industries, which have already been followed up through interviews in this study.

Second, we have through this study revealed expectations about high user growth related to electronic communications. Digitization and automation may lead to greater dependence on ekom and potentially provide time savings, which the model helps put a value to. On the other hand, existing studies on growth impulses from ICT calls for caution with regard to model substantial value growth as a result of digitalization. It is also reason to believe that the marginal benefit from increased time spending on electronic communication is decreasing.

In the current update of the NOCOM model, the use of electronic communication is primarily based on valuation coefficients per hour available at work and as awake in the spare time, where the activity level in each institutional sector depends on the day, the time of time day and the presence of a possible crisis situation. Small to moderate changes in growth for usage is of less importance. In future studies carried out in relation to the NOCOM model, we recommend that the high expectations about growth in usage investigated further, and whether this feature should be modeled in another way in the model.

Third, we have through our project identified several ripple effects that have not been included in the NOCOM models' checklist earlier. We recommend that a potential future

valuation study for electronic communication attempts to value the ripple effects of outages identified in this and earlier study, as long as realistic estimates are considered obtainable.

A second best solution would be to rank the severity of ripple effects, such that they can be assessed by the NOCOM model's module for non-monetized effects. Concerning net effects through the value chains, these may be estimated using regional economic equilibrium models. In this regard, a challenge would be that outages in electronic communication typically occur in relatively short periods, where reallocation of factor inputs are challenging, especially in the case of time-critical activities.

In its current state, the most considerable weakness in the parametric determination in the NOCOM model is related to the unit value coefficients. Hence, we recommend that a valuation study for electronic communication is conducted to raise the quality of these parameters. Other type of parameters where parameter quality concern gradual outages and variations in the sector's activity level over time. In addition, the NOCOM model could be strengthened by further developing the model's infrastructure module.

Still, the NOCOM model is a complex model that captures the key economic mechanisms associated with outages in electronic communication. The model contains relatively sophisticated volume parameters for each sub-sector in all of Norway's municipalities. It also follows standard assumptions in economic evaluation analysis about economic development.