Economic implications of reducing or abolishing roaming fees

Fien Lagaet

Supervisors: Prof. dr. ir. Sofie Verbrugge, Prof. dr. ir. Didier Colle
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Master's dissertation submitted in order to obtain the academic degree of
Master of Science in Industrial Engineering and Operations Research

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Fien Lagaet, June 2017

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Abstract

When RLAH takes effect June 15th 2017, European travellers can send text messages, make voice calls and use data services abroad at the same price they pay at home, or in other words roam like at home. This dissertation handles on the impact RLAH will have on different types of operators. An analytical model has been introduced to simulate various scenarios. The output values of the model suggest that the impact of RLAH is not guaranteed to be negative. Under a set of circumstances (e.g. roaming traffic doubling) the impact of RLAH for MNOs remains minimal. MVNOs on the other hand, suffer more profit loss when RLAH takes effect. RLAH does not have to be a setback for the providers, it can also be an opportunity as the roaming volumes will increase significantly. Operators have to encourage their subscribers to use more mobile services abroad to profit from RLAH. Operators should also equip themselves to cope with the increasing demand. It is important to be able to ensure both the domestic and the visiting users a certain level of quantity.

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***Abstract*— When RLAH takes effect June 15th 2017, European travellers can send text messages, make voice calls and use data services abroad at the same price they pay at home, or in other words 'roam like at home'. This dissertation handles on the impact RLAH will have on different types of operators. An analytical model has been introduced to simulate various scenarios. The output values of the model suggest that the impact of RLAH is not guaranteed to be negative. Under a set of circumstances (e.g. roaming traffic doubling) the impact of RLAH for MNOs remains minimal. MVNOs on the other hand, suffer more profit loss when RLAH takes effect. RLAH does not have to be a setback for the providers, it can also be an opportunity as the roaming volumes will increase significantly. Operators have to encourage their subscribers to use more mobile services abroad to profit from RLAH. Operators should also equip themselves to cope with the increasing demand. It is important to be able to ensure both the domestic and the visiting users a certain level of quantity.**

Keywords — Roam like at home; Roaming; policy; Europe; MNO; MVNO

I. Introduction

In the fall of 2015, Europe decided that mobile operators will no longer be able to charge additional fees for mobile roaming as of June 15th 2017, which means that mobile usage (text, voice and data) will be charged equally abroad as at home or in other words 'roam like at home' (RLAH). A number of rather special effects may occur as RLAH will not impact each operator equally.

Various papers have been written about the roaming regulation up to RLAH. For example [2] describes the three structural measures that were introduced to encourage competitive pricing, among other things. Next, the techno-economics department of UGent wrote a descriptive paper on the impact of RLAH [1]. The paper covers a historic overview of international roaming in the EU as well as the challenges, opportunities and solutions. In comparison to these descriptive works, this paper provides a quantitative analysis of RLAH and focuses on the different effects the new roaming legislation will have on Belgian MNOs and MVNOs.

Section II provides a general overview of roaming and the charges involved. In section III some questions are formulated to guide the research. Section IV introduces the analytical model that will be used to simulate some scenarios. The results of this model will be represented and analysed in section V.

II. Overview of Roaming and the Legislation

In this section a general overview of roaming is given, this includes a historical overview of the roaming legislation and an explanation of the different types of operators and traffic.

A. What is roaming

When a subscriber is abroad and wants to send an SMS home, two operators are involved. His home operator, the domestic service provider (DSP), and the operator that manages the visited network, the foreign service provider (FSP). To offer the end user connectivity while being in a foreign country, the DSP uses the network of an FSP, known as roaming. Different costs, charges and caps are involved in these transactions. The wholesale costs are the costs for the foreign provider to allow the use of its network. The FSP charges a fee to the home operator for this usage, known as the wholesale charge or the inter-operator tariff. This wholesale charge is limited by the wholesale cap. Up to June 2017, the home operator could recover the wholesale charge by charging it to the end user on the retail level, known as the retail roaming charge. When RLAH takes effect, the home operator can no longer recover the wholesale charge by charging the end customer an additional fee, which will lead to revenue losses. [1] These transactions are summarized in fig. 1.

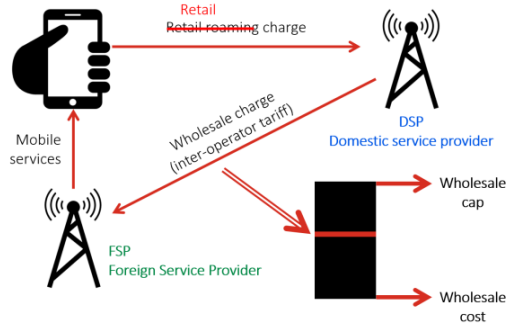

Fig. 1. Roaming vs roaming like at home [1]

B. *Evolution of the legislation on roaming in the EU*

When RLAH is active, mobile users will no longer need to worry about high phone bills when using their phones in the EU. The telecom operators will however experience revenue losses. As retail revenues decrease, so should the wholesale prices. They need to be limited by legislation. In this section the evolution of the roaming legislation in the EU is given.

The first roaming regulation (**Roaming I**) was introduced in 2007. Roaming I introduced caps on both incoming and outgoing voice prices, wholesale as well as retail. Since then, the imposed caps have been lowered and additional caps have been added. In 2009, the existing caps for voice calls were lowered, introducing **Roaming II**. Additional wholesale and retail caps were imposed for incoming and outgoing text messages. For data services only a wholesale cap was imposed. In 2012, the wholesale caps were lowered again, after a research showing that the wholesale costs had decreased over the years. A retail cap for data was added (**Roaming III**). In preparation for RLAH, relative caps are decided for retail prices (**Preparation RLAH**). All the caps were absolute caps until then. The cap on the retail prices for text messages became the domestic price plus two cents. For data and outbound calls the cap is set to the domestic price plus 5 cents [1]. On 31 January 2017 an agreement on the new wholesale caps was reached. For data usage a glide path will be introduced. The current cap of €50 per GB will decrease to €7.7 per GB on 15 June 2017, and continue to decrease in stages after that [3]. The strong decrease in price is based on the expectation that the wholesale cost will drop over the coming years as a result of an increase in data usage, new technologies, effective competition and economies of scale.

C. *Types of operators and traffic*

Mobile network operators (MNO) are "operators who own a network (infrastructure and radio spectrum) and provide the full range of mobile services (text, voice and data) to their customers" [2]. Mobile virtual operators (MVNO) "provide mobile communication services without having their own radio spectrum" [2]. An MNO can have inhabitants of another country roam on its network, while an MVNO typically cannot. This causes traffic imbalances for MVNOs as they have a lot of outgoing roaming traffic but no incoming roaming traffic. Abolishing roaming fees will therefore affect MNOs and MVNOs differently.

Two types of roaming traffic exist. When a subscriber of a DSP goes abroad and uses mobile services there on the network of a FSP, it is called outbound roaming for the DSP. For the FSP however this is referred to as inbound roaming, since a subscriber of another operator uses their network. Receiving countries have more inbound traffic than outbound traffic. On the other hand, sending countries have more outbound traffic than inbound traffic. The impact of RLAH will be different for both. For mobile operators whose customers travel a lot, the revenue loss caused by RLAH will be vast, while for mobile operators in countries where a lot of people travel to (and inhabitants rather stay home), the effect will be smaller.

III. Objectives

The goal of this master thesis is to analyse the economic impact of the new roaming legislation, starting in June 2017. To be able to quantify this impact, it is important to know which effects the previous measures have had. Some example questions are used to guide this research: Did the roaming volumes increase since the roaming regulation was imposed in the EEA? Which trends can be seen for the roaming volumes over the years and are the trends the same for all services (text, voice, data)? These questions are interesting because volume increases are expected to happen when RLAH is active. Based on the answers, assumptions can be made for the RLAH period and questions raised:

- Will roaming still be profitable for all MVNOs?
- Will the gap in profit between an MNO and an MVNO increase and if so, by how much?
- To which extent will the RLAH have a different impact on sending and receiving countries?

In 2016 – 2017 a lot of articles were written about the abolishment of the roaming fees in which some concerns were raised. Roam like at home, too good to be true? A particular question that came to the surface is whether the potential loss in roaming revenues for the providers will be passed on to the customer [9]. The operators could recover the potential revenue loss by increasing the domestic retail prices or by increasing the price for roaming in the rest of the world (RoW). If they do so, by how much would the retail prices have to increase to recuperate this revenue loss in function of the increasing volumes? Does this increase differ for an MNO and an MVNO?

IV. Model

First of all a descriptive analysis of the past is conducted. It provides some answers to the previously formulated questions about the past. When a clear view of the past is obtained, the analysis can be extended to the future. To do so, a quantitative model is built to calculate the domestic and roaming revenues and costs. Once the building blocks of the model are constructed and implemented in Java, the input parameters are defined. Their values are based on the data analysis of the past. Four scenarios are tested with this model. The difference between these scenarios is the volume consumption abroad. This analysis is done to formulate an answer on the previously formulated questions about RLAH.

The calculations are done over a period of time: Q3 '12 – Q2 '18. This covers the period in which the old roaming regulation applies, the transition period between the old regulation and the RLAH legislation, and a RLAH period of one year. The input variables of the model are divided in three categories. The first one is 'general information'. Its first parameter is the number of customers the provider has [C]. The second parameter is the number of quarters that one wants to simulate [Q]. The second category is 'service'. In this category the four parameters that define a particular service such as SMS, voice and data are included:

- the average revenue per unit outbound roaming [r/u_{out}]
- the average revenue per unit inbound roaming [r/u_{in}]
- the average cost per unit outbound roaming [c/u_{out}]
- the inbound outbound ratio [I/O]

In the model, different user profiles can be created. This is the last category of input parameters. It is defined by six parameters that can vary over the different profiles:

- the percentage of customers that has this profile [%P]
- the percentage of the profile that roams [%R]
- the percentage of time the customers who do roam spend abroad [%T]
- the average domestic usage when at home [d]
- the outbound domestic ratio [O/D] (which is explained in detail in section V.B)
- the average revenue per unit domestic usage [r/u_{dom}]

Now, the values of these input parameters have to be defined. The number of customers is 10 million for all the analyses in this paper. The parameters regarding the domestic traffic are based on historic averages [4] and profiles [6] designed by BIPT. The parameters of the services concerning roaming are calculated from [6]. The inbound outbound ratio was found in a report of BEREC [7].

The model calculates the revenues and costs for each combination of a service and a profile that belongs to the service, based on this the total domestic revenue and the total roaming profit are calculated. 'Total' meaning the revenues and costs of all services combined with all the corresponding profiles are included. As the revenues and costs are unit-based, the volumes have to be calculated first. The calculation method differs for domestic, outbound and inbound traffic but is the same for each service.

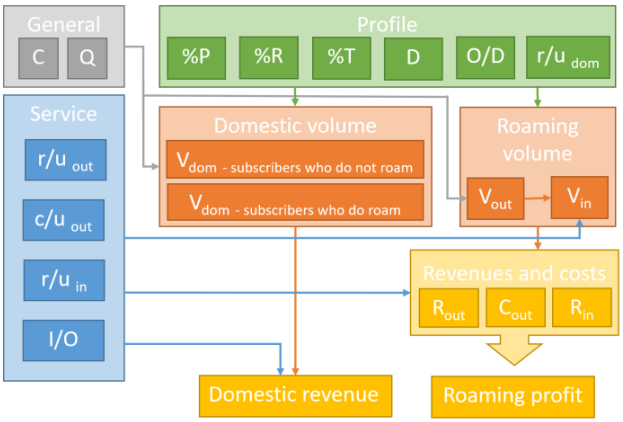

Fig. 2. Visualisation of the input parameters of the model per category and building blocks of the model.

V. Results

A. Analysis of the past

Based on [6] and [8], the past is analysed, focussing on the impact of seasonality, data roaming and the RoW roaming prices.

1) Seasonality

Roaming traffic has a seasonal nature for all services: every third quarter the volume peaks. These are the months July, August and September. This is the holiday season. Thus tourism creates considerable seasonal variation.

2) Spectacular increase in volume of data services

The roaming volumes for SMS and voice services are quite stable. They follow a slightly increasing trend over time. The roaming volumes for data services, however, make a spectacular increase. A similar increase is visible for the domestic data traffic. Smartphones enable users to communicate via apps that use the internet such as WhatsApp instead of SMS and skype instead of voice calls. Wi-Fi, which is available in more and more places, and the lowering retail price for data services encourage the use of these apps.

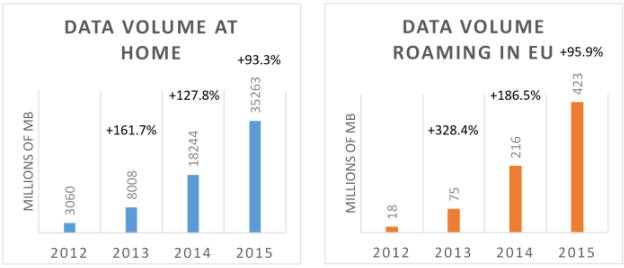

Fig. 3 The increase in data volume is similar for domestic and roaming traffic

3) Steady RoW prices

The European average of the retail roaming price in the rest of the world shows a downward trend for all services. There is no indication that operators tended to raise the retail price for roaming in the rest of the world to make up for the loss of revenue due to the roaming legislation within EU countries which lowered the regulated caps.

B. Analysis of the future

In this section the results of the model are discussed. First the approach of the analysis is elaborated. Four scenarios and five assumption cases will be explained. Then the results of these simulations are given.

Roaming volume increases are expected to happen when RLAH takes effect. But how fast will these increases happen? By how much will the roaming volumes increase? To deal with this uncertainty, four scenarios are proposed, based on a wholesale report of BEREC [7] that analyses the results of RLAH-type offers in the transition period. The difference between the scenarios is the outbound domestic (O/D) ratio, which is defined relative to the old O/D ratio. The four scenarios are described in table I.

TABLE I. DESCRIPTION OF THE SCENARIOS

scenario	description
1	Subscribers use the same amount abroad as they did before RLAH. The lower retail tariffs for roaming have no influence on the roaming volumes. The O/D stays the same.
2	The O/D ratio doubles for all services. The doubled ratio is still smaller than 1, which means that the subscriber still uses less volume when abroad than at home.
3	The subscriber uses the same amount of volume abroad as at home. The O/D ratio is equal to 1.
4	The O/D ratio doubles for SMS and voice calls but triples for data services. This scenario is used to model a stronger increase in data services than in SMS and voice services.

TABLE II. DESCRIPTION OF THE ASSUMPTION CASES

case	description
1	The values of the input parameters are chosen the same as in the same quarter a year before, whenever they do not violate the new legislation. This is the case described above.
2	It is noticeable that Belgian providers pay the maximum fee to the FSP for outbound roaming, while the Belgian providers do not charge the maximum fee to the FSP for inbound roaming. What is the effect on the roaming profit of the provider if he does charge the maximum fee?
3	In the standard case the increasing I/O trend stagnated in 2015. What is the effect on the roaming profit if the trend continued in the transition period until Q2 '17.
4	What if the increasing I/O trend continues during the RLAH period?
5	Belgium is currently a receiving country for all services. When RLAH takes effect, it is possible that the outbound roaming volumes increase more than the inbound roaming volumes do. If this happens to the extent that outbound roaming volumes exceed the inbound roaming volumes, Belgium becomes a sending country. The new I/O ratio is based on Finland, which is a sending country.

TABLE III. SUMMARY OF THE REVENUES AND COSTS PER UNIT

cents PU	SMS	voice	data
outbound cost	1.0	3.2	0.77/0.60[a]
inbound revenue	0.6	3.0	0.77/0.60[a]
regulated cap	1.0	3.2	0.77/0.60[a]

[a] Two values because the cap changes again in Q1 '18

Other parameters of interest are the outbound and inbound revenue per unit and the outbound cost per unit. When RLAH is active, a subscriber pays the same price per unit abroad as at home. Thus the outbound revenue per unit is equal to the domestic revenue per unit, which has been specifically determined per profile. The outbound cost and inbound revenue per unit are capped by the legislation. The actual charge is chosen to be the same as in Q2 '17, whenever these values do not violate the new regulation. Thus, if the charge in Q2 '17 is lower than the regulated cap, this value is continued, otherwise the charge is set equal to the cap. A summary of the revenues and costs per unit is given in table III. These parameters form the standard assumption case. Variations of this case can be seen in table II.

The analysis focuses on two periods:

- Q3 '15 – Q2 '16: In this period the old roaming legislation still applies. This period will be used as a reference period throughout this section.
- Q3 '17 – Q2 '18: In this period the new RLAH legislation applies. This period will be analysed for the different scenarios and assumption cases.

The roaming profit of the second period is compared to the roaming profit in the reference period. Fig. 4 shows the new roaming profit of MNOs and MVNOs. The comparison with the reference period is visualised in fig. 5 according to a colour scale. The result for the MVNO is the same in all assumption cases because the difference between the assumption cases concerns inbound roaming traffic, which MVNOs typically cannot host.

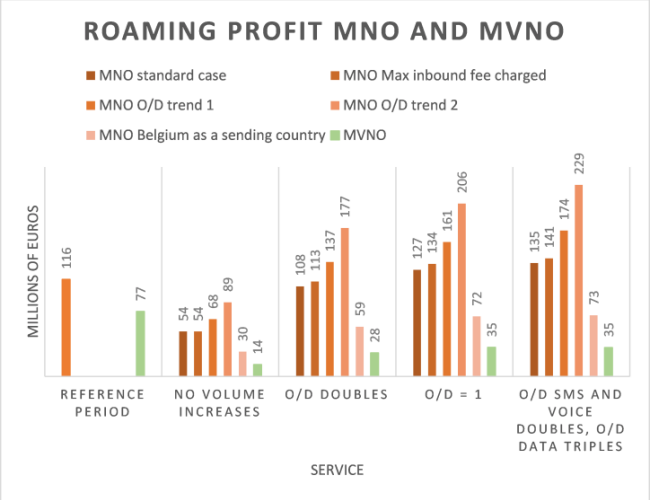

Fig. 4. Roaming profit MNO and MVNO when RLAH takes effect for various scenarios and assumptions

An MVNO loses roaming profit compared to the reference period in all scenarios. Even more noticeable is that the SMS roaming service is not profitable at all for MVNOs. The outbound revenue per SMS is on average €0.009618 while the cost is €0.01. This results in a loss of €0.000382 per SMS. It is forbidden to sell services at loss. Three possible reactions of the MVNO are given:

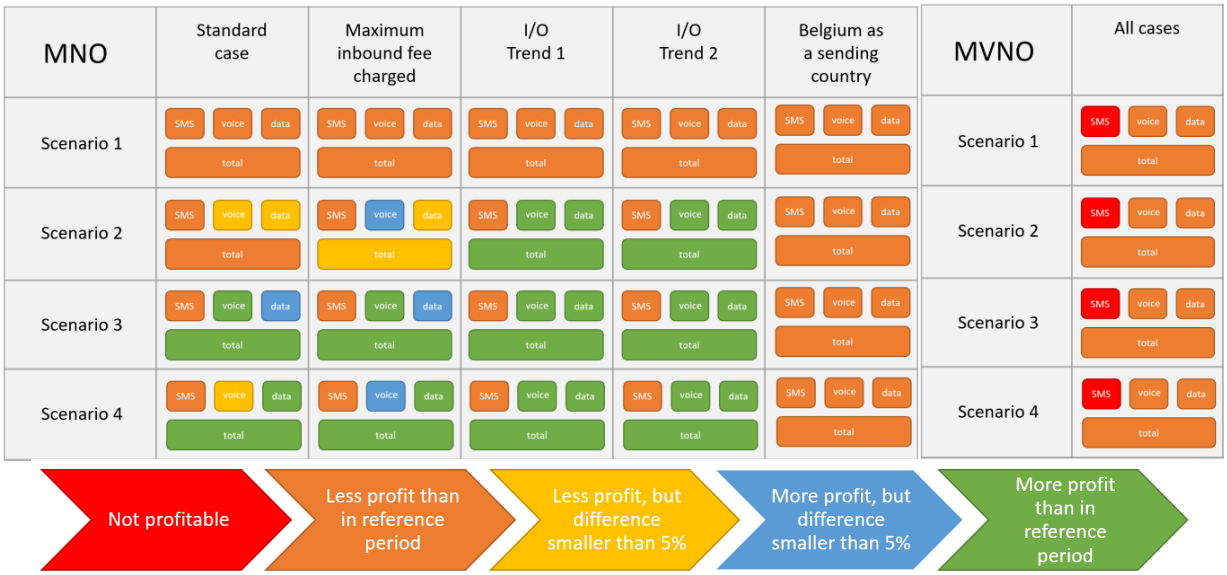

Fig. 5 results for an MNO and an MVNO

- Raise the domestic retail price by at least €0.000382 per SMS. SMS roaming service will then no longer be unprofitable.
- Apply for the sustainability clause.
- Reallocate the domestic retail revenue per unit. SMS is often part of a package. The combined package is most likely still profitable.

However, every situation leads to a competitive disadvantage for MVNOs, so does doing nothing, as the MNOs have higher roaming profits.

For an MNO, SMS roaming services are profitable in all situations. This is due to the inbound roaming revenue of €0.006 per SMS. However, there is not one situation in which SMS services generate more profit, or even the same profit, as in the reference period. This is the only service for which this never happens. As SMS roaming profit is only a very small share of the total roaming profit, this will not have a big impact on the total roaming profit.

If Belgium becomes a sending country, the inbound roaming revenues drop. Even if the data volume triples, the provider still loses profit compared to the reference period. This is the only assumption case in which the roaming profit never increases compared to the reference period.

Now the results of the other four assumption cases are discussed. In the first scenario the volumes do not change. Due to the increasing trend in roaming volumes and the lower retail roaming prices when RLAH takes effect, it is not likely that this scenario will happen. For the other scenarios, the only combination of a scenario and an assumption case for which the provider loses a significant amount of profit (more than 5%) of its total roaming profit is the second scenario combined with the standard assumption case. Increasing the maximum inbound fee provides a solution, the profit loss then becomes smaller than 5% for the same combination. If the operators would want to recover the profit loss by increasing the domestic retail revenues, the domestic retail price increases in table IV apply. If these increases would be implemented, the profit becomes equal to the profit in the reference period. In the other combinations the provider actually makes more profit than in the reference scenario, and no increases in the domestic retail price are necessary.

TABLE IV. INCREASE IN DOMESTIC ROAMING RETAIL PRICE FOR SCENARIO 2 STANDARD CASE AND MAXIMUM INBOUND FEE CHARGED

	SMS	**voice**	**Data**
MNO	0.0353	0.0014	0.0015
MNO max inbound fee	0.0173	0	0.0015
MVNO	0.0439	0.0741	0.0409

The gap between an MNO and an MVNO is given in table V. The gap was €38.3 million in the reference period. In most situations the gap enlarged, but in some the gap is similar or even smaller than in the reference period. This is the case for the scenario in which subscribers used the same volume combined with the standard assumptions and in all scenarios if Belgium becomes a sending country. The gap can also be seen in fig. 4 as both the profit MNOs and MVNOs is visualised.

These results suggest that the impact of RLAH is not guaranteed to be negative, under a set of circumstance (e.g. roaming traffic doubling) the impact of RLAH for MNOs remains minimal. In fact, if roaming volumes should increase to the extent that subscribers use the same amount of volume per day when abroad as they currently do at home, the roaming profit actually increases for MNOs. MVNOs on the other hand, suffer more profit loss when RLAH takes effect. Due to the absence of revenues of incoming traffic, their total roaming

profit decreases under all realistic circumstances, even to such an extent that SMS roaming services become unprofitable. The better result for MNOs leads to a competitive advantage over MVNOs. Even when both would decide to recuperate the potential profit loss by increasing the domestic retail prices, the MVNO has to set higher prices than the MNO, also leading to a competitive disadvantage for the MVNO.

TABLE V. GAP BETWEEN MNO AND MVNO

(€ million)	Standard case	Maximum inbound fee charged	I/O trend 1	I/O trend 2	Belgium as a sending country
S1	40	43	54	75	15
S2	79	85	109	149	31
S3	93	100	126	171	37
S4	101	106	140	194	39

VI. DISCUSSION

As could be seen in the analysis, some operators are able to maintain the current profit level in a set of circumstances. The biggest influence is the roaming volume as the roaming profit increases with increasing volumes. If the roaming volume doubles, MNOs actually make more profit than they used to. A lot of people did not roam at all or very little, especially for data services, as they were scared for large bills. It is thus important to advertise RLAH properly and encourage the subscribers to use (more) mobile services when abroad. As the roaming market will change from a low volume high price market to a high volume low price market, operators benefit from stimulating their users to roam more when RLAH takes effect. The biggest challenge for the operators will be to estimate the correct roaming volumes in the future.

Operators have to discuss new inter-operator tariffs (IOT) with foreign service provides to minimalize their costs. These wholesale charges should be discussed with the retail prices in mind. Some have more leverage than others. As MVNOs have no incoming roaming traffic, they have little leverage to negotiate better deals. For net receivers the impact of RLAH is not as big as for net senders. The costs for net senders will become very high compared to the revenue if they do not renegotiate the IOTs well.

The new roaming legislation will not only change the roaming market, the domestic market will also be affected. Providers should ensure a good quality of service (QoS) for both the domestic user and the visiting user. The operator should be equipped to handle the sharp increase in roaming volume, especially for data services, to still be able to satisfy the domestic user.

Little people take roaming tariffs into account when choosing a provider or a tariff plan. However, operators should be careful about applying for the sustainability clause or about increasing domestic retail prices, as these may well be reasons for leaving the operator.

VII. CONCLUSION

The results suggested that the impact of RLAH is not guaranteed to be negative, under a set of circumstances (e.g. roaming traffic doubling) the impact of RLAH for MNOs remains minimal. In fact, if roaming volumes should increase to the extent that subscribers use the same amount of volume per day when abroad as they currently do at home, the roaming profit actually increases for MNOs.

MVNOs on the other hand are equipped worse for RLAH. Due to the absence of inbound roaming traffic and low profit margins in the domestic market the profit loss is percentage-wise bigger for them.

Operators should encourage their subscribers to use more mobile services abroad, as the same level of roaming profit can be reached or exceeded depending on the roaming volume. They should also equip themselves to cope with the increasing demand. It is important to be able to ensure both the domestic and the visiting users a certain level of quality.

RLAH does not have to be a setback for the providers, it is also an opportunity as the roaming volumes will increase significantly.

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Abbreviations

ARP: Alternative roaming provider

BEREC: Body of European Regulators for Electronic Communications

BIPT: Belgian Institute for Postal services and Telecommunications

DSP: Domestic service provider

FSP: Foreign service provider

FUL: Fair use limit

I/O ratio: Inbound outbound ratio

MNO: Mobile network operator

MVNO: Mobile virtual network operator

O/D ratio: Outbound domestic ratio

RLAH: Roam like at home

RoW: Rest of world

Chapter 1

Context of the Master's dissertation

1.1 Introduction

In the fall of 2015, Europe decided that mobile operators will no longer be able to charge additional fees for mobile roaming as of June 15th 2017, which means that mobile usage (voice, text and data) will be charged equally abroad as at home or in other words 'roam like at home' (RLAH). Though this implies that prices for consumers will drop when roaming, the costs for mobile operators however will not. As a direct result, mobile operators may have to change their business model to compensate for this revenue loss. A number of rather special effects may occur as roaming like at home will not impact each mobile operator equally.

1.2 Motivation of the dissertation

Various papers have been written about the roaming regulation up to RLAH. An example of such a paper is "Competition at last? An economic analysis of current mobile data roaming regulations in Europe" [1]. Among other things this paper describes the three structural measures that were introduced to encourage competitive pricing. Next, "Techno-economic analysis of international mobile roaming" [13] provides an overview of the changing business dynamics of roaming as well as a

mechanism that combines roaming scenarios that existed at that time. The techno-economics department at UGent wrote a descriptive paper on the impact of RLAH [4]. The goal of this paper was to give an overview of the roaming regulation in the EU both in the past and in the future. The paper covers a historic overview of international roaming in the EU as well as the challenges, opportunities and solutions.

In comparison to these descriptive works, this thesis provides a quantitative analysis of RLAH and focuses on the different effects the new legislation will have on Belgian MNOs and MVNOs. An analytical model is constructed to quantify this impact. The profitability of the operators is compared pre-RLAH and once RLAH has taken effect. In 2016 - 2017 a lot of articles were written about the abolishment of the roaming fees in which some concerns were raised. Roam like at home, too good to be true? A particular question that came to the surface is whether the potential loss in roaming revenues for the providers will be passed on to the customer [22]. This question is also be included in the research.

1.3 Course of the book

In chapter two a literature study is conducted to get familiarised with the general concepts of roaming and the evolution of the legislation on roaming in the EU. This forms an important knowledge base for the remainder of this dissertation. To start, a general overview of roaming is given. The difference between roaming and RLAH is explained. The historical overview of the legislation includes the structural measures that were taken to encourage competition as well as an overview of the regulated wholesale and retail caps. Various parameters exist that will influence the economic impact of RLAH, such as the type of operator and the behaviour of the inhabitants of a country. At the end of this chapter some questions are formulated that will guide the research in this master dissertation. Some of these questions are about the past. It is important to know which effects the previous measures had to substantiate some assumtions for the RLAH period. An analysis of the past is conducted in the third chapter and is based on Belgian data [24] as well as on European averages [16]. The literature study and analysis of the past do not only provide

some general insights in the effect of the roaming legislation but also enlighten wich data is available as input for the model.

The fourth chapter introduces the analytical model that is used to simulate some scenarios. The input parameters and building blocks of the model are described. The values of the required input parameters of the model are then defined in chapter five. The sixth chapter analyses the quantitative results the model generates for different scenarios and assumption cases for the RLAH period. The analysis focuses on the impact of increasing roaming volumes and the effect of the ratio incoming traffic - outgoing traffic. The necessary increase in domestic prices, needed to obtain the same profit level as pre-RLAH, is also calculated for various roaming volumes and assumptions. In the last chapter the conclusions of this dissertation are formulated.

Chapter 2

Literature study

In June 2017, the new roaming regulation takes effect. This roaming regulation is called 'roam like at home' (RLAH). It enables European travellers to send text messages, make voice calls and use data services at the same price they pay at home. Thus, when RLAH takes effect in June, mobile users will no longer need to worry about high phone bills when using their phones abroad in the EU. The telecom operators will however experience revenue losses. To make sure that the telecom operators limit the charges to each other, and thus a competitive market for everyone, legislation on the wholesale charges is necessary. Three structural measures were drafted to compensate the lack in competition. These are explained in this chapter and are followed by a historical overview of the roaming legislation. The European Commissions view on fair use limits and data consumption when roaming like at home is also covered in this section. To understand the legislation better, the primary concepts concerning roaming will be explained first, at the beginning of this chapter. These primary concepts combined with the roaming legislation will lead to the research questions of this master dissertation that will guide the research. These are discussed at the end of the chapter.

2.1 Introduction of the primary concepts of roaming

This section gives a general overview of the transactions needed to enable roaming. The costs, charges and caps that are involved in these transactions are explained one by one. The difference between roaming and roaming like at home is indicated. This overview is followed by an explanation of parameters that influence the impact of the RLAH regulation. The first parameter is the type of operator. Depending on their geographical coverage and their infrastructure, a difference can be made between operators. Then there are two types of roaming. The second parameter is the ratio between them. This ratio determines if the country is a netto sender or a netto receiver. This will also make a difference in the effect RLAH will have. This overview forms an important knowledge base for the remainder of the dissertation.

2.1.1 What is roaming

Roaming is known as offering connectivity to an end user while being in a foreign country. This happens for example when a subscriber is abroad and he wants to send an SMS home. Two operators are involved:

- **the domestic service provider (DSP):** this is the subscribers provider at home
- **the foreign service provider (FSP):** this is the provider abroad that will offer the connection to the end user.

When the subscriber sends an SMS abroad, he uses the network of an FSP, thus, his home provider uses the network of a foreign service provider (FSP) to offer connectivity to the end user while being in a foreign country. Different costs, charges and caps are involved in the transactions that happen when roaming. The wholesale costs are the costs for the FSP to allow the use of its network. The FSP charges a fee to the DSP for this usage, known as the wholesale charge or the inter-operator tariff. This wholesale charge is limited by a maximum fee, it is called the wholesale cap. The DSP can recover the wholesale charge by charging it to the end user on the retail level, known as the retail roaming charge [4]. When RLAH the DSP can no longer recover the wholesale charge by charging the end customer an additional fee, which will lead to revenue losses. These transactions are summarised in figure

2.1. In general all transactions that occur between operators are on the wholesale level while the transactions between the operator and the end user are carried out on the retail level.

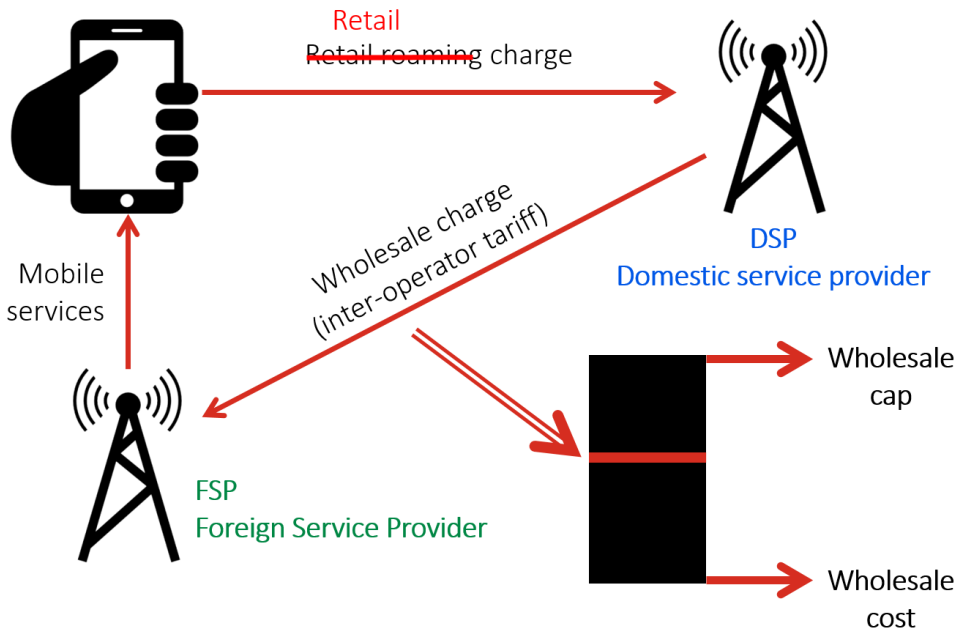


Figure 2.1: Roaming vs roaming like at home

2.1.2 Key differences between the operators

Mobile services (voice, text and data) can be provided by different kind of operators. Mobile network operators (MNO) are "operators that own the network (infrastructure and radiospectrum) and provide the full range of mobile services (voice, text and data) to their customers" [1]. Mobile virtual operators (MVNO) "provide mobile communication services without having their own radiospectrum" [1]. MVNOs negotiate wholesale rates with an MNO to get access to their network. They can set retail prices independently of the MNO. An MNO can have inhabitants of another country roam on its network, while an MVNO typically can not. This causes traffic imbalances for MVNOs. They have a lot of outgoing roaming traffic but no incoming roaming traffix. Abolishing roaming fees will therefore affect MNOs and MVNOs differently.

Another type of mobile operator is the cross-country mobile operator. These are MNOs but they have a network in multiple countries. Their network has a broader geographical coverage. In figure 2.2 the geographical coverage of Deutsche Telekom is represented. This mobile operator is active in 13 countries. When a subscriber of Deutsche Telekom is abroad in another country where Deutsche Telekom is active, the Deutsche Telekom can steer the traffic to their own network. Therefore there will be no additional roaming charge, no additional cost, except maybe internal costs. Therefore cross-country mobile operators will suffer less revenue loss than operators only active in one country. This can lead to an advantage.

Figure 2.2: geographical coverage - Deutsche Telekom

2.1.3 Inbound and outbound traffic

Two types of roaming traffic exist. When a subscriber of a domestic operator travels abroad and uses mobile sevices there on the network of a foreign operator, it is called outbound roaming for the domestic operator. For the foreign operator however it is called inbound roaming, since a subscriber of another operator uses their network. Some countries have more inbound traffic than outbound traffic, these are receiving countries. On the other hand, sending countries, have more outbound traffic than inbound traffic. In figure 2.2 a map of Europe can be seen. For most of the countries an indication is given whether they are a netto sending or a netto receiving country. The impact of RLAH will be different for both. It is also possible that the traffic flow changes when RLAH is active. The effect depends on the amount of incoming and outgoing traffic. For mobile operators whose customers travel a lot, the revenue loss caused by RLAH will be vast but the wholesale costs will also drop. For mobile operators in countries where a lot of people travel to (and inhabitants rather

stay home), there will be little to no effect. Spain for example is a netto-receiver, with a lot of incoming traffic from tourists. Without regulation, they might want to keep wholesale charges high, since other operators have to buy capacity from them. Norway on the other hand is a netto-sending country, therefore they will have to pay large amounts of inter-operator tariffs to ensure connectivity abroad for their customers. As a direct result of RLAH, they risk not to be able to recuperate these wholesale costs. A possible solution to cover these losses is to raise the domestic prices, which is known as the waterbed effect [4]. The waterbed effect occurs in two sided markets. If the price is pushed down at one side, but not at the other side, the price at the other side will increase [5]. If the retail roaming charges decrease, the domestic retail charges might increase to compensate. This is a re-balancing of the prices. This might be an unintended consequence of the regulation: the price could increase, instead of fall, especially for customers who do not roam. If an operator in a competitive market increases the domestic prices it will lead to a disadvantage in the market and therefore a reduction of their market share. The need to increase domestic prices depends on the country. As explained before there are sending and receiving countries, their need to raise domestic prices will differ.

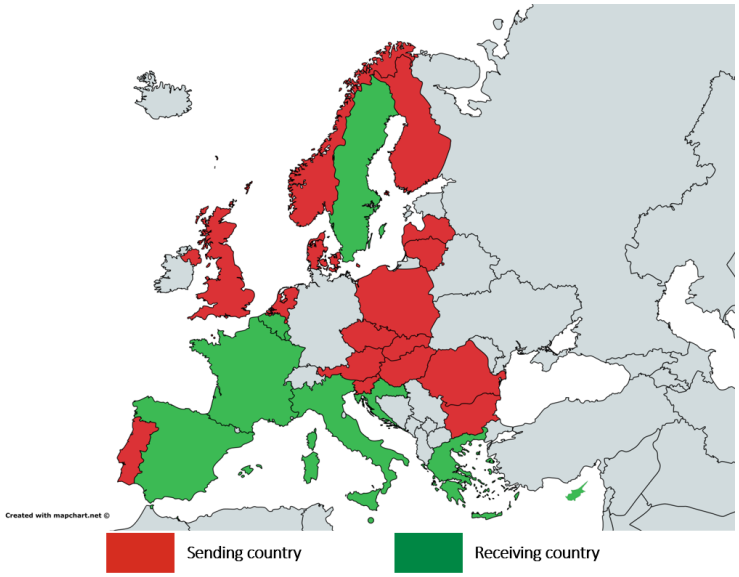


Figure 2.3: geographical location: netto sending and receiving countries

2.1.4 Traffic steering

The inter-operator tariff is limited by a wholesale cap and the cost to offer this connectivity. The billed tariff is negotiated between the two operators. If the domestic operator has a good negotation with one or two foreign service operators in a certain region and a bad negotiation with another foreign operator, it can only benefit from the good negotiation if the traffic is directed to the preferred network since this will minimise the domestic operators costs. When it is impossible to steer the traffic, there is less pressure for competitive pricing and negotiation between operators. Even if they have a good deal with an operator in a certain region, it is still possible they will have to pay a lot more money to another operator if the traffic is directed to this other operator's network. Hencce, to keep the wholesale costs under control and as low as possible it is important to steer the traffic to the preferred network if this is possible.

The automatic selection is driven by the last network prevalence, a built in list (sim selection) and handset selection. This means that if there is no network coverage of the preferred foreign operator, the customer can still be directed towards another not-preferred network. The customer can also hand-select another network.

2.2 Evolution of the legislation on roaming in the EU

In this section the European Union roaming regulation will be elaborated. The wholesale caps and the retail caps are regulated and have changed over the years. First, the reasons for these caps will be discussed. Then an overview of the roaming legislation and its changes over the years is given, as well as the glidepath that will be introduced in the coming years.

2.2.1 Three structural measures to compensate lack of competitive pricing

Roaming charges should be driven by competition rather than regulation. In the past, charges have been a lot higher than the actual costs. It is important to bring the retail roaming charges closer to a competitive level to avoid bill shocks for cus-

tomers and to encourage the use of mobile services abroad. To achieve roam like at home the roaming retail charges are eliminated within Europe. When roaming like at home, operators will not be allowed to charge the inter-operator tariff directly to their subscribers, therefore it is important that the wholesale charges are also brought closer to a competitive level. To compensate this lack in competition structural measures were drafted [1].

The **single market measure** wants to achieve a single telecommunications service market, to bring the borders down and activate economies of scale.

MVNOs were not allowed to negotiate with FSPs themselves until 2012. They could only offer roaming through the home MNO. The agreement with the home MNO did not only include a domestic roaming agreement (determining the wholesale charges) but also an international roaming agreement. This means that the roaming cost for the MVNO existed of a wholesale price negotiated in the domestic roaming agreement between the MVNO and the MNO plus the wholesale price negotiated in the international roaming agreement between the MNO and the FSP. The **direct access measure** changes this. MNOs will have to meet all reasonable requests for wholesale roaming access. Thus, the MVNO can directly negotiate international roaming agreements with the visited MNO. This measure therefore allows more players to enter and compete in the wholesale roaming market[1].

Operators have to separate roaming and domestic offers due to the **separate sale measure**. Thus, customers can choose an alternative roaming provider (ARP) [1]. Customers will be more aware of roaming prices due to this measure. This measure will be outdated when RLAH takes effect. It is possible that the domestic retail prices outside bundles increase or that the retail prices for roaming in the rest of the world increase. Customers should be more aware of these prices.

2.2.2 Historical overview

The first roaming regulation (**Roaming I**) was introduced in 2007. Roaming I introduced caps on both incoming and outgoing voice prices, wholesale as well as

retail. Since then the imposed caps have been lowered and additional caps have been added. In 2009 the existing caps for voice calls were lowered, introducing **Roaming II**. Additional wholesale and retail caps were imposed for incoming and outgoing text messages. For data services only a wholesale cap was imposed. To avoid bill shocks for data usage, operators were requiered to notify their customers if the latter exceed a certain amount set to € 50 exl. VAT. In this case the customer can decide to further use the service or to not spend any more money on data services. In 2012 the wholesale caps were lowered again, after a research showing that the costs had decreased over the years. A retail cap for data was added **(Roaming III)**.

All the caps were absolute caps until April 30 2016. In preparation for RLAH, relative caps are decided for retail prices **(Preparation RLAH)**. The cap on retail prices for text messages became the domestic price plus two cents. For data and outbound calls the cap is set to the domestic price plus 5 cents. A summary of the caps can be found in table 2.1. A summary of the evolution of the legislation as a preparation for RLAH can be found in table 2.2. On 31 January 2017 an agreement on the new wholesale caps was reached. For data usage a glidepath is introduced. The strong decrease in price is based on the expectation that the wholesale cost will drop over the coming years as a result of an increase in data usage, new technologies, effective competition and economies of scale. The current cap of €50 per GB will decrease to €7.7 per GB on 15 June 2017, and continue to decrease in stages after that. The cap will be lowered to €6 per GB from 1 January 2018, €4.5 per GB from 1 January 2019, €3.5 per GB from 1 January 2020, €3 per GB from January 2021 and €2.5 per GB from 1 January 2022[2].

Table 2.1: Wholesale and retail caps [eurocents, excl. VAT] (R=retail, W=wholesale)

		Voice (outgoing)		SMS		Data [per MB]	
		W	R	W	R	W	R
Roaming I	30 Aug. 2007	30	49				
	30 Aug. 2008	28	46				
Roaming II	1 July 2009	26	43	4	11	100	
	1 July 2010	22	39	4	11	80	
	1 July 2011	18	35	4	11	50	
Roaming III	1 July 2012	14	29	3	9	25	70
	1 July 2013	10	24	2	8	15	45
	1 July 2014	5	19	2	6	5	20
	1 July 2015	5	19	2	6	5	20

Table 2.2: Eurotariff - retail prices [**?**]

	1 July 2014	30 April 2016	15 June 2017
Outgoing voice calls (per minute)	€ 0.19	domestic price + up to € 0.05	no extra roaming fee, same as domestic price
Incoming voice calls (per minute)	€ 0.05	€ 0.0114	no extra roaming fee, same as domestic price
outgoing texts (per SMS message)	€ 0.06	domestic price + up to € 0.02	no extra roaming fee, same as domestic price
Online (data download, per MB)	€ 0.20	domestic price + up to € 0.05	no extra roaming fee, same as domestic price

2.2.3 Fair use limit (FUL): a safeguard for abuse of RLAH

Safeguards are needed to avoid abuse linked with customers buying a low-price SIM-card in another country than the one of their residence. This is known as permanent roaming [8]. RLAH is not meant for permanent roaming. These abuses might also impose a waterbed effect, mentioned before in section 2.1.3, because it is possible that the operator of the low-price SIM card has to increase the domestic retail prices

to cover for this abuse. A fair use limit (FUL) can be imposed as a safeguard, which limits roaming to a maximum amount per customer per time period. This can act as a potential safeguard mechanism for operators against abuse.

In September 2016 the European Commission introduced a new mechanism based on the number of stable links a customer has with an EU member state. When there is abuse based on permenant residence elsewhere, significantly large usage or in exceptional circumstances in the domestic markets, operators can apply small surcharges after alerting their users [3].

In December 2016, the Commission formally adopted a roaming fair use policy. [10]. In the fact sheets more details can be found [11]. "Operators can detect possible abuses based on the balance of roaming and domestic activity over a 4-month period: if a customer spends a majority of their time abroad and consumes more abroad than at home over these 4 months, the operator can ask the customer to clarify the situation within 14 days. This additional check will only affect customers who travel intensively, not more than 1% of the customers."

2.2.4 Mobile data use consumption

RLAH might be different depending on the contract at home. Since some operators offer contracts that include unlimited or very high data allowances for low unit prices. These offers do not exist in all member states, which implies a greater risk of abuse for the ones that do. More details about how RLAH will work can be found in the technical roaming fact sheet [12]:

- "For pre- paid metered contracts: when you go abroad, you can Roam like at Home up to the amount of credit remaining for that month, at the same prices you would pay at home. If you pay less per unit of data than the wholesale data price cap, you can use a data volume equivalent to the value of your remaining monthly credit at the wholesale roaming data price cap. You can top up your credit if necessary."
- "For the most competitive contracts offering data allowances at very low do-

mestic unit prices (below the wholesale cap): when you go abroad you will continue to enjoy your full allowance of calls and texts. For data, you will have twice the volume of data equivalent to the value of your monthly contract in terms of the wholesale roaming data price cap."

2.3 Research questions

The goal of this master dissertation is to analyse the economic impact of the new roaming legislation, starting in June 2017. To be able to quantify the impact of RLAH, it is important to know which effects the previous measures had because knowledge of the past is the key to the present and the savior of the future. Some questions are formulated to guide the research:

- Did the roaming volumes increase since the roaming regulation was imposed in the EEA?
- Which trends can be seen for the roaming volumes over the years and are the trends the same for all services (text, voice, data)?

These questions are interesting because volume increases are expected to happen when RLAH takes effect, but did they happen in the past? Based on the answers, assumptions can be made for the RLAH period. The literature study raised some questions about the RLAH period:

- Different types of operators exist and are discussed in section 2.1.2. RLAH will impact them differently. Will roaming still be profitable for all MVNOs?
- Will the gap in profit between an MNO and an MVNO increase and if so, by how much?
- Another discussed difference between operators is the sending behaviour of the inhabitants of their country. To which extent will RLAH have a different impact on sending an receiving countries.

In 2016 - 2017 a lot of articles were written about the abolishment of the roaming fees in which some concerns were raised. Roam like at home, to good to be true? A particular question that came to the surface is whether the potential loss in roaming

revenues for the providers will be passed on to the customer. The operators could recover the potential revenue loss by increasing the domestic retail prices or by increasing the price for roaming in the rest of the world (RoW). If they do so, by how much would the retail prices have to increase to recuperate this revenue loss in function of the increasing volumes? Does this increase differ for an MNO and an MVNO? Increasing the domestic retail prices or the roaming retail prices in the rest of the world can be an unwanted side-effect of abolishing the roaming fee. To know if this side-effect is likely to happen, a closer look can be taken to these prices and regulation in the past.

2.4 Summary

In this chapter the motivation for this master dissertation was clarified by performing an extensive literature study.

First some primary concepts were explained, these are necessary to understand the roaming legislation and to be able to conduct the implications RLAH will possibly have. These primary concepts included a general overview of the transactions when roaming. The difference between roaming and roaming like at home was also explained. Different types of operators were introduced: MNOs, MVNOs and multi-country operators. Then the importance of geographical location was explained. Some countries are netto-sending countries while others are netto-receiving countries, the influence of roaming like at home will be different for them. An example of a sending and a receiving country is given together with the possible effects on them when roaming like at home. To end the first section an explanation of traffic steering and its effect on competitive pricing is given.

In the second part an overview of the evolution of the roaming legislation in the EU is given. First of all three structural measures were given and explained. The single market measure wants to achieve a single telecommunications service market. The direct access measure ensures that MNOs have to meet all reasonable requests for wholesale roaming access. This means that an MVNO can directly negotiate international roaming agreements with the visited MNO. The separate sale measure

says that operators have to separate roaming and domestic offers, so that customers will be more aware of roaming prices. Then a historical overview is given of the roaming legislation. The introduction of the retail and wholesale caps is explained and an overview of the value of the caps over time is given. At the end of this section the European Commisions view on fair use limits and mobile data consumption when roaming like at home is summarised.

In the third and final part of this chapter the research question were listed with a short explanationd of why they are interesting. These questions will guide the research: first an analysis of the past, then the analysis of the RLAH period. These research question form the basis for all the chapters that come next. The goal is to find answers to these question through different methods and techniques.

Chapter 3

Lessons learned from qualitative data analysis

This chapter focuses on the collection and processing of data. The goal of the data analysis is threefold:

- obtain better insights in the evolution of roaming,
- answer some of the research questions
- and provide input for the model for the other research questions.

First and foremost the data analysis provides a first high-level overview of the impact of the roaming legislation to the end-user. Combining the volumes, the retail prices and the regulated caps, for example, provides an overview of the evolution of roaming over time. Secondly, the research questions about the past can be answered with the results of the data analysis. And at last, the processed data can later serve as input for the model needed to answer the other research questions. The insights can also help making rightful assumptions for the model and help to justify them.

The data analysis first focuses on the evolutions of EU/EEA roaming for which the roaming regulation applies. Did the volumes increase over time? Is the retail pricing competitive or do the operators ask as much as they are allowed to? How did the wholesale price evolve compared to the wholesale caps? Then the data analysis focuses on roaming in the rest of the world (RoW). Did the roaming legislation on

EU/EEA roaming influence the price setting for roaming in the rest of the world? For both sections two types of data are used: Belgian and European averages. The trends in this chapter are first analysed for Belgian MNOs. These results are then compared to the European averages, to see if the same trends apply.

3.1 Data Methodology

The first part of the data is supplied by the Belgian Institute for Postal services and Telecommunications (BIPT). The data focuses on the Belgian operators. It is gathered from three Belgian MNOs: Belgacom, Base and Mobistar. The data covers the period 1 July 2011 - 30 September 2016, split by calendar quarter, i.e. from the third quarter of 2011 until the third quarter of 2016. Some parts of the data, however, are only available since the third quarter of 2012. The data contains a variety of elements, including an overview of roaming volumes, the cost of roaming for mobile operators and the total revenue per service.

The second part of the data is gathered from benchmark data reports from the Body of European Regulators for Electronic Communications (BEREC). This data is similar to the data of the Belgian MNOs, but this time European averages are analysed, instead of data that only concerns Belgian MNOs. The period covered by the data varies, but is in general from the second quarter of 2007 until the first quarter of 2016. While the data provided by BIPT only focuses on MNOs, some MVNOs are also included in the European averages. BEREC reports that over 150 operators provided information, including some MVNOs. They estimate that approximately 95% of the customers using roaming services are covered in the data [9].

Remark: The number of operators who participated by providing information to BIPT or BEREC changes. This can also cause differences from quarter to quarter. This might for example effect the volumes from quarter to quarter.

The data is split into three categories. These are different kind of services: SMS, voice calls made and data. The data is represented per calender quarter.

In the provided data a distinction is made between three types of customers: pre-paid customers, post-paid customers and special corporate customers. Pre-paid customers are subscribers (residential and business) who pay for services in advance. They use 'top-up' facilities. Post-paid customers are subscribers (residential and business) who are regularly billed by their operator. They have a contract with their operator. Special corporate is a tariff that is not available to individuals. This tariff was negotiated. To belong to special corporate both the domestic and roaming tariffs need to be negotiated. These tariffs should not be included in any figure about the services. All the revenues in this section are therefore calculated as an average of the prices pre-paid and post-paid customers pay. All revenues exclude VAT.

To reveal the effect of the roaming legislation, the retail or wholesale cap is also added to the figures in this chapter. On 30 April 2016 the retail cap for SMS, voice calls made and data became relative to the domestic price and could no longer be represented by an absolute number. This is also indicated in the graphs. A summary of the wholesale and retail caps over time can be found in section 2.2.2.

3.2 Evolution of EU/EEA roaming

This section focuses on the evolution of roaming within the EU, to which the roaming regulation applies. The volumes, the retail prices and the wholesale prices are represented. They are compared to the retail and wholesale caps to reveal the effect of the roaming legislation.

3.2.1 Evolution of the volumes and retail prices per service over time compared to the retail cap

First of all the evolution of the volumes is analysed. The analysis focuses on the change in volume and retail price over time compared to the retail cap. The analysis is conducted separately for every service. These services are SMS, voice and data. The volumes are represented per quarter.

SMS

In figure 3.1 the evolution of roaming for text messages is represented for the Belgian MNOs. The total volume per quarter is indicated by bars and expressed in millions of messages. Its value can be read on the left axis. The average retail price for one SMS is also visualised on the same figure. This is the average revenue an operator receives for one SMS. The price can be read on the axis on the right. To reveal the effect of the roaming legislation, the retail cap is also added to the figure. In 2016 the retail cap for SMS became relative to the domestic price and could no longer be represented by an absolute number. This is also indicated in the graph.

Roaming traffic has a seasonal nature. This can be seen in graph 3.1. The volume peaks every third quarter. These are the months July, August and September. Tourism creates considerable seasonal variation. In the holiday season more subscribers are abroad. This explains the volume increase in every third quarter. Keeping the seasonal nature in mind, it is better to compare the volume in a quarter to the volume in the same quarter one year earlier. Only a small increase over time can be noticed, if the third quarter of 2016 is excluded, which is seen as a transitional period between the old roaming regulation and RLAH. The old regulatory measures, that were applicable since 2007, were replaced with new roaming tariffs, known as 'Roam Like At home +' (RLAH+), as of April 30, 2016 (see section 2.2.2). This can be a reason for the increase in volume in the third quarter of 2016. Another trend that can be noticed is that the average retail revenue per SMS remains close to the retail cap over time.

Figure 3.2 visualises the European averages. The average retail price is compared to the retail cap. This graph covers a broader period than the previous graph. In 2009 the Euro-SMS was introduced. The average retail price dropped from €0.27 in the first quarter of 2009 to €0.11 in the third quarter of 2009, after the regulation was introduced. Prices continued to drop to €0.05 in the fourth quarter of 2015, where the retail cap is €0.06. This gives a retail price reduction of 81% since 2009.

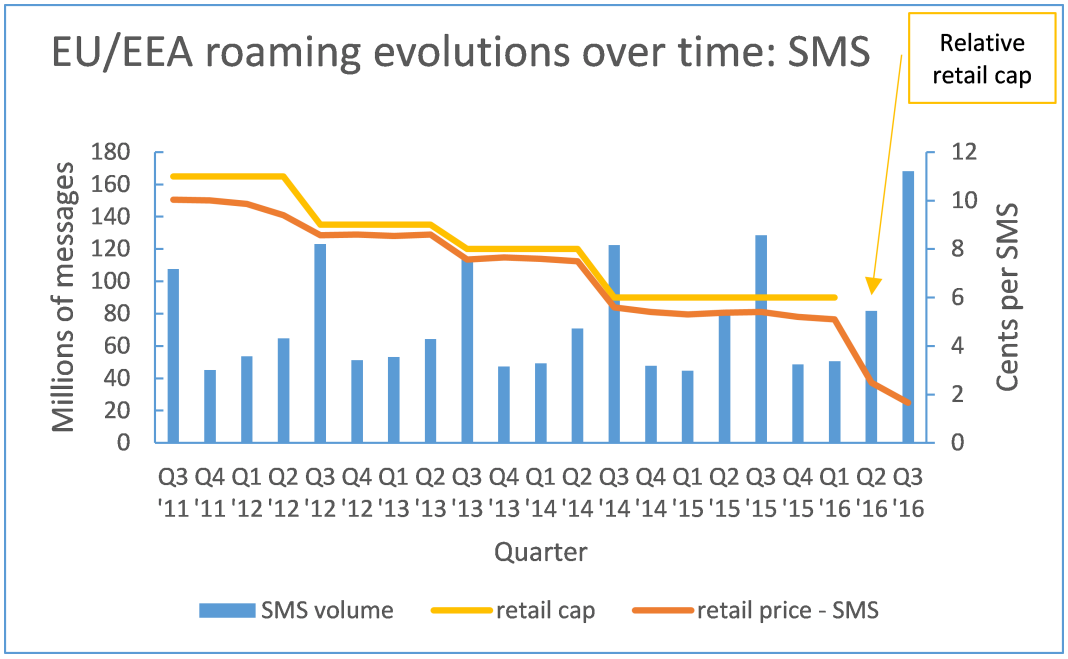


Figure 3.1: Roaming traffic has a seasonal nature. The volume peaks every third quarter. SMS volumes are quite stable over time, only a small increase can be noticed. The retail prices remain close to the retail cap. (Belgium)

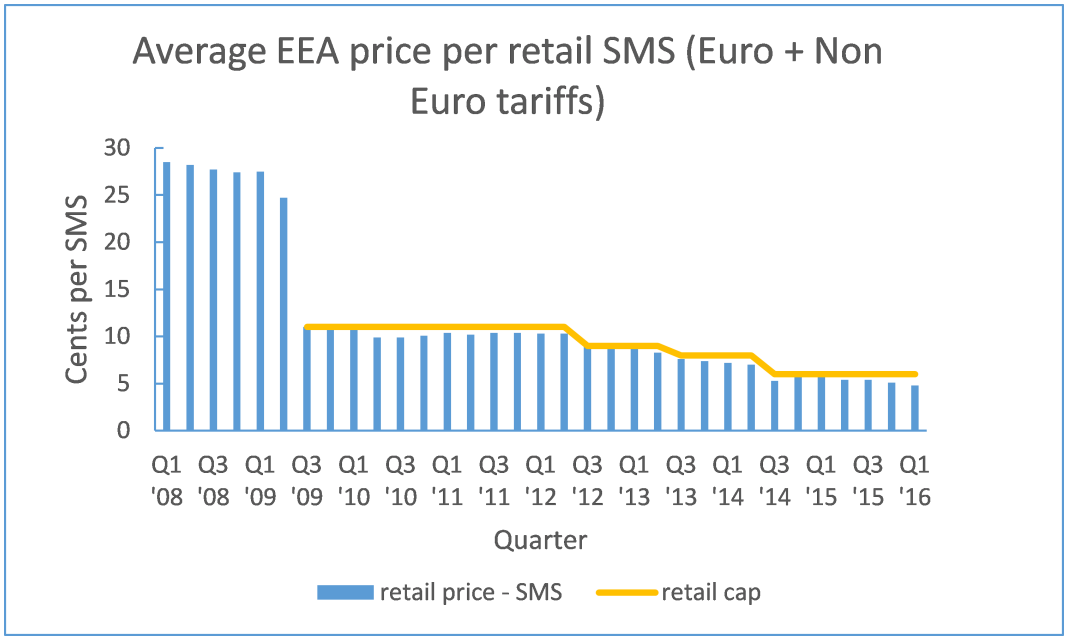


Figure 3.2: The average European retail price per SMS follows the regulated retail price cap.

Voice

The volumes and retail prices for voice services are expressed in a similar manner in figure 3.3. The volumes are expressed in millions of 'actual' minutes. I.e. the number of minutes used for the duration of a call as recorded in the call detail record (CDR). The revenues, however, are expressed per billed minute, because this gives a better overview of the real earnings.

The volumes of voice calls also show a peak every third quarter, confirming the seasonal nature of roaming traffic. The volumes also follow a slightly increasing trend. The European Commission stated that the seasonal nature of voice roaming traffic has a potential impact on the mobile network dimensioning costs for some countries since traffic concerning voice calls is quite stable. According to the European Commission this effect can be somewhat mitigated by the decrease in domestic volume of users moving into tourist areas[7].

The average revenue remains close to the cap but sometimes exceeds the retail price cap. This can for example be seen on the graph in the third and fourth quarter of 2012. This is due to the 30 second minimal initial charging interval. Phone calls shorter than 30 seconds increase the total revenue with the equivalent revenue of 30 seconds, but only increase the total volume with the actual duration. The outcome is a higher revenue per minute. It seems that operators are not inclined to compete on the retail rates because the retail revenues remain close to the caps, while the margin between the retail and wholesale prices is significant [9].

This result can also be seen for the European averages in figure 3.4. For voice calls made the price before the regulation is €0.698 and €0.614 for the second and third quarter of 2007. This drops to approximately €0.44 in 2008. The retail cap is €0.49 in the first half and €0.46 in the second half of 2008. The retail price remains fairly below the retail cap.

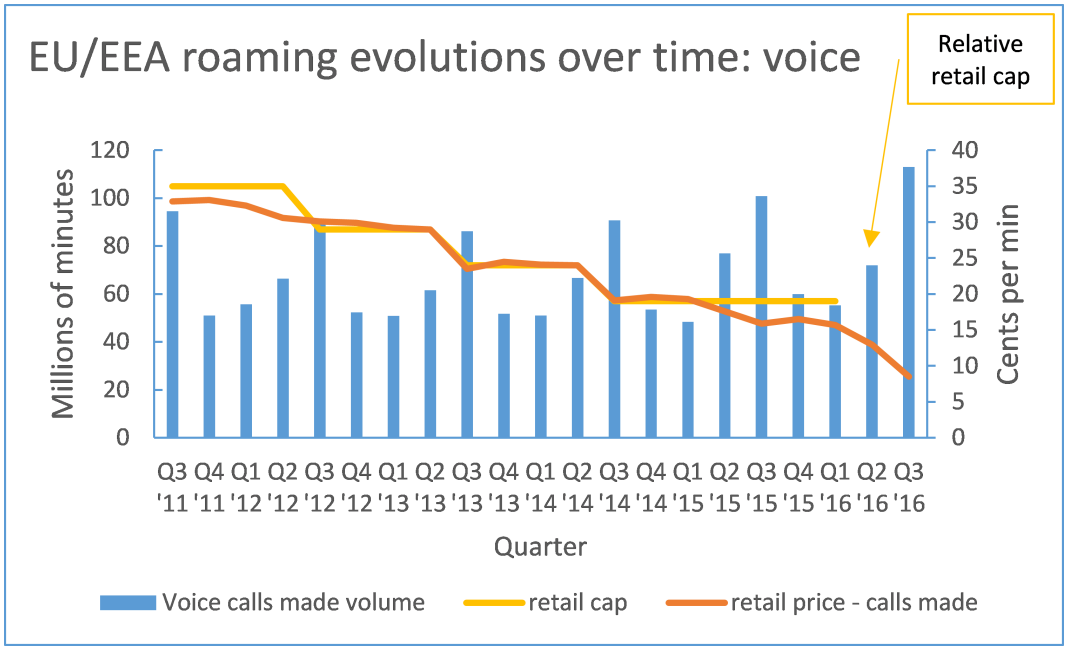


Figure 3.3: Roaming traffic has a seasonal nature. The volume peaks every third quarter. The volume of voice traffic is quite stable. It follows a slightly increasing trend. The average revenue per minute remains near the retail cap over time. (Belgium)

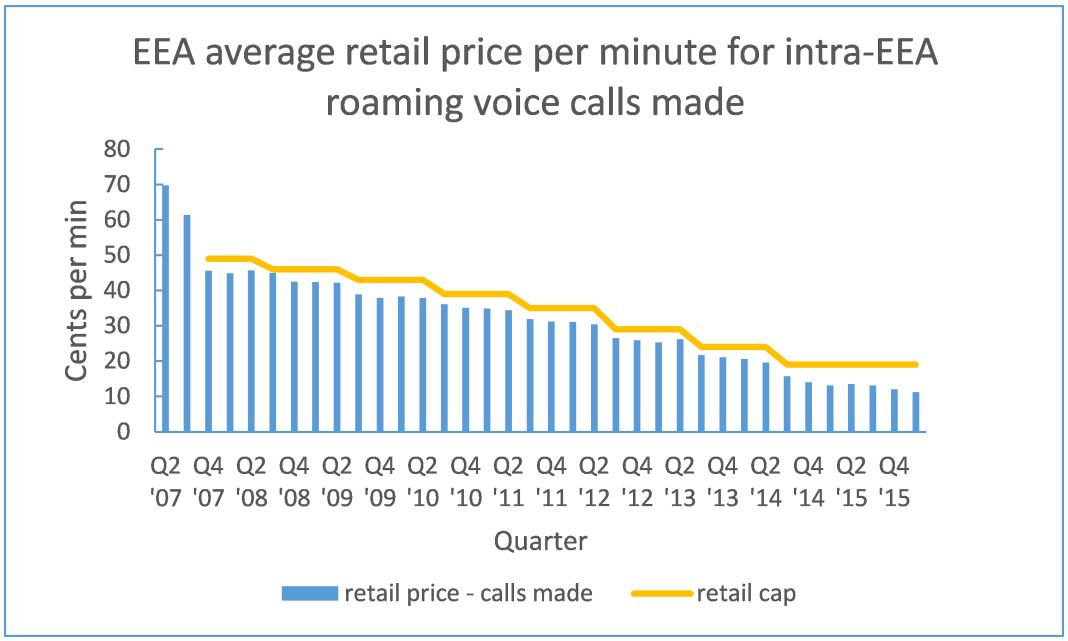


Figure 3.4: The average European retail price per minute voice call made follows the trend of the regulated retail cap.

Data

The seasonal nature of roaming can also be noticed for data services. The European Commission stated that this seasonal nature will not have an impact on the network dimensioning costs for data services in particular. There is a strong trend of increasing domestic data traffic. This increase means that the seasonal traffic peak will most likely be exceeded by the total domestic demand in the following year(s). The networks are dimensioned to cope with the increase in domestic volumes, and can therefore also cope with the seasonal nature of data roaming traffic [7].

While the volumes for SMS and voice services only make a minimal increase, data volume encounters a spectacular increase, especially in 2016. The European Commission also stated that the volume of data roaming in 2015 is more than 100 times the volume in 2008 [3]. In figure 3.6 the domestic data usage is compared to the usage when roaming in the EU. The roaming volume in the rest of the world (RoW) was not included in these totals. All the data is expressed in millions of MB, but to be able to compare the data, the vertical axis in fig 3.6b is one hundredth of the axis in fig 3.6a. The percentage increase from one year to the next is indicated. The large increase that can be seen for the data volumes when roaming in the EU, can also be seen in the domestic data volumes. The volume increases are similar in 2014 and 2015 for domestic traffic and roaming traffic. The stable volume for SMS and increasing volume for data can be explained by the increased use of applications on smarthphones and tablets. Smarthphones enable users to communicate via applications that use the internet suchs as WhatsApp instead of SMS and skype instead of voice calls. WiFi, which is available in more and more places, and the lowering retail price for data services encourages the use of these apps.

The average revenue per MB Data has dropped significantly since the retail caps were implemented. This can be seen in both graphs (3.5 and 3.7). The retail price is a lot lower than the retail cap. In the fourth quarter of 2007, the price per MB was €6.09. The first retail cap, €0.70, was introduced in the third quarter of 2012. The price dropped from €1.21 in the previous quarter to €0.51 and continued to drop to €0.05 in the first quarter of 2016, when the retail cap was €0.20.

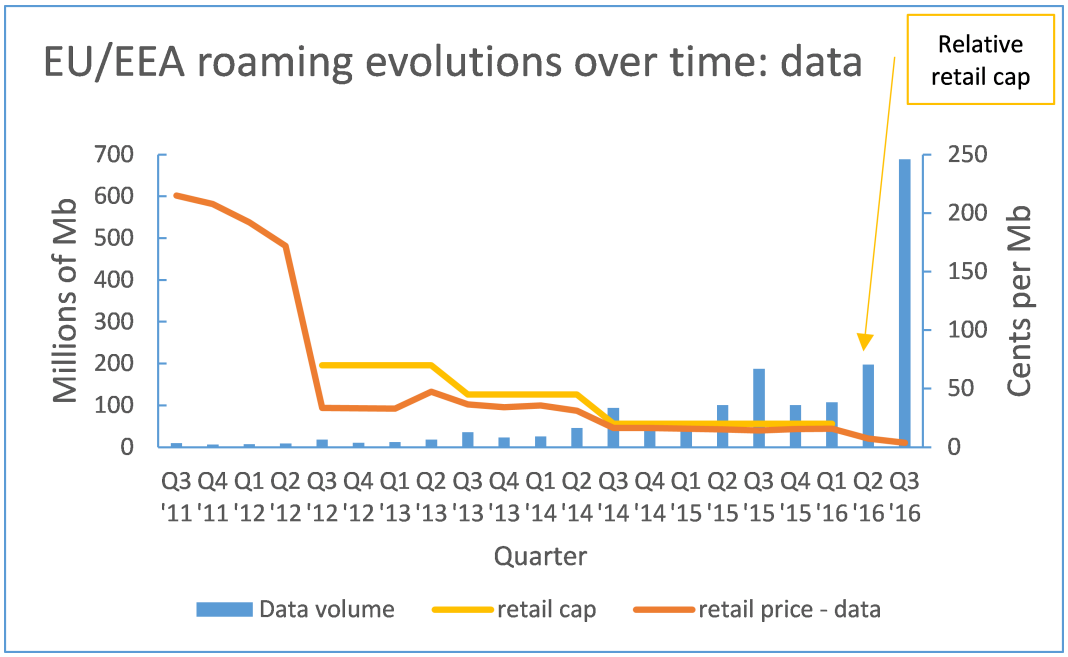
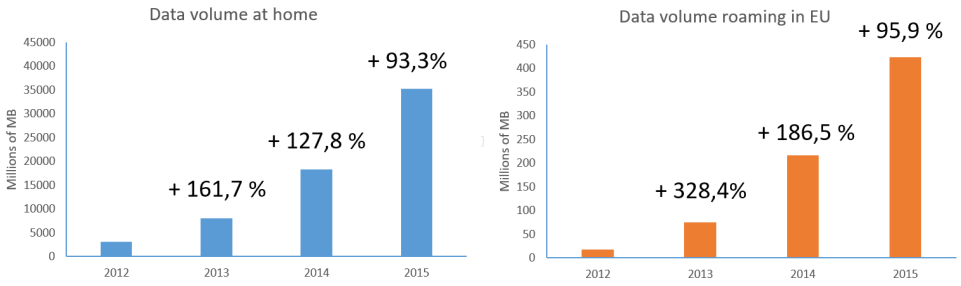


Figure 3.5: Roaming traffic has a seasonal nature. The volume peaks every third quarter. The volumes of data encounter a spectacular increase over time, especially in 2016. The average revenue per MB dropped significantly when the retail roaming regulation started. (Belgium)



(a) domestic data volume (b) roaming in the EU data volume

Figure 3.6: The increase in data volume is similar for domestic and roaming traffic.

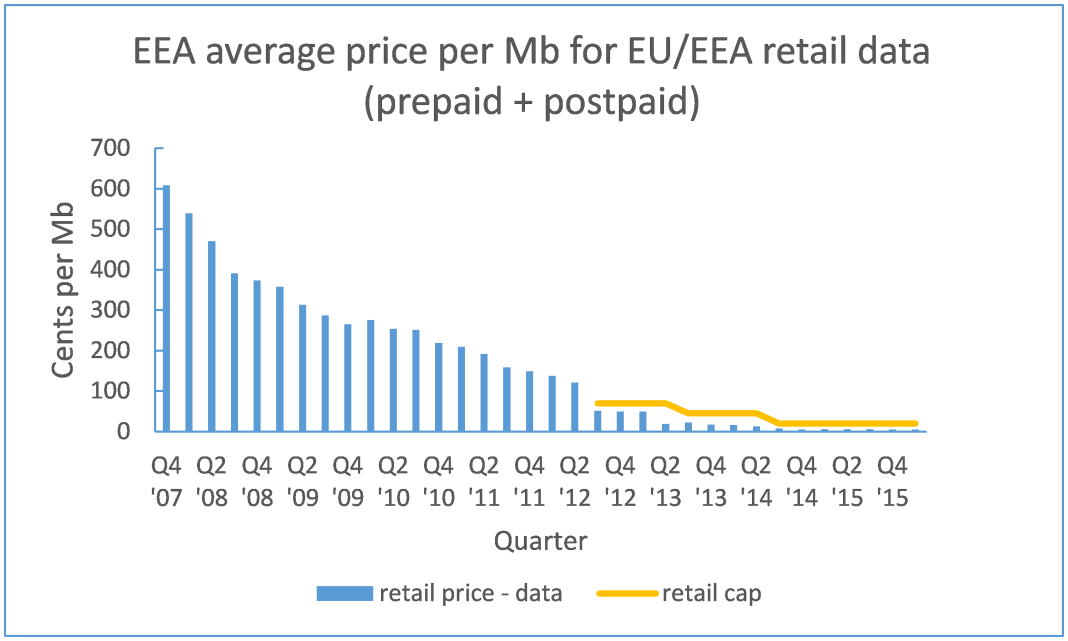


Figure 3.7: The average European retail price per MB drops significantly over time and remains fairly below the retail cap.

3.2.2 Evolution of the wholesale prices per service compared to the wholesale cap

In this section the evolution of the wholesale prices in Europe is discussed for the different types of traffic: SMS, voice calls and data. The prices are also compared to the wholesale caps.

SMS

Before the regulation of 2009, the wholesale price for SMS was €0.136 in Q1 in 2009, see figure 3.8a. The price dropped to €0.043 in Q3 in 2009. The drop in price follows the trend of the wholesale caps closely in the following quarters.

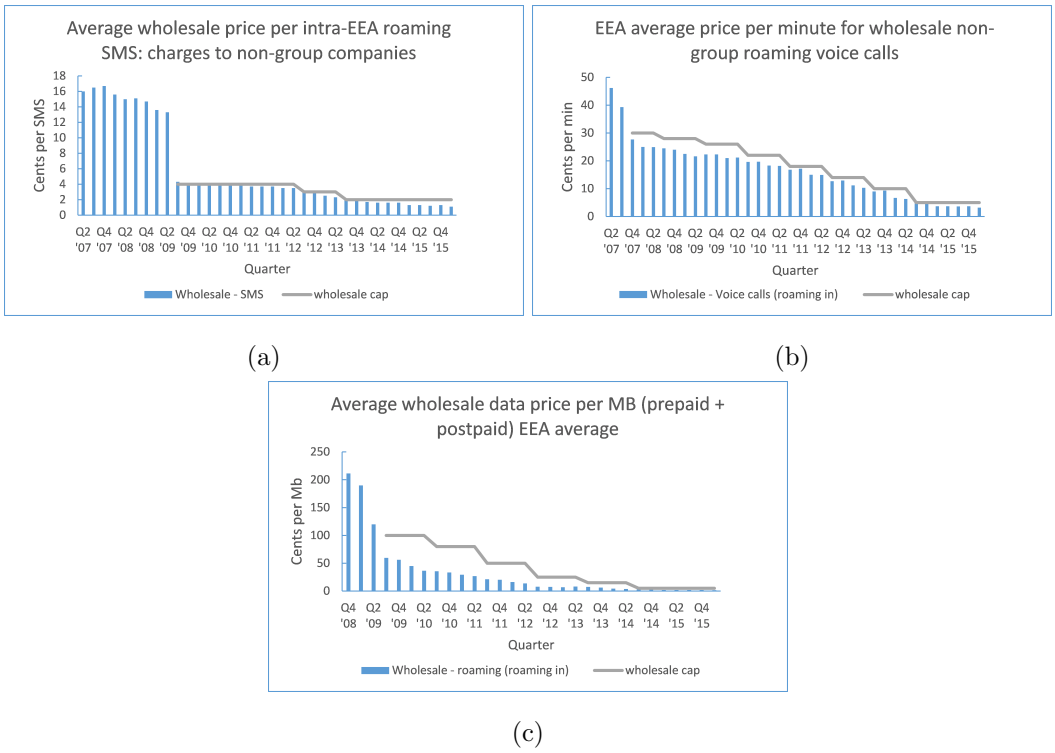
In the third quarter of 2009, the wholesale price exceeds the wholesale cap. When this happens, it is most likely because only the annual average price has to comply with the regulation, not the quarterly average price. Hence it is possible that some quarters compensate for others. It is also possible that there might have been inaccuracies in reporting [9].

Voice

The average wholesale price for voice calls followed a constant reduction over the previous years, but the trend has been flat since the third quarter of 2014. This trend is visualised in figure 3.8b. The wholesale price remains fairly below the wholesale cap.

Data

The wholesale data price remains near the wholesale caps (figure 3.8c). The price dropped from €1.20 in the second quarter of 2009 to €0.60 in the next quarter, when the wholesale roaming regulation was introduced.



(a) (b)

(c)

Figure 3.8: The average European wholesale prices follow a decreasing trend. The price remains fairly near the wholesale cap for SMS. For voice and data services the wholesale price remains fairly below the wholesale cap.

3.3 Evolution of roaming in the rest of the world compared to the legislation on roaming within Europe

This section focuses on roaming in the rest of the world (RoW), while the previous sections focused on roaming within Europe. Did the roaming legislation on roaming in the EU have an effect on the prices operators set for roaming in the rest of the world? Did the operators try to recover revenue losses within Europe with the revenues from outside of Europe?

The revenues are shown for each service in figures 3.9, 3.10a and 3.11a. For the voice calls made a shorter period is covered in these graphs. The period varies sometimes, depending on which data was available. There was no data available for the European averages for SMS services.

SMS

The average revenue per SMS for the Belgian MNOs (figure 3.9) is €0.38 in the third quarter of 2011 and decreases up to the second quarter of 2012, when it is €0.35. In the next quarter, the third quarter of 2012, the average revenue encounters a small increase of 18%. From this point on the price fluctuates around €0.40. In the third quarter of 2016, the price drops to €0.33. The difference between the start and end of the total period is a decrease of 5.32 cents per SMS. This is a decrease of 14.1 % in total. The percentage increase per quarter fluctuates around zero over time. The average of the percentage increase per quarter is -0.5 % over the period July 2011 - September 2016.

Similar data was not available for the European averages and is thus not discussed.

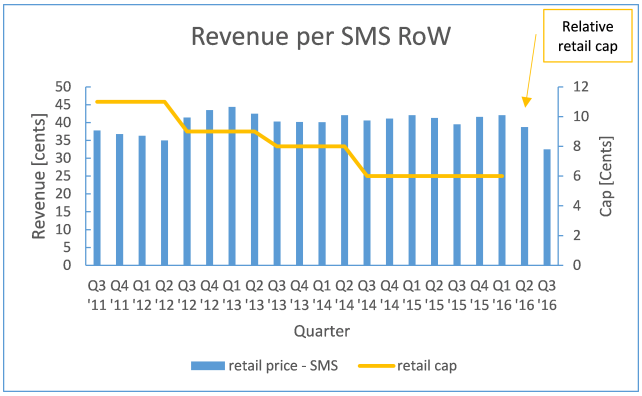
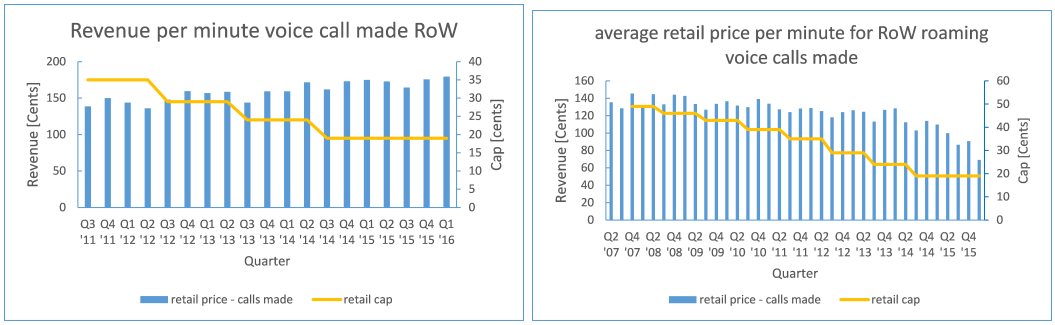


Figure 3.9: The revenue per SMS when roaming in RoW fluctuates around €0.40. The percentage increase fluctuates around zero. (Belgium)

Voice

The Belgian MNOs set an average retail price of €1.49 per minute of voice call made when roaming in the rest of the world in the third quarter of 2011. The price follows a slightly increasing trend. In the first quarter of 2016 the price is €1.79. The percentage increase over the total period is 29 % for calls made, which is an increase of €0.41 in total. The average percentage increase per quarter is 1.6 %, thus the price for voice calls made has slightly increased over time. (The data was not available for the second and third quarter of 2016.)

The European average shows a different, downward trend. The price before the roaming regulation was €1.35 in the second quarter of 2007. It was €1.24 in the third quarter of 2011, a low price compared to the Belgian average of €1.49 in that period. The price drops to €0.69 in the first quarter of 2016, more than 1 €less than the Belgian average. The total percentage decrease is 48 %, which is €0.66 per minute (over a period of 9 years). If the same period is considered as for the Belgian MNOs (starting in the third quarter of 2011, instead of in 2007), the total decrease is 44 % or €0.55. Then the average percentage decrease per quarter is 2.8% instead of 1.6 % for the total period covered.



(a) For the Belgian MNOs the revenue follows a slightly increasing trend.

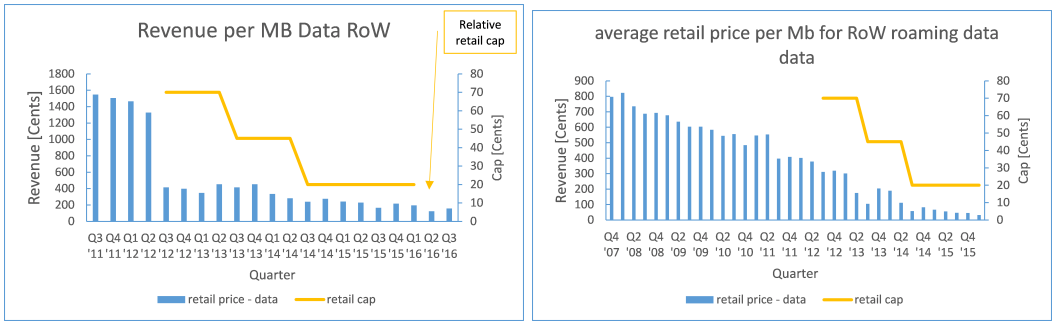
(b) The average European revenue follows a decreasing trend.

Figure 3.10: The average retail price per minute of voice call made for RoW roaming, Belgian MNOs compared to the European average

Data

The average retail price per MB for Belgian MNOs has dropped significantly since the roaming legislation has been introduced. In the third quarter of 2011, one paid €15.48 per MB. The price dropped to €4.15 in the third quarter of 2012 and continued to drop. The price per MB is €1.58 in the third quarter of 2016. The average percentage increase per quarter is -7.3 % over the entire period. The total percentage decrease from the third quarter in 2011 until the third quarter of 2016 is 89.8 %, which is good for €13.9082 less per MB of data used.

The average European price per MB was €7.97 in the fourth quarter of 2007. In the third quarter of 2011 one paid €3.97 per MB, which is almost €12 less than Belgium customers paid. The price dropped to €0.33 in the first quarter of 2016. This is a decrease of 96 % over total period of the graph, or €7.64. The average percentage decrease per quarter is 6.38 %. If the same period is considered as for the Belgian MNOs, the total percentage increase was 91.8 %, or €3.64. The average percentage decrease per period was 8.27 %.



(a) For the Belgian MNOs the revenue per MB data when roaming in RoW has decreased with 89.8 %.

(b) The European average of the revenue per MB data when roaming in RoW has decreased with 91.8%

Figure 3.11: The average retail price per MB for RoW roaming, Belgian MNOs compared to the European average.

3.4 Summary

The goal of this chapter was threefold. First of all to obtain insights in the evolutions. Secondly, to answer some of the research questions. And at last, to be used as input data for the model needed for the other research questions. These insights can also help making rightful assumptions for some parameters in the model.

First of all the methodology of the data collection was explained. Then the chapter was split in two parts. The first part analysed roaming within the EU/EEA. The second part focused on roaming in the rest of the world and the possible influence of the legislation within Europe. The analysis of each part first focused on data gathered from three Belgian MNOs. Then the results were compared to the European averages, to see if the same trends apply. The most important findings are the following:

- **Spectacular increase in volume of data services**

  The roaming volumes for SMS and voice calls are quite stable. They follow a slightly increasing trend over time. The roaming volumes for data services, however, make a spectacular increase. A similar increase is visisble for the domestic data traffic. Smarthphones enable users to communicate via applications that use the internet suchs as WhatsApp instead of SMS and skype

instead of voice calls. WiFi, which is available in more and more places, and the lowering retail price for data services encourages the use of these apps.

- **Seasonality**

  Roaming traffic has a seasonal nature for all services: every third quarter the volume peaks. These are the months July, August and September. This is the holiday season. Tourism creates considerable seasonal variation. The European Commission stated that the seasonal nature of voice roaming traffic has a potential impact on the mobile network dimensioning costs for some countries since traffic concerning voice calls is quite stable. According to the European Commission this effect can be somewhat mitigated by the decrease in domestic volume of users moving into tourist areas[7]. For data services the seasonal nature will not have an impact on the network dimensioning costs in particular. There is a strong trend of increasing domestic data traffic. This increase means that the seasonal traffic peak will most likely be exceeded by the total domestic demand in the following year(s). The networks are dimensioned to cope with the increase in domestic volumes, and can therefore also cope with the seasonal nature of data roaming traffic.

- **Steady RoW prices**

  The European average of the retail roaming price in the rest of the world shows a downward trend for all services. The operators did not increase the retail price for roaming in the rest of the world to make up for the loss of revenue due to the roaming legislation within EU countries which lowered the regulated caps.

- **Significant margin between the retail and wholesale prices**

  The retail price per SMS and per minute voice call (made and received) remain rather close to the retail cap. For data services the retail price remains fairly below the retail cap. The regulation has led to a constant reduction in the average EU wholesale prices for intra-EEU roaming voice calls. These trends indicate that operators are not inclined to compete on the retail rates because the retail revenues remain close to the caps, while the margin between the retail and wholesale prices is significant.

Chapter 4

Building blocks of the model

In this chapter the model that is constructed to calculate the total revenue is explained. The building blocks of the model, each consisting of smaller building blocks, is explained in detail. Their parameters and calculation methods are clarified. The input parameters and the possible output parameters are also explained. An overview of the model, the input parameters and the output parameters can be seen in figure 4.1. All abreviations are explained in the corresponding section.

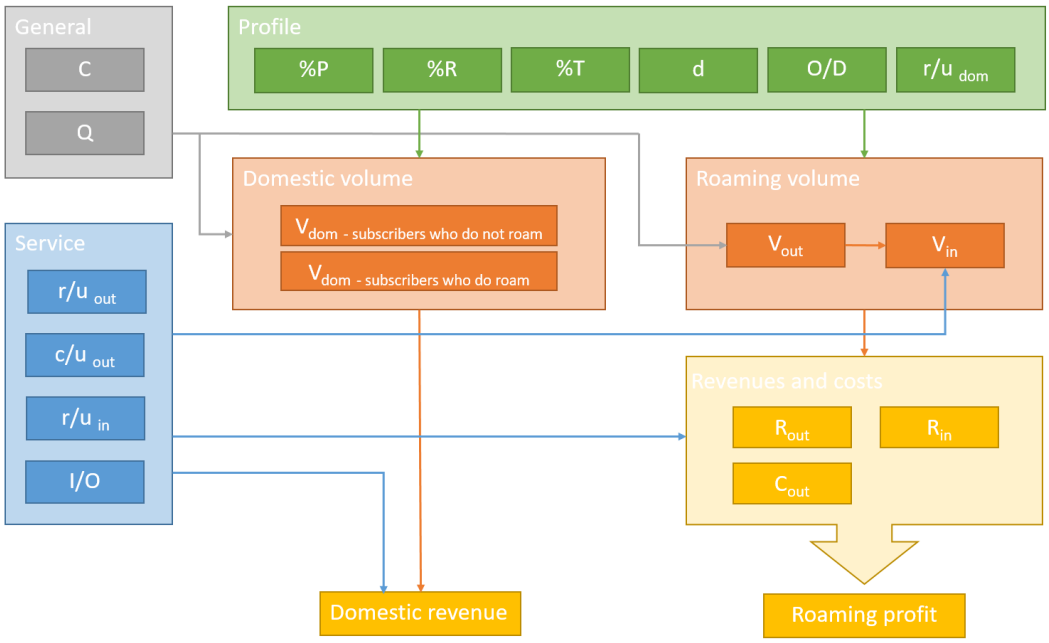


Figure 4.1: Overview of the model

4.1 Input for the model

The input of the model is divided into three categories: general information, services and profiles. These are visualised as a grey box, a blue box and a green box in the overview. The first category is general information. This includes input parameters that are not service or profile specific. These are parameters that are the same for all services and all profiles. The seconds categorie, services, is defined by some revenues, some costs and an inbound outbound ratio. This ratio is service-specific. To be able to calculate the volumes later on, parameters about the usage are included in the profiles. Profiles are also service-specific. This makes it possible to model every type of user.

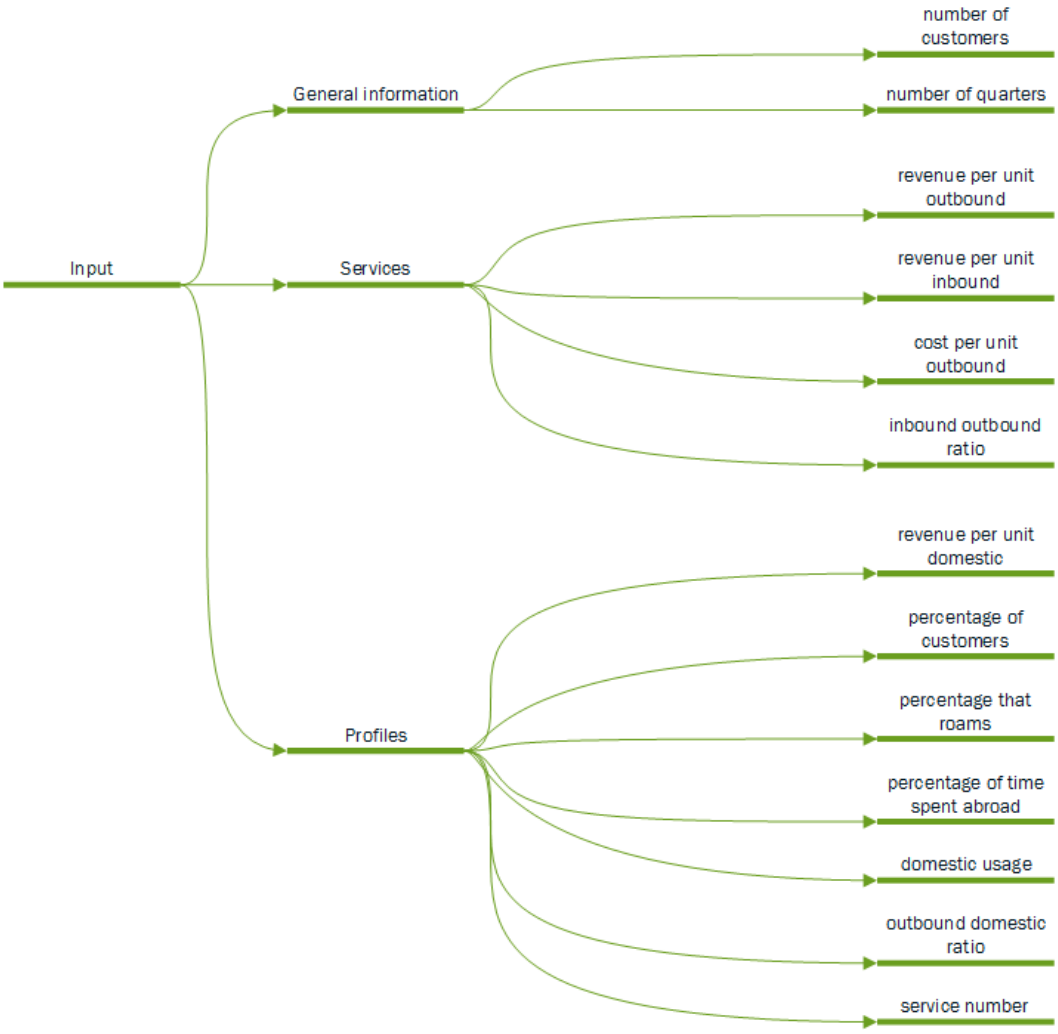


Figure 4.2: Overview of the input of the model

4.1.1 General information

Some general information about the provider or about the time horizon is needed to build the model. To be able to do the calculations of the volumes and revenues, two general input parameters are needed:

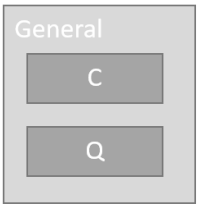


Figure 4.3: Inputparameters: general information

- **Number of customers [C]**

  The customers are divided into different profiles per service. To know how many customers belong to a profile (as an absolute number), the total number of customers has to be known. Afterwards, this number is used in the calculation of the volumes and the corresponding revenues.

- **Number of quarters that are considered [Q]**

  The model will calculate the volumes and revenues for each quarter over a certain amount of time. The time horizon is thus also an input parameter of the model.

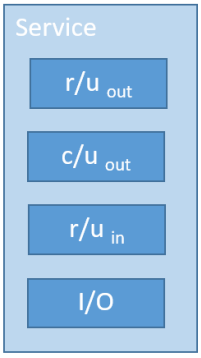


Figure 4.4: Inputparameters: service

4.1.2 Services

In this model three services are included: SMS, voice and data. These services each have their contribution to the total revenue. Each service can be defined by four parameters. These parameters are necessary to calculate the total revenue later on in the model.

- **Average revenue per unit outbound roaming within the EU [r/u $_{out}$]**
  When a subscriber of a domestic operator goes abroad and uses the mobile network of a foreign operator for a service, it is called outbound roaming. The customer is charged when he uses the service abroad in the EU (in another country than the country of its subscription). The charge to the customer for this type of roaming is also a revenue for the operator and thus an input parameter for each service.

- **Average cost per unit outbound traffic within the EU [c/u $_{out}$]**
  Outbound roaming also has a cost. The domestic operator has to pay a fee to the foreign operator for the usage of its network. This is known as the interoperator tarrif.

- **Average revenue per unit inbound roaming within the EU [r/u $_{in}$]**
  The other type of roaming, included in this model, is inbound roaming. If a subscriber of another foreign operator uses the network of the domestic operator for whom this model is used, the foreign operator will have to pay a fee to the domestic operator. This charge is thus, again, a revenue for the operator in consideration.

- **Inbound outbound ratio [I/O]**
  Some countries have more inbound than outbound traffic, these are receiving countries. Others countries have more outbound than inbound traffic: sending countries. (For more information see section 2.1.3.) The inbound outbound ratio is included in this model to calculate the inbound volume later on. The inbound volume is defined in function of the outbound volume. This parameter also enables to test the influence of this ratio on the revenue with the model.

4.1.3 Profiles

Different types of customers have different needs. They use different amounts of each service. Some of them roam, others may never roam. How much time do they spent abroad on average? To make this distinction in the model different profiles are created. They all have the same input parameters, but with different values. A profile can be defined by five input parameters:

Figure 4.5: Inputparameters: profile

- **Percentage of customers who have this profile [%P]**
  Each profile has a different usage pattern, therefore they will yield different volumes and therefore different revenues. To be able to calculate this later on, the number of customers with this profile needs to be known. The first parameter is the percentage of the total number of customers that has this profile for the service the profile belongs to.

- **Percentage of the customers of this profile who roam [%R]**
  For each profile, the customers who have this profile can be divided into two categories: the customers who roam and the customers who never roam. The customers who never roam should be excluded from the volume calculations cencerning outbound and inbound roaming. They do not make use of services abroad. They only provide domestic revenues. Due to the seasonal effect, the percentage of customers with a certain profile who roam will vary throughout the year, depending on the quarter. It is likely that more people will roam in the summer months (third quarter), thus the parameter will have a higher value in this quarter.

- **Percentage of time that the customers of this profile who do roam, spend abroad per quarter [%T]**
  The usage pattern of customers might be different when abroad. To be able to calculate the domestic and outbound volumes properly, the average time

abroad per quarter should be known. The parameter is expressed as a percentage of time.

- **Average domestic usage [d]**

  This is the volume the customer would use if he was in the country of his subscription. Since each profile applies to one kind of service, as will be elaborated later on, this usage is defined for a certain type of service.

- **Outbound domestic ratio [O/D]**

  The outbound volume is defined as a percentage of the domestic volume. If this percentage is equal to 100, a customers' usage is the same aborad and at home. If the ratio is 90% and the domestic usage for sms services is for example 1000 text messages in a quarter, then the customer would use 900 text messages if he would be abroad the whole quarter.

- **Average revenue per unit for domestic usage [$\mathbf{r/u_{dom}}$]**

  This is the charge to the customer if he uses the service in the country of its subscription. He is charged per unit of this service. For SMS services this means per text message, for voice calls made the unit of charge is a min and for data services the unit of charge is a MB. In this model the charge to the customers is a revenue for the operator. This input parameter is an average revenue. All customers pay the same unit price.

- **Service number**

  Each profile belongs to one, and only one, service. To be link the profiles to the correct service, the different types of services are given a number. SMS has number 1, voice number 2 and data number 3. The profile gets the service number of the service it belongs to as input parameter. This parameters is only used in the implementation. Not in the actual model.

4.2 The model

In this part the calculations to obtain the output are explained. The volumes and revenues are calculated for three different types of traffic: domestic traffic, outbound roaming and inbound roaming. The last two togheter represent the roaming volumes and roaming profit. (More information see section 2.1.3.) Different types of traffic need different methods to calculate the volumes and revenues. Each of these methods is elaborated in this section for each type of traffic.

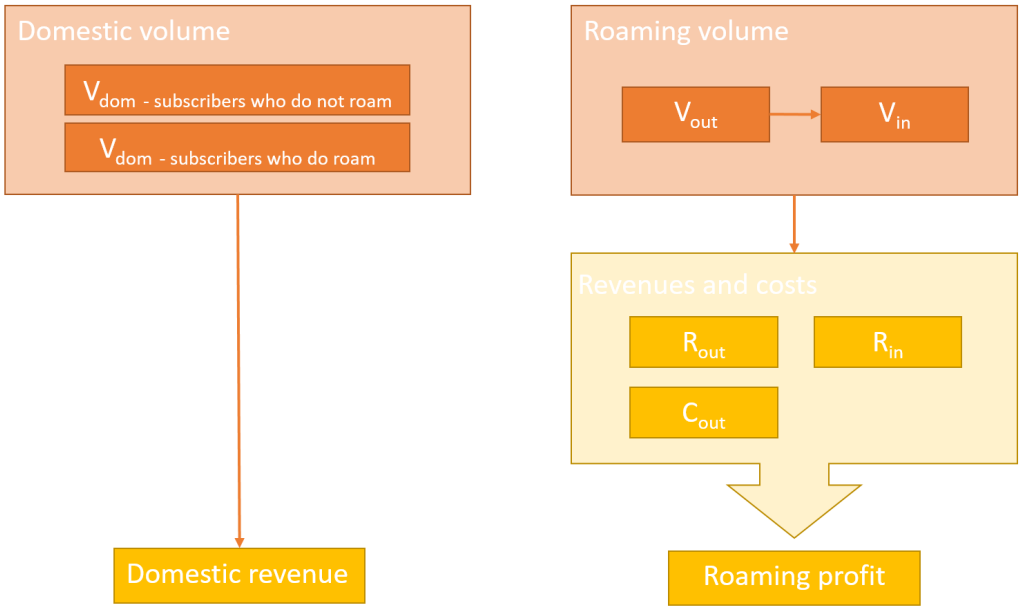


Figure 4.6: overview of the body of the model

4.2.1 Calculation methods for the different traffic types

The volumes and revenues are calculated for each combination of a service and a profile that belongs to the service. Three variables are created: the total domestic revenue, the total outbound revenue and the total inbound revenue. These represent the revenue for each type of traffic, over all profiles and all services. The total revenue is equal to the sum of these three types of revenues.

4.2.2 Calculation of the volumes

With the provided input parameters, the volumes can be calculated for every combination of a service and one of the profiles that belong to this service.

Domestic volume [$\mathbf{V_{dom}}$]

The volume is calculated for the combination of a type of service and a profile. First of all, the number of customers belonging to that profile needs to be known. The percentage of customers belonging to this profile is an input parameter. The total number of customers is as well. The needed input parameters are the following:

- C: total number of subscribers
- %P: percentage of total number of customers that have this profile for this service
- %R: percentage of the customers belonging to this profile that roam
- d: average domestic usage
- %T: percentage of time spent abroad

The domestic volume can than be split up in two categories. The total domestic volume used by the subscribers who do not roam in that quarter and the total domestic volume used by the subscribers who do roam.

The total domestic volume used by the subscribers who do not roam in that quarter is given by:

$$\mathrm{V}_{\text{ domestic - subscribers who do not roam}} = C \cdot \%P \cdot (100 - \%R) \cdot d \tag{4.1}$$

The total domestic volume used by the subscribers who do roam in that quarter is defined by an extra factor: the time they spend abroad, or rather the time spend at home. This calculation is based on a homogenous use of the average domestic usage. When a person is abroad, he has no domestic usage. The domestic usage is defined as the volume he uses in the whole quarter. This volume will not be used in total of he spends some time in a foreign country. The total domestic volume of these customers is given by:

$$\mathrm{V}_{\text{ domestic - subscribers who do roam}} = C \cdot \%P \cdot \%R \cdot (100 - \%T) \cdot d$$

The total volume is given by the sum of both:

$$\mathrm{V}_{\text{ domestic}} = \mathrm{V}_{\text{ domestic - subscribers who do not roam}} + \mathrm{V}_{\text{ domestic - subscribers who do roam}}$$

Outbound volume [$\mathbf{V_{out}}$]

The following parameters are needed to calculate the outbound volume:

- C: total number of subscribers
- %P: percentage of total number of customers that have this profile for this service
- %R: percentage of the customers belonging to this profile that roam
- d: average domestic usage
- %T: percentage of time spent abroad
- O/D: outbound domestic ratio

The outbound volume is only generated by subscribers who do roam in that quarter. Their volume is dependent of the time they spend abroad. The calculation is again based on a homogenous use of the average domestic usage. The outbound domestic ratio is an indicator of how much a subscriber belonging to this profile uses the service. If the ratio is 100%, then the consumption is the same abroad as at home.

The total outbound volume used is:

$$\mathrm{V}_{\text{ outbound}} = C \cdot \%P \cdot \%R \cdot \%T \cdot d \cdot O/D$$

Inbound volume [$\mathbf{V_{in}}$]

The following parameters are needed to calculate the inbound volume:

- $\mathrm{V}_{\text{ outbound}}$: the outbound volume
- I/O: the inbound outbound ratio.

The total inbound volume is calculated as a fraction of the total outbound volume:

$$\mathrm{V}_{\text{ inbound}} = \mathrm{V}_{\text{ outbound}} \cdot I/O$$

4.2.3 Calculation of the revenue

With the provided input parameters and the calculated volumes, the revenues can be calculated for each combination of a service and one of the profiles that belong to this service. The formulas for calculating the revenues are the same for every type of service, but they are different for each type of traffic.

Domestic revenue

The domestic revenue is easily calculated now that the domestic volume is know. The domestic revenue is equal to the domestic volume multiplied by the revenue per unit of domestic usage. The last parameter is an input parameter of the service and thus known. The needed input parameter is:

- $\mathrm{r/u}_{\mathrm{domestic}}$ = the revenue per unit of domestic usage

$$\mathrm{R}_{\mathrm{domestic}} = \mathrm{V}_{\mathrm{domestic}} \cdot \mathrm{r/u}_{\mathrm{domestic}}$$

Outbound revenue

The interoperator tarrif is also included in this model as a cost. The profit of outbound roaming is calculated as the revenue an operator receives from the customers minus the interoperator tarrif. The needed input parameters are:

- $\mathrm{r/u}_{\mathrm{outbound}}$ = the revenue per unit of outbound roaming
- $\mathrm{c/u}_{\mathrm{outbound}}$ = the cost per unit of outbound roaming

$$\mathrm{P}_{\mathrm{outbound}} = (\mathrm{V}_{\mathrm{outbound}} \cdot \mathrm{r/u}_{\mathrm{outbound}}) - (\mathrm{V}_{\mathrm{outbound}} \cdot \mathrm{c/u}_{\mathrm{outbound}})$$

Inbound revenue

The inbound revenue is calculated in a similar manner as the domestic revenue. The revenue is equal to the volume of inbound roaming multiplied with the revenue per unit. The needed input parameter is:

- $\mathrm{r/u}_{\mathrm{inbound}}$ = the revenue per unit of domestic usage

$$\mathrm{R}_{\mathrm{inbound}} = \mathrm{V}_{\mathrm{inbound}} \cdot \mathrm{r/u}_{\mathrm{inbound}}$$

4.3 Output of the model: total revenue

The model can generate multiple output parameters. The first parameter that is intersting is the total profit. This is the sum of the profits for all types of traffic (domestic, outbound and inbound) and for all services (SMS, voice and data) in combination with their profiles. The focus of this thesis is roaming. Therefore, it is also interesting to know the roaming profit, separately from the domestic profit. This profit is calculated for all services separately and as the sum over all services. Other parameters that the model calculates are the volumes for each type of traffic and for each service.

4.4 Assumptions

This model is an abstraction of the reality. Some assumptions have been made, to be able to model the volumes, revenues and costs. These are explained in this section.

- **The model is applicable on countries on whom the legislation is applicable**

  This model is meant to reveal the effect of the roaming legislation on operators in countries on whom the legislation in applicable. The legislation holds in the EU, including the islands belonging to a European country, and in three countries with who an agreement is concluded: Iceland, Liechtenstein and Norway.

- **RoW roaming excluded**

  The output of the model is the total revenue. This output parameter includes the revenues from domestic, outbound and inbound traffic for three services: SMS, voice and data. Revenues and costs from roaming in the rest of the world (RoW) are not included in this model. The model focuses on the effects the roaming legislation will have in the EU.

- **Voice calls received are excluded**

  Three services are included in this model. These are: SMS, voice calls made and data. Any other service can however easily be added.

- **All customers pay the same unit price**

  Customers have different subscriptions, with different retail prices per unit. In this model the revenues are based on the average price a customer pays. They all pay the same price per unit.

- **Interoperator tarrif is the same, regardless of the country the subscriber is roaming in and regardless of the foreign operator**

  Depending on the negotiations, the operator might have a better deal with some operators than with others. The interoperator tarrif will be different, depending on this contract. In the model, the average interoperator tarrif is used for the calculations. There is no distinction made between foreign operators, they all offer the same for the same price. This also excludes traffic steering from the model. Since the foreign operators all charge the same tarrif, there is no preference for one or the other.

- **Network and labour costs are not included**

  The costs to offer connectivity also include labour costs, property costs, spectrum costs and so on. Depending on the geopgraphical location these costs will differ. These costs are not included in this model. What is included in this model, is the interoperator tarrif. This cost is included to be able to reveal the effect of roaming like at home.

4.5 Implementation

In this section, the implementation of the model will be discussed. The model is implemented in Java. To do so, the TESS-environment is used. This is a programming environment in Java, designed by UGent. Techno-economic models are implemented in this environment. It is used to create models that are economically evaluated over a certain time period. The most important element of this environment is the TimeFunction. This function represents time series. Calculatons can be done with these TimeFunctions, such as additions, subtractions, multiplications... The UML diagram of the model is visualised in appendix A.

4.6 Summary

In this chapter the model was described that will be used to analyse the RLAH period. First of all the input parameters of the model were explained. Then the building blocks of the model and the calculation methods within these building blocks. These calculation methods are used to calculate the volumes and revenues for all three types of traffic and all services. This is the output of the model. The next step is to determine the default values of the input parameters of the model. This will be done in the next chapter.

Chapter 5

Methodology for default input variables

Now that the model is implemented, the input parameters have to be defined. In this chapter the methodology to obtain the default values for these parameters is explained. First a decision is made for the general parameters. Then the input parameters of the profiles are discussed and finally the ones of the services. The methodology is different depending on the time period. Most of the data was available from June 2012 until September 2016[1]. For the rest of 2016 and 2017 the method had to be adjusted. In June 2017 the new roaming legislation starts. This will also effect some of the parameters.

5.1 General information

The general information needed in the model is the number of customers and the number of quarters that are considered. The first one can be adjusted every time the model is executed. For now, 10 000 000 customers are assumed, which matches the number of SIM cards included in the data from BIPT [24]. It is thus possible to compare the results of the model with the data from BIPT. The calculations in the following sections are not based on the total number of customers, but percentages. The considered time period starts in June 2012 and models the revenues up to the

[1]Time period can differ depending on the parameter

second quarter of 2018. Thus, the period consists of 24 quarters. Both the past when the old roaming regulation applied as the transition period as one year of RLAH is simulated.

5.2 Profiles

In the model different user profiles can be created. The value of these input parameters of these user profiles are based on multiple sources. Parameters regarding domestic traffic are based on historic averages reported by BIPT [18] [17] and profiles designed by BIPT [19]. For the parameters that are needed in the model to calculate the outbound roaming revenues and costs, most of the calculations for their default values are based on data found in the excel files that were provided by BIPT [24]. (The same files that were used in chapter 2.) The inbound-outbound ratio was found in a report from BEREC [21]. All these calculations are now discussed in more detail per parameter.

5.2.1 Percentage of customers who have this profile

This parameter indicates the total number of customers that have a certain profile for the service the profile belongs to. BIPT reported the number of active SIM-cards (without M2M) per type of operator (See table 5.1) [17]. For MNOs the SIM-cards are split up between post-paid and pre-paid cards. Their market share (only considering MNOs) can be found in table 5.2. In 2016, data from [24] is used. In the third quarter of 2016 7.401 million subscribers used a postpaid card, while 2.711 million subscribers used a prepaid card. The total number of prepaid and postpaid cards in the model is defined by these percentages. The percentages of 2016 are used, because the profiles do not have an influence on the past due to the values of other input parameters. This is explained in the next paragraph.

In [18] the number of SIM-cards is given by purpose: 'voice only', 'voice and data', or 'data only'. This is given for the residential market and the business market from 2013 to 2015 (table 5.3). The number of 'data only' SIM cards in negligable. The percentage of SIM-cards used for voice only is 40% and the percentage of SIM-cards used for voice and data is 60%.

Table 5.1: Number of active SIM-cards (without M2M) per type of operator (in millions)

	postpaid MNO	prepaid MNO	light MVNO	full MVNO
2012	6.380	4.061	1.351	0.522
2013	6.580	3.662	1.106	0.966
2014	6.803	3.309	881.000	1.742
2015	7.079	3.139	922.000	1.798

Table 5.2: percentage of clients with postpaid or prepaid card

	postpaid (%)	prepaid (%)
2012	61.11	38.89
2013	64.25	35.75
2014	67.28	32.72
2015	69.28	30.72
2016*	73.19	26.81

Table 5.3: The number of SIM-cards per purpose for residential and business usage.

	Residential			Business		
	voice only	voice and data	data only	voice only	voice and data	data only
2013	4.410	3.900	0.220	0.890	1.290	0.280
2014	3.900	4.310	0.280	0.680	1.420	0.420
2015	3.320	4.940	0.280	0.580	1.640	0.430

Before 2016, the percentage of customers who have a certain profile will not have an influence - with the current input parameters - since the domestic volume is kept constant for all profiles. In 2016, however, this percentage influences the total domestic volume and therefore also the total outbound and inbound volumes. Therefore a general distribution is proposed for all years. This distribution will be

used for all quarters. It takes into account that 73% of the customers have a post-paid subscription and that 35% of the customers do not use data services. In 2017, the same percentages are used as default values.

5.2.2 Average domestic usage

BIPT reported the average used volume per service per active SIM card per year from 2012 until 2015 [17]. In a similar report from 2013 the data usage is given per active SIM-card that is enabled for data services [18]. In the report from 2015 [18], however, the average usage is calculated per active SIM-card. This includes the ones that do not use data services. In the model the average usage per SIM-card that uses data services is needed. Thus, the average data usage in 2014 and 2015 has to be recalculated. In the report from 2013 the number of SIM-cards is given, with their purpose: 'voice only', 'voice and data', or 'data only'. This is given for the residential market and the business market from 2013 to 2015 (see table 5.3). The number of SIM-cards per purpose is used to calculate the average domestic volume for data per active SIM-card for which the purpose includes data services, instead of per active SIM-card. The number of SIM-cards per purpose (residential and business combined) enables the calculation of the percentage of SIM-cards that is only used for voice services. The average volume per user for data services in 2014 and 2015 is now multiplied by the number of SIM-cards in total and divided by the number of SIM-cards that include data services. A summary of the average monthly volumes per service can be seen in table 5.4.

Table 5.4: Average monthly volume per user per service. For data services a difference is made between the average over all SIM-cards (data) and the average over the SIM-cards that use data services (data*)

	SMS	voice	data	data*
2012	171	101	27	63
2013	176	102	70	135
2014	166	105	160	274
2015	160	104	289	444

In the period June 2012 - December 2015, the input variables are the average usage per user per service per quarter. Since there are three months in a quarter, the input values are the values from table 5.4 multiplied by three and the same for every profile for SMS and voice. For data services the values from the column data* are used for the profiles that use data. For the profiles that do not use data, the data consumption is set to 0.

To model the domestic usage in 2016, the customer profiles from BIPT are used [19]. A summary of these profiles can be found in appendix B. The average domestic volume in 2016 is the volume belonging to this profile. When the number of text messages is infinite for the profile, the number is set to 250 text messages for post-paid profiles and to 200 text messages for pre-paid profiles. When taking the percentage of customers that each profile has into account, the average number of text messages sent is 165. The average usage of voice calls is 173 minutes. The average usage for data services is 529 MB.

The study of BIPT to construct these profiles only took tariff plans from 2016 into account. The same profiles will be used to model 2017.

5.2.3 Average domestic revenue

In 2012 and 2013 the average revenue reported by BIPT is used[18]. These averages can be seen in table 5.5. These averages are applied to every profile.

Table 5.5: The average domestic revenue per unit per service in cents

	SMS	Voice	Data
2012	1.8	13.1	10.4
2013	1.5	10.7	4.3

The domestic revenues in 2014 and 2015 depend on the profile. A gradual transition is made between 2013 and 2016. The prices in 2016 are explained in the next paragraph. From 2013 on, prices (and thus revenues) are kept constant during the year. The formulas used for the transition are:

$$\text{avg revenue 2014} = \text{avg revenue 2013} - (\text{avg revenue 2013} - \text{avg revenue 2016}) * \frac{1}{3}$$

$$\text{avg revenue 2015} = \text{avg revenue 2013} - (\text{avg revenue 2013} - \text{avg revenue 2016}) * \frac{2}{3}$$

A summary of the prices can be found in appendix D. The average price over all the profiles is now €0.015 per text message. €0.106 per minute and €0.043 per MB in 2014. For data services this changes to €0.042 in 2015. The difference with the average revenues in 2012-2013 is very small.

To determine the domestic price in 2016, the profiles of BIPT are used. These profiles give an indication of the volumes and the total monthly price. In the model, the input parameter is the price per unit per service. To calculate this, the interrelation between the prices of the different services is chosen equally to those in 2013 (see table 5.5). These prices are multiplied by a factor X to obtain the real unit price per service. This factor X is determined for every profile separately. To obtain this parameter the solver in excel is used. For each profile, the volume per service is multiplied by the price for this service. The sum over the three services then gives the total price a customer would have to pay. This price has to be as close as possible to the real price, given by BIPT per profile. To do so, the percentage difference is calculated between the price given by BIPT and the calculated total price, for every profile. Then the sum of all these percentage differences is minimised. This is done with the help of the solver. The factor X (different for every service) is the parameter than can be changed, while the sum percentage difference is the variable that has to be minimised. The result can be found in appendix D.

As mentioned in the previous section, the same profiles will be used in 2017. As a consequence, the same prices are valid as in 2016.

5.2.4 Percentage of customers of this profile who roam

In an impact assessment of the roaming implementing regulation of the European Commission, statistics on travelling patterns of EU residents are reported[20]. The average number of days abroad within the EEA per year in 2013 (including one-day trips) is 10.9 for Belgian residents when all residents are considered. It is 14.6 when only the residents who travel at least once a year are considered. By dividing these two numbers, the percentage of the population that roams at least once a year is calculated: 74.7%. The average number of trips abroad within the EU of at least one overnight stay abroad per inhabitant who travels at least once per year is 1.16 in Belgium. The number of people who travel at least once a year is multiplied by the average number of trips. This gives the average number of trips in total. The average number of days abroad in the EEA per year is divided by the average number of trips per inhabitant that travels at least once a year, to obtain the average duration of a trip. A summary of these calculations can be found in table 5.6.

Table 5.6: Summary of the calculations for the average number of trips and the average duration of such a trip in Belgium

# days abroad in EEA per residents	10.9
# days abroad in EEA per resident who travels at least once a year	14.6
% of population that roams at least once a year	74.7
# trips abroad in EEA (per resident who travels at least once a year)	1.16
total number of trips as % of total population	86.65
avg number of days per trip	12.59

Now that the total number of trips per year is known, the trips have to be allocated to a quarter. To do so, the total volumes per quarter per service are used. For each quarter, the percentage of the volume used in that quarter relative to the total volume that year is calculated per service. Then the percentage of the volume used in this quarter on average is calculated, thus the average over the three services. Now, the total number of trips per year is distributed over the four quarters in a year. The number of trips per year is assumed to be equal to the amount in 2013 in every year. The assumption is made that every person makes at most one trip per

quarter, then the number of days can be kept constant at 12.59. The percentage of people who roams can now be calculated as the number of trips assigned to that quarter divided by the total population. (The total population does not need to be known, since the total number of trips was expressed as a % of the total population.)

For 2016, data is available for the first three quarters. The total volume per service in the fourth quarter is estimated. To do so, the percentage change is used. Due to the seasonality, quarters have to be compared to the quarter a year before, not the previous quarter. The percentage change over the years for the fourth quarter can be found in table 5.7. To model the total volume in the fourth quarter of 2016, the same percentage change as from 2015 to 2016 is assumed. This gives a total volume of 49.45 million text messages, 70.18 million minutes and 203.53 million MB. Now that the total volume is estimated, the calculations for 2016 are completely similar to those before. The percentage of the total volume used for a service can be calculated for all 4 quarters. Then, the average can be calculated over the four quarters. And the percentage of subscribers roaming in that quarter can be calculated.

Table 5.7: Percentage change in total volume for the fourth quarter over the years per service

	SMS	voice	data
2012 - 2013	92.64	99.22	226.62
2013 - 2014	100.65	103.30	214.58
2014 - 2015	101.81	112.20	201.81

To simulate 2017, the same approach is used as for the fourth quarter of 2016. The percentage change from 2015 to 2016 is used to calculate the total volumes in 2017 (until June). Then the calculations can be continued as for the previous periods.

5.2.5 Percentage of time that customers who have this profile and who do roam, spent abroad per quarter

The percentage of time spent abroad per traveller is constant, since the duration of all trips is chosen to be constant (see previous section.) The average duration is 12.59 days. This number is divided by the total duration of a quarter: 90 days. The percentage of time spent abroad by the customers who do roam thus is 13.98%.

5.2.6 Outbound-domestic ratio

To calculate the outbound-domestic ratio, the average domestic usage per quarter should be divided by the average usage abroad, if one would be abroad for a whole quarter. First the volume used per trip on average is calculated per service by dividing the total volume of that service in that quarter, by the total number of trips in that quarter. These volumes are divided by the number of days per trip 12.59 and multiplied by 90, the number of days in a quarter. The average domestic usage per quarter was calculated in 5.2.2. Dividing one by the other, gives the outbound-inbound ratio. An overview can be found in appendix F. The outbound-domestic ratio is assumed to be the same for every profile. For the RLAH period different outbound-domestic ratios will be tested. The default value is equal to the value a year before, in the same quarter.

5.3 Services

For the services the input parameters are the revenues and costs of domestic usage and roaming usage. The revenues and costs are known from Q3 2012 until Q3 2016. For the fourth quarter in 2016 the revenue or cost is chosen to be the same as in the previous quarter.

5.3.1 Average Revenue Outbound

The average revenue per service for outbound services is calculated per quarter by dividing the total revenue per service per quarter by the total volume for that quar-

ter and service. An overview is provided in appendix G

From June 2016 until June 2017, the maximum average revenue for outbound services is relative to the domestic price. Afterwards, the retail price for outbound roaming is the same as for domestic services.

5.3.2 Average Revenue Inbound

The average revenue per service for inbound services per quarter could be found in the excel files provided by BIPT [24]. These are the wholesale charges for roaming in. An overview is provided in appendix G. The average revenue is chosen equal to Q3 in 2016 from then on, as long as this value does not violate the regulated cap. If this is the case, the cap is chosen.

5.3.3 Average Cost Outbound

The average cost per service for outbound services per quarter can be found in the excel files provided by BIPT [24]. This cost is the wholesale charge for roaming out. An overview is provided in appendix G. The average revenue is chosen equal to Q3 in 2016 from then on, as long as this value does not violate the regulated cap. If this is the case, the cap is chosen.

5.3.4 I/O

The inbound outbound ratio is reported in an annex to the Commission implementing regulation [21] for 2013, 2014 and 2015. To know the ratios in 2012, the percentage change between 2013 and 2014 is calculated. It is assumed that the percentage change between 2012 and 2013 is the same as between 2013 and 2014. The ratio can now be calculated as the ratio in 2013 divided by the percentage change + 100 %. In 2016 the assumption is made that the inbound outbound ratio is the same as in 2015. The values are summarised in table 5.8. In the RLAH period the I/O ratio will be varied. At first the assumption will be made that the I/O ratio stays the same as in 2015.

Table 5.8: Inbound outbound ratio (in %) over the years. In 2012 and 2016 the ratio is estimated.

	SMS	voice	data
2012*	97	99	152
2013	102	114	161
2014	107	131	170
2015	127	168	247
2016*	127	168	247

5.3.5 Summary

In this chapter the values of the input parameters of the model are discussed. They are based on various files of BIPT and BEREC. The calculations to achieve these values are explained. Now that the default values are defined, simulations can be done with the model to analyse the impact of RLAH. These are described and analysed in the next chapter.

Chapter 6

The impact of RLAH on Belgian Operators: MNO vs MVNO

Different types of operators exist, they were discussed in section 2.1.2. Roam like at home (RLAH) will not impact each operator equally. An MVNO cannot host inbound traffic. Will roaming still be profitable for the MVNO? Will the gap in profit between an MNO and an MVNO increase and if so, by how much? Another difference between operators is the country of their origin. Some countries are sending countries, while others are receiving countries. Will RLAH impact them differently and to what extent will the impact differ? In 2016 - 2017 a lot of articles were written about the abolishment of the roaming fees that raised some concerns. Roaming like at home, too good to be true? A particular question that came to the surface is if the potential loss in roaming revenues for the providers will be passed on to the customer. [22] The operators could recover the potential revenue loss by increasing the domestic retail prices or by increasing the price for roaming in the rest of the world. If they do so, by how much would the retail prices have to increase to recuperate this revenue loss in function of increasing roaming volumes? Does this increase differ for an MNO and an MVNO? These questions are used to guide the research in this chapter.

6.1 Scenarios and assumptions description

This section serves as a guideline of the research that will be done in this chapter. After an analysis of the past is conducted, four scenarios and five assumptions are used to analyse the impact of RLAH on the profit of a mobile provider. The analysis is done for every combination of a scenario and an assumption.

First of all the revenues and the costs over the past years will be visualised and discussed. The values of the input parameters of the model in these periods have been discussed in chapter 5. This section focuses on two periods in particular. The first one is the period that ranges from Q3 '15 to Q2 '16, in which the old roaming regulation still applies and it will be used as a reference period throughout this chapter. The second period of interest is the RLAH+ period. This period ranges from Q3 '16 to Q2 '17. It is the transition period between the old roaming regulation and the RLAH regulation.

The values of the input parameters of the model (see chapter 4) were described in detail in chapter 5. The most important ones are emphasised again in this section. The ones that remain the same throughout this whole chapter are not mentioned again. The ones of interest for this research are the outbound - domestic (O/D) ratio[1], the inbound - outbound (I/O) ratio[2], the average outbound revenue, the average inbound revenue and the average outbound cost.

[1]The outbound volume is calculated per subscriber. It is an indicator of the volume the subscriber uses when abroad. For example if he sends 5 text messages per day at home and only 1 per day when abroad, the O/D ratio is 20%.

[2]The total inbound volume is calculated as a percentage of the total outbound volume per quarter. If in a particular quarter the total outbound volume for SMS is 80 million text messages and the I/O ratio is 120%, the total inbound volume is 96 million text messages.

Figure 6.1: Relation between domestic volume, outbound volume and inbound volume

The first input parameter of interest is the O/D ratio. Roaming volume increases are expected to happen when RLAH is active. But how fast will these increases happen? By how much will the roaming volumes increase? To deal with this uncertainty, four scenarios are proposed. They are based on a wholesale report of BEREC [21]. In this report results of a RLAH-type offers in the transition period are analysed. Operators mentioned an increase of about 10%-20% for SMS. Some mentioned SMS roaming traffic doubled. Similar results were reported for voice calls: an increase of 20%-23%. Some operators reported voice roaming traffic doubled or tripled. For data the increase was more spectacular. An increase of 90%-200% was mentioned. Some operators reported an increase of even 550%. BEREC did point out several reasons why no solid conclusions could be drawn in the paper. A first reason is the small sample size and variation between the answers. RLAH offers in the transition period attracted mostly intensive users, therefore the estimated volumes can be too high. However, when RLAH takes effect, the demand of low-end users will also increase. This could compensate the over estimation due to the intensive users. Another reason is that is is possible that the operators used different methodologies to gather the information. The last reason BEREC mentiones is that the data volumes show an increasing trend. The volume increase can therefore not entirerly be attributed to RLAH tariffs. The scenarios will be used in each analysis conducted in this chapter. The difference between the four scenarios is the outbound - domestic (O/D) ratio. The outbound volume is calculated as a percentage of the domestic volume. This percentage is the O/D ratio. The inbound volume is calculated as a percentage of the outbound volume. This percentage is the inbound - outbound (I/O) ratio. If the domestic volume and the I/O ratio stay the same and the O/D ratio increases, both the outbound volume and the inbound volume will increase.

The relation between the domestic volume, the outbound volume and the inbound volume can be seen in figure 6.1. In every scenario the O/D ratio is defined relative to the O/D ratio in the transition period. The O/D ratio of this period can be seen in table 6.1.

Table 6.1: O/D ratio per quarter per service in the transition period (%)

(in %)	SMS	voice	data
Q3 '16	44.49	28.39	56.86
Q4 '16	34.53	47.07	44.86
Q1 '17	45.25	49.50	29.92
Q2 '17	47.91	42.14	36.21

- **Scenario 1:** In this scenario the lower retail tariffs for roaming have no influence on the roaming volumes. Subscribers use the same amount as they did before. This means that in Q3 '17 the O/D ratio is the same as in Q3 '16. In Q4 '17 the O/D ratio is the same as in Q4 '16. Thus in this scenario, both the outbound and inbound volumes stay the same as in the transition period, and this for all services.

- **Scenario 2:** There has been an increasing trend in outbound usage the past years. Based on this, it is safe to assume that users will use twice as much volume as they do now. If this happens, they would still use less volume than at home[3], while they pay the same tariffs abroad as they do at home. Thus, the O/D ratio doubles for all services in this scenario.

- **Scenario 3:** In this scenario, the subscriber uses the same amount of volume abroad as at home. The O/D ratio is equal to 1 or 100% for all services.

- **Scenario 4:** In the past a spectacular increase in data consumption was noticed while the SMS and voice volumes more or less stayed the same or increased very slowly. The drop in the retail price of data services is also more

[3]The O/D ratio is smaller than 1 in all quarters for all services except for data services in Q3 '17. The ratio in Q3 '16 was 56.86%. If this ratio doubles, the new ratio is 113.71% which is higher than 100%. Thus the user uses more volume abroad than at home.

significant than the ones for SMS and voice. In this scenario, the data volume abroad increases more than the SMS and voice volume. The O/D ratio for text messages and voice calls doubles, while the O/D ratio for data services triples.

Other parameters of interest are the outbound and inbound revenue per unit and the outbound cost. When RLAH is active, a subscriber pays the same price per unit abroad as at home, leading to an outbound revenue per unit equal to the domestic revenue per unit, which has been specifically determined for every profile in chapter 5. The outbound cost and inbound revenue are capped by legislation. To determine the actual price, the same price as in Q2 '17[4] is chosen, whenever these values do not violate the new regulation. Thus, if the price in Q3 '17 is lower than the regulated cap, this value is continued. If this value would violate the cap, the price is set equal to the cap. This is the highest charge allowed. A summary of the inbound revenue per unit and the outbound cost per unit is given in table 6.2. For data services, two numbers are mentioned. This is because the cap changes in the third quarter of 2017 for the RLAH regulation, but also changes in the first period of 2018. The wholesale caps for data services will be changed according to a glide path (see section 2.2.2).

Table 6.2: Scenario 1: The outbound cost and the inbound cosrevenue when RLAH takes effect compared to the regulated cap. (€)

	SMS	voice	data
outbound cost	0.010	0.032	0.0077 / 0.0060
inbound revenue	0.006	0.030	0.0077 / 0.0060
regulated cap	0.010	0.032	0.0077 / 0.0060

[4]The price has not changed since Q3 '16. This was the last quarter for which data was available. Thus the price in Q2 '17 is actually the price of Q3 16. This is described in more detail in chapter 5.

Apart from the scenarios, different assuptions are also made. The combination of the basic assumptions is called the **Standard case**. Small changes are made in the basic assumptions that lead to four extra cases. Then four scenarios and five assumption cases exist. These cases are:

- **Standard case:** The values of the input parameters are chosen equal to the values in the same quarter a year before whenever possible. This case was described above and in chapter 5.
- **Case 2 maximum inbound fee charged:** The first change that is made is to the inbound revenues per unit. In table 6.2 a summary of the inbound revenue per unit and the outbound cost per unit is given. These numbers are based on data of the Belgian providers. It is noticeable that Belgian providers pay the maximum fee to the FSP for outbound roaming, while the Belgian providers do not charge the maximum fee to the FSP for inbound roaming. What is the effect on the profit of the provider if he does charge the maximum fee?
- **Case 3 I/O Trend 1:** In the standard case the I/O ratio is the same as it was in 2016[5] and in 2016 it was the same as in 2015. This means that the increasing trend of the I/O ratio stagnated in 2015. What is the effect if the trend continued in the RLAH+ period, thus until Q2 '17?
- **Case 4 I/O Trend 2:** This case is in line with the previous one. What if the trend for the I/O ratio does not stagnate in 2016, but also not in 2017? What if the increasing trend continues during the RLAH period?
- **Case 5 Belgium as a sending country:** Belgium is currently a receiving country for all services. When RLAH starts, the volumes will increase. It is possible that the outbound roaming volumes increase more than the inbound roaming volumes. If this happens to the extent that the outbound roaming volumes exceed the inbound roaming volumes, Belgium becomes a sending country instead of a receiving country. In this case the RLAH regulation is applied to Belgium, but if it would be a sending country.

[5]The I/O ratio is defined per year, not per quarter. It is thus the same in every quarter.

Now that the four scenarios and the five assumption cases are known, the analysis can be conducted. In every section the combination is made of all scenarios with one assumption case. The titles of the following five sections will therefore refer to the assumption cases. One of the main questions for the research is the different impacts RLAH will have on an MNO and an MVNO. Therefore, the results will be discussed for both an MNO and an MVNO. The gap in profit between an MNO and an MVNO will also be discussed. The chapter ends with a section about the possible increase in domestic retail prices or in roaming retail prices in the rest of the world. This provides an answer to the research question about the increase in domestic retail prices relative to the volume increase.

The model returns the results per quarter. In this chapter, the results will be represented per year. Every year starts in the third quarter of a calendar year and ends in the second quarter of the next calendar year. This is done because the roaming regulation changes June 15 2017. The transition period to RLAH started April 30 2016. From then on, the roaming prices were relative to the domestic retail prices. Thus, if the year starts in the third quarter, the same regulation applies in all quarters of that year.

To maintain a clear overview throughout the analysis the following table is used. The table will be filled in for an MNO and an MVNO separately. A colour code is used to indicate if the provider makes more or less profit than he did in the reference period. This is done per service and in total. The profit is different for an MNO and an MVNO. The MVNO can typically not host inbound roaming traffic (see section 2.1.2) and will therefore have no inbound roaming revenues. It is possible that the MNO makes more profit than in 2015, while the MVNO does not due to this difference. The profit is defined as the following:

$$\text{roaming profit}_{\text{MNO}} = \text{outbound revenue} + \text{inbound revenue} - \text{outbound cost}$$

$$\text{roaming profit}_{\text{MVNO}} = \text{outbound revenue} - \text{outbound cost}$$

	Standard case	Maximum inbound fee charged	I/O Trend 1	I/O Trend 2	Belgium as a sending country
Scenario 1	SMS voice data total	SMS voice data total	SMS voice data total	SMS voice data total	SMS voice data total
Scenario 2	SMS voice data total	SMS voice data total	SMS voice data total	SMS voice data total	SMS voice data total
Scenario 3	SMS voice data total	SMS voice data total	SMS voice data total	SMS voice data total	SMS voice data total
Scenario 4	SMS voice data total	SMS voice data total	SMS voice data total	SMS voice data total	SMS voice data total

Figure 6.2: The table that will be used to represent the results with a colour code in a clear way for an MNO and an MVNO separately.

For this clear overview a colour scale is used:

- **red:** not profitable
- **orange:** less profit than in Q3 '15 - Q2 '16
- **yellow:** less profit than in Q3 '15 - Q2 '16, but differs no more than 5% of the profit in Q3 '15 - Q3 '16
- **blue:** more profit than in Q3 '15 - Q3 '16, but differs no more than 5% of the profit in Q3 '15 - Q3 '16
- **green:** more profit than in Q3 '15 - Q3 '16

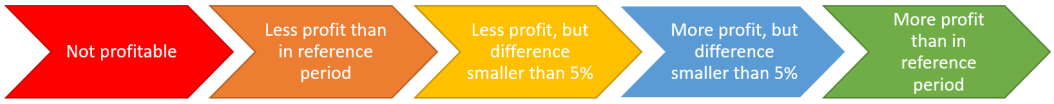


Figure 6.3: Colour scale

6.2 History: old roaming regulation and transition period

As mentioned in the previous section the first part of the research in this chapter is the past. The revenues and the costs over the past years are visualised and discussed. The values of the input parameters of the model in these periods have been discussed in chapter 5. This section focuses on two periods in particular.

- **Q3 '15 - Q2 '16:** In this period the old roaming regulation still applies. Analysing this period is interesting because it will be used as a reference period throughout this chapter. It will also often be referred to as 'the reference period'.
- **Q3 '16 - Q2 '17:** This is the transition period from the old roaming regulation to the new RLAH regulation. In this period the outbound retail prices are relative to the domestic retail prices. This period will often be referred to as the 'transition period'.
- The RLAH period will also be included in some figures in this section. This is to provide a visualisation of the drop in roaming profit. To represent this period, the first scenario is used. In this scenario the roaming volumes stay the same as they were in the transition period. This scenario is combined with the first assumption case: the standard case.

6.2.1 MNO

In figure 6.4, the revenues and costs can be seen for the periods that were elaborated above. The fourth period is the period before the new RLAH regulation and the transition period. It is the reference period. The fifth period is the transition period. The analysis will focus on these two periods. The first bar shows the outbound revenue. This is the revenue the provider earns by charging the subscriber for roaming. The second bar is inbound revenue. This revenue is gathered by charging the FSP for the use of its network. The outbound cost, the third bar, is the charge the provider pays to the FSP for using the network of the FSP when a subscriber of the operator roams. The fourth bar is the roaming profit. As explained earlier, this is the outbound revenue plus the inbound revenue minus the outbound cost. As mentioned in section 4.4 some costs are not included. Such costs are network costs, labour costs... Thus, roaming is not necessarily profitable in reality if the roaming profit is higher than zero in this model. This number does however give an indication of the profitability of roaming, and it also enables the comparison between periods.

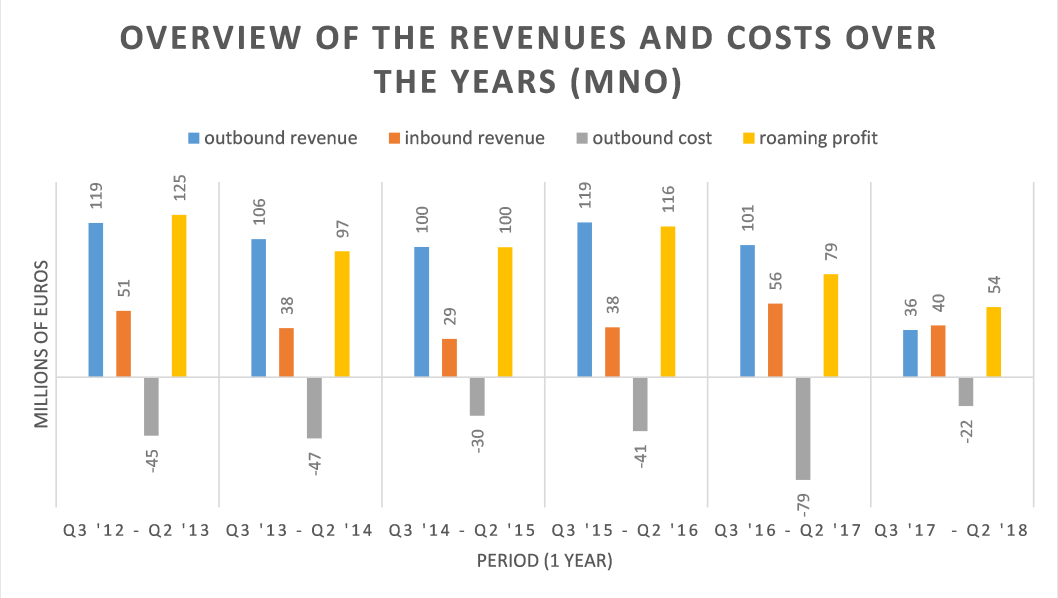


Figure 6.4: Overview of the revenues and costs over the years for an MNO.

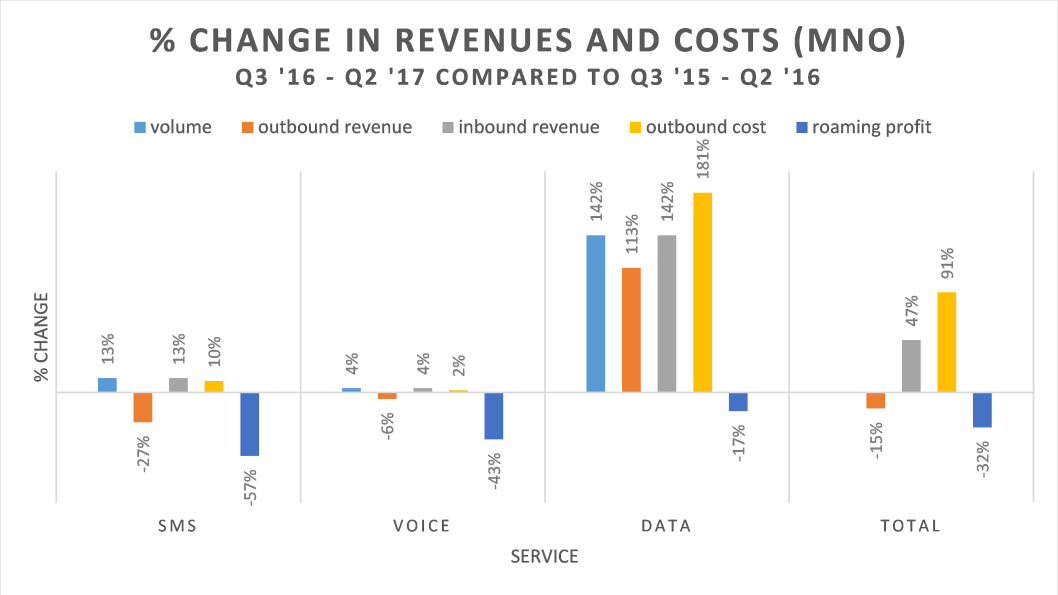


Figure 6.5: The percentage change in revenues and costs in the transition period (Q3 '16 - Q2 '17) compared to period one year earlier (Q3 '15 - Q2 '16) for an MNO.

In the transition period (the fifth period) the outbound roaming cost almost doubles, while the outbound revenue drops approximately 15%. Due to the increase in inbound revenues (47%) the roaming profit only drops approximately 32%. In figure 6.5 the percentage change from the transition period to the period before of the volume, the outbound revenue, the inbound revenue, the outbound cost and the roaming profit is visualised per service. The volumes have increased for all services, but the data volume increased significantly. The outbound revenue dropped for SMS and voice calls, while the outbound revenue increased for data services. The small increase in volume did not cover the revenue loss due to the lower retail prices for SMS and voice calls. For data services, the increase in volumes was spectacular and large enough to cover for the lower retail prices. Data roaming services even generated more outbound revenue than the year before.

The volumes for inbound roaming are higher than for outbound roaming, because Belgium is a sending country for all services. The revenues are, however, lower for inbound roaming than for outbound roaming (see figure 6.4). In the transition period the total ratio between the inbound revenue and the outbound revenue is 0.3 for SMS, 0.58 for voice calls and 0.58 for data services, while the ratio between

the inbound volume and the outbound volume is 1.27 for SMS, 1.68 for voice calls and 2.47 for data. The revenue for inbound roaming is lower than the revenue for outbound roaming, while the volume is higher. The total ratio inbound roaming revenue - outbound roaming revenue (thus the revenue over all services) is 0.56, while it was 0.32 the year before. In figure 6.4, one can see that this is due to a drop in outbound roaming revenue, while the inbound roaming revenue increased.

6.2.2 MVNO

An MVNO is a mobile virtual operator. They do not own a network (infrastructure and radio spectrum). An MNO can have inhabitants roam on their own network, an MVNO typically cannot. This causes traffic imbalances for MVNOs. Abolishing the roaming fees will therefore affect MNOs and MNVOs differently. In this section this effect is analysed for the transition period and the periods before. The outbound roaming and the outbound cost stay the same, because the same domestic and roaming retail prices and wholesale roaming prices apply as for the MNO. (*Remark: this assumption is made because no input data was available to correctly estimate the difference in these prices between an MNO and an MVNO*). The trends for the outbound revenue and cost were already discussed in the previous section (see figure figure 6.4).

In figure 6.6 the percentage change of the volume, the outbound revenue, the outbound cost and the roaming revenue can be seen for every service for an MVNO. The difference with MNOs is the total roaming profit, which is lower because the MVNO has no inbound revenue. The total roaming profit dropped by 71% for the MVNO while they dropped only 32% for an MNO. The percentage drop in roaming profit is similar for all services for an MVNO.

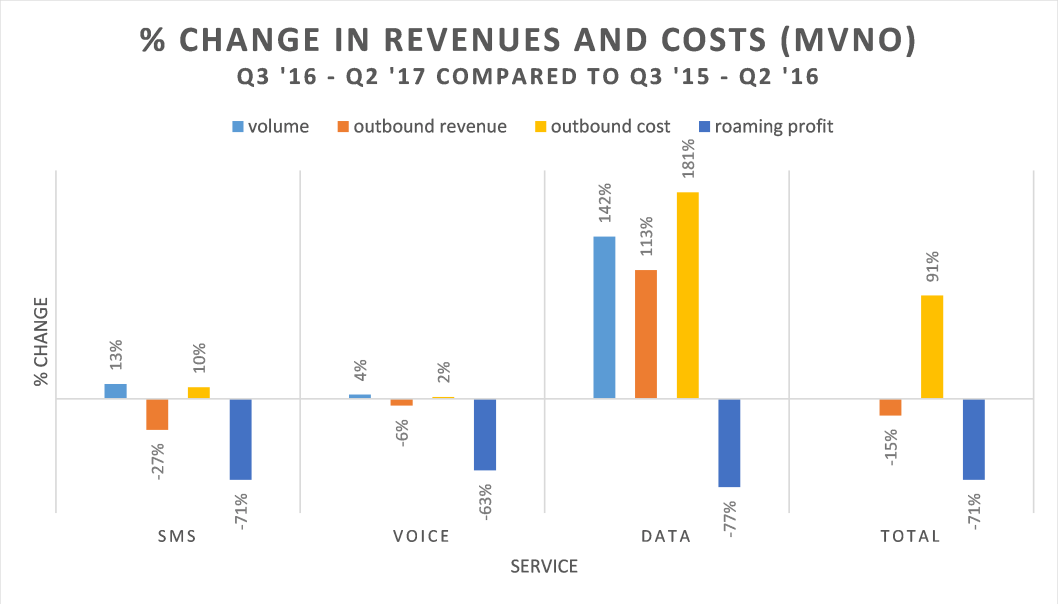


Figure 6.6: The percentage change in revenues and costs in the transition period (Q3 '16 - Q2 '17) compared to period one year earlier (Q3 '15 - Q2 '16) for an MVNO

6.2.3 Gap between MNO and MVNO

Figure 6.7 shows the difference in roaming revenue between an MNO and an MVNO (with the same number of total subscribers, the same domestic retail prices and the same wholesale prices). With the abstraction of different retail and wholesale prices, the difference is equal to the inbound revenue.

The gap between an MNO and MVNO has always been big, as can be seen in figure 6.7. In the first period there was already a difference of approximately €51 million. In that period, the gap was good for 69% of the total roaming revenue of the MVNO and 41% of the total roaming revenue of the MNO. The difference in revenues dropped over the years for SMS and voice calls, but the gap for data services became larger. This causes a total gap of approximately €56 million between an MNO and an MVNO in the transition period. Approximately 70% of the gap is caused by the difference in data services. This justifies to focus on data services in the remaining research. The percentages also dropped, the gap between an MNO and MVNO became smaller, relative to the total roaming revenues. In the transition period, however, this gap is good for approximately 250% of the roaming revenue

of the MVNO, 71% of the roaming revenue of the MNO. These percentages are summarised in table 6.3.

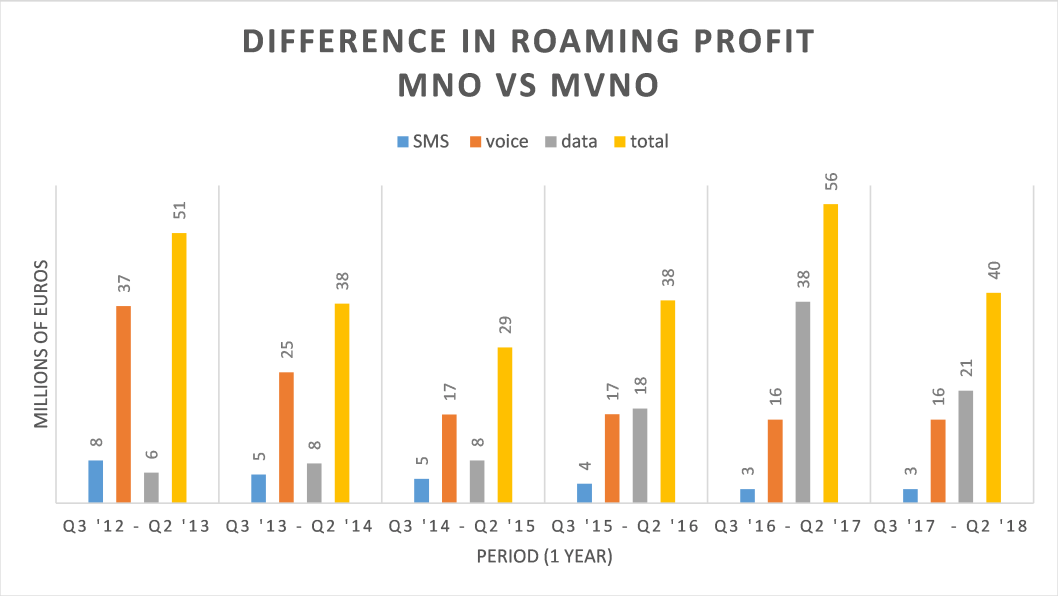


Figure 6.7: Comparison of the roaming profit over the years per service for an MNO vs MVNO. The roaming profit of an MNO minus the roaming profit of an MVNO.

Table 6.3: Comparison of the roaming profit (€) over the years per service for an MNO vs MVNO. First the absolute number is given in €million, then as a percentage of the total roaming revenues of an MNO and as a percentage of the total roaming revenues of an MVNO.

	Q3 '12 - Q2 '13	Q3 '13 - Q2 '14	Q3 '14 - Q2 '15	Q3 '15 - Q2 '16	Q3 '16 - Q3 '17	Q3 '17 - Q2 '18
million €	51	38	29	38	56	40
as % (MNO)	41%	39%	29%	33%	71%	74%
as % (MVNO)	69%	64%	42%	49%	249%	283%

6.2.4 Discussion

In this section the revenues and the costs were visualised over the past years. The observations focused on the trends over the years, and in particular the year Q3 '16 - Q2 '17 (transition period before RLAH). Over these years, the roaming profit dropped and increased again to the same level due to the lowering prices and in-

creasing volumes (especially for data services). The trends found in this section correspond to two statements of Proximus' annual report of 2016. [25] First of all Proximus states that the turnover from mobile services decreased due to regulatory measures. From the end of April 2016, Proximus reduced its roaming rates in accordance with the European regulations. That, in combination with an adverse change of the mix of travel destinations of the customers (more European destinations, less roaming in the rest of the world) resulted in weaker sales from mobile services since mid-2016. Another statement in this annual report is that the loss of revenue from wholesale access was partly recovered due to a higher turnover for incoming roaming. Increasing inbound revenues can indeed be seen in figure 6.4.[6]

The difference in profit between an MNO and an MVNO is approximately 2.5 times the total roaming profit of the MVNO in the transition period while it was only half of the roaming profit of the MVNO the year before. The reason if this increase is that the new roaming regulation had a smaller impact on the MNO. The MNO was able to recover some of the outbound revenue loss and increasing outbound cost with the increasing inbound revenue. The MVNO however, does not have this extra revenue and only saw the revenues drop and the costs increase. They had no benefit of the new roaming regulation, only disadvantages.

[6]Each period in the figure starts in Q3, the annual report covers Q1 2016 to Q4 2016. The inbound roaming revenue was approximately €34 million in 2015 and €77 million in 2016. This is an increase of approximately 126%.

6.3 RLAH scenario analysis: standard case

Now that the revenues and costs of the past have been analysed, the RLAH period will be analysed. In section 6.1 different scenarios and assumption cases were discussed to guide the analysis. The scenarios are used to reveal the effect of increasing roaming volumes. The scenarios are summarised here:

- **Scenario 1:** The O/D ratio stays the same.
- **Scenario 2:** The O/D ratio doubles.
- **Scenario 3:** The O/D ratio is equal to 1.
- **Scenario 4:** The O/D ratio doubles for SMS and voice, triples for data.

In this assumption case the values of the input parameters stay the same as in the same quarter a year before whenever possible, meaning if they do not violate the new roaming regulation. More details can be found in section 6.1. The analysis is done for a Belgian MNO and a Belgian MVNO. The revenues in the RLAH period (Q3 '17 - Q2 '18) are compared to the ones in the reference period (Q3 '15 - Q2 '16). This reveals the impact of RLAH on the revenues and costs, compared to the period before the new roaming regulation. The gap between them is also analysed.

6.3.1 MNO

The roaming profit is calculated for every scenario, per service and in total. The roaming profit for every scenario is compared to the profit revenue in the reference period: Q3 '15 - Q2 '16[7]. This is done to show the impact of roaming like at home on the revenues and costs of the operator. It is possible that the operator wants the same revenues as in that period. The difference is visualised in figure 6.8.

The first thing to notice is that in three out of four scenarios an MNO actually makes more total roaming profit than they did in the reference period: Q3 '15 - Q2 '16. A second thing to notice is that due to the low domestic prices for SMS

[7]The scenarios and assumption cases only apply to the RLAH period (Q3 '17 - Q2 '18). The roaming revenues and costs, and thus the roaming profit, for Q3 '15 - Q2 '16 is always the same. The results of this period can be seen in section 6.2

services, and the high outbound roaming cost, the providers experience a revenue loss (compared to the period Q3 '15 - Q2 '16) in all four scenarios for SMS services. The cost of outbound roaming is higher than the revenue of outbound roaming for SMS services. The average revenue per SMS (domestic and outbound) when RLAH is active, is only €0.009618 while the average wholesale cost per SMS is €0.01. The inbound revenue per SMS is €0.006. The profit loss decreases if the volume increases, because the inbound roaming revenues increase and make up for the loss. In the past, a continuing trend of data services replacing SMS services could be seen for both domestic traffic and roaming traffic. When RLAH is active, the most significant drop in retail price is the one for data services. The lower price will encourage this trend. Thus it does not seem likely that the SMS volumes will increase more than they do in these scenarios, thus the SMS roaming profit is lower than in the reference period. For the input parameters in this model, SMS outbound roaming services is profitable for an MNO due to the inbound roaming revenues.

For voice calls, the MNO makes more profit than in the reference period in only one scenario. In this scenario the O/D ratio is equal to one. This means that the subscriber uses as much volume abroad as he does at home. For the subscriber the costs are the same, whether he is abroad or at home. But the operator has to pay a charge if he uses abroad. The subscriber pays on average €0.057, which is more than the operator has to pay the foreign service provider: €0.032. The operator receives €0.030 per minute inbound roaming. Voice roaming services are thus profitable in all four scenarios. The profit is however lower in three out of four scenarios.

For data services the average revenue per MB outbound roaming is €0.0127 and the cost for the operator is only €0.0073. The inbound revenue per unit is also €0.0073. Data roaming services are thus profitable in all four scenarios. However, in two out of four scenarios the provider makes less profit than in the reference period. The profit margin is smaller than it used to be in the reference period. In scenario three the extra profit compared to the reference period is approximately €2.5 million. For the fourth scenario this is approximately €27 million. Now the total roaming revenues are analysed. As mentioned earlier, two out of four scenarios

are good for an increase in profit instead of a decrease compared to the reference period: Q3 '15 - Q2 '16. If the volumes would stay the same as they are now, RLAH would lead to a decrease of approximately €62 million (table 6.4). This is good for 54% of the total roaming revenue in the reference period. If the volumes are twice as big, the profit still decreases. The difference is approximately €8 million. The third and fourth scenario generate an increase of approximately €12 million and €20 million respectively.

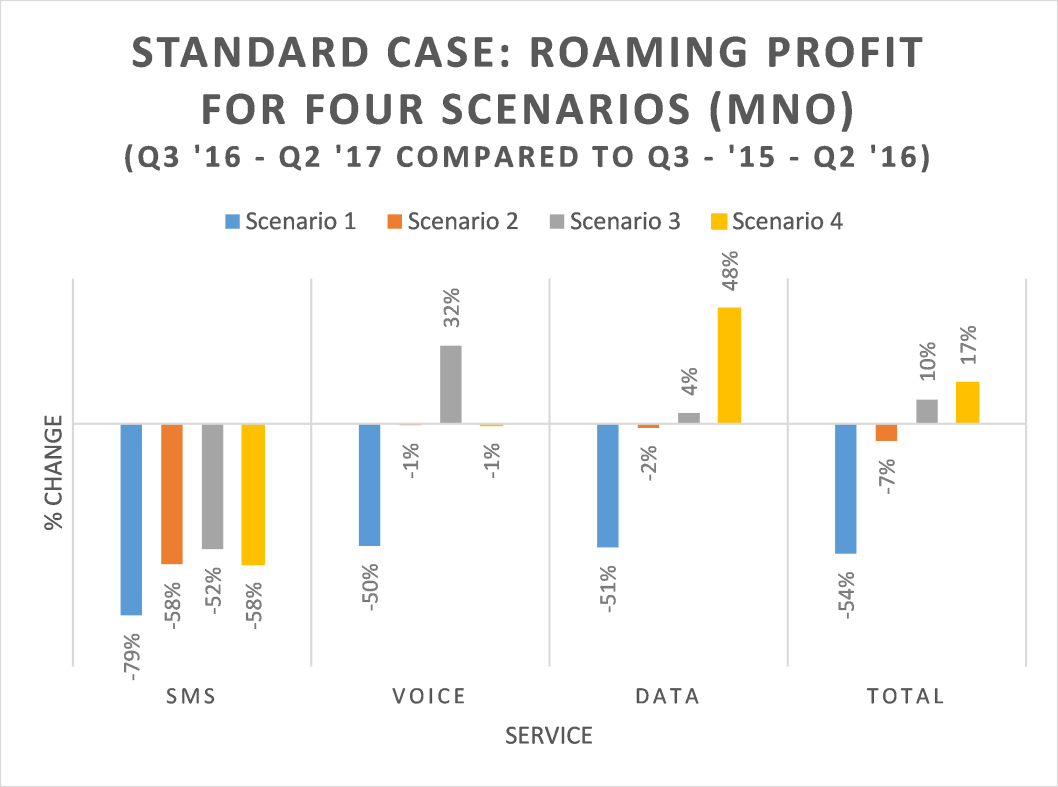


Figure 6.8: The percentage difference in roaming revenues between Q3 '17 - Q2 '18 and Q3'15 - Q2 '16 for the four scenarios for an MNO.

Table 6.4: The absolute difference in roaming revenues between Q3 '17 - Q2 '18 and Q3 '15 - Q2 '16 for the four scenarios for an MNO (million €).

	SMS	voice	data	total
scenario 1	-9.49	-23.86	-28.67	-62.02
scenario 2	-6.96	-0.28	-0.92	-8.16
scenario 3	-6.21	15.32	2.52	11.62
scenario 4	-6.96	-0.28	26.78	19.54

6.3.2 MVNO

To simulate the roaming revenues for an MVNO, the inbound revenues are left out, since an MVNO can typically not host any inbound traffic. In figure 6.8 the percentage change in roaming revenue is visualised for an MVNO. The first thing to notice is that for all services and all scenarios the revenues drop.

Secondly, for SMS services, the percentage decrease is higher than 100%. The MVNO has a loss instead of profit because the average domestic retail price per SMS is lower than the average wholesale cost for the MVNO. The SMS roaming service is not profitable at all for MVNOs and the higher the SMS volume increase for the MVNO, the worse it gets. It is forbidden to sell services at loss. Three possible reactions of the MVNO are given:

- Raise the domestic retail price by at least 0.000382 per SMS. SMS roaming service will then no longer be unprofitable.
- Apply for the sustainability clause.
- Reallocate the domestic retail revenue per unit. SMS is often part of a package. The combined package is most likely still profitable.

However, every situation leads to a competitive disadvantage for MVNOs, so does doing nothing, as the MNOs have higher roaming profits.

For voice calls and data services the loss depends on the scenario, but is always signigicant. If the volumes increase, the losses become smaller because these services

are still profitable. The absolute values can be seen in table 6.5.

In total, the roaming revenue loss compared to the reference period is approximately 82% if the volumes do not increase. If the volumes for SMS and voice double, and the data volume triples, the profit loss is approximately 55%. This is more or less the same as when the O/D ratio is 1 for all services.

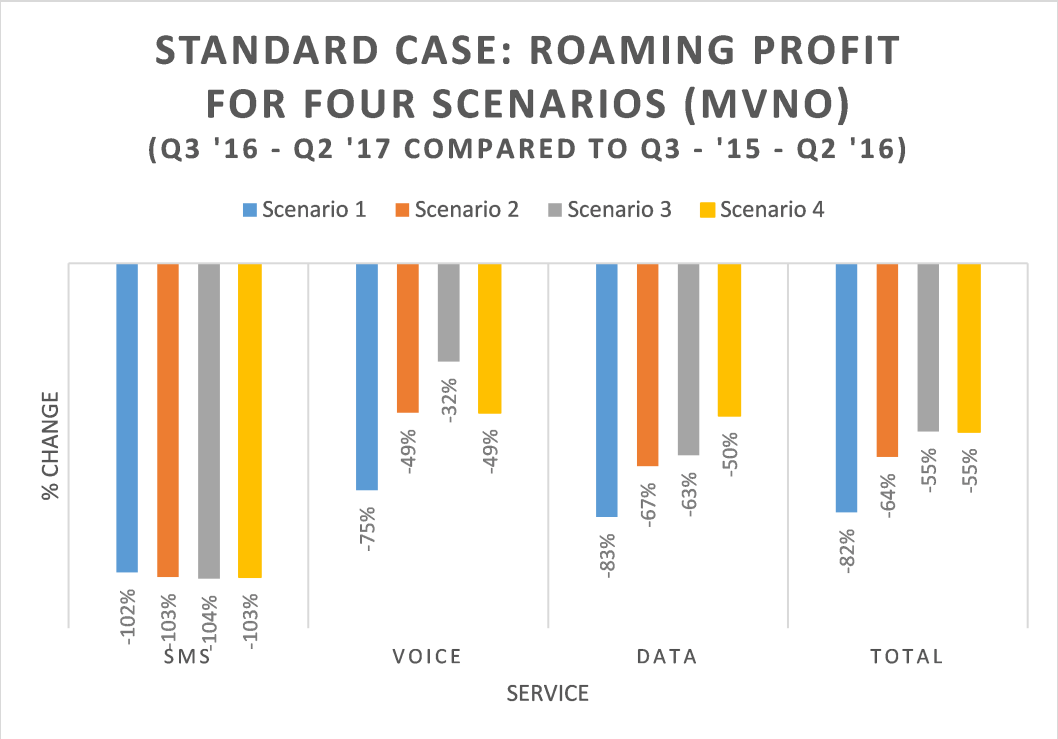


Figure 6.9: The percentage difference in roaming revenues between Q3 '17 - Q2 '18 and Q3'15 - Q2 '16 for the four scenarios for an MVNO.

Table 6.5: The absolute difference in roaming revenues between Q3 '17 - Q2 '18 and Q3 '15 - Q2 '16 for the four scenarios for an MVNO (million €).

	SMS	voice	data	total
scenario 1	-8.50	-22.87	-32.05	-63.42
scenario 2	-8.64	-15.07	-25.64	-49.35
scenario 3	-8.68	-9.92	-24.28	-42.88
scenario 4	-8.64	-15.07	-19.24	-42.95

6.3.3 Gap between MNO and MVNO

In figure 6.10 the difference in roaming revenue between an MNO and an MVNO (with the same number of total subscribers, the same domestic retail prices and the same wholesale prices) can be seen. With the abstraction of different retail and wholesale prices, the difference is equal to the inbound revenue, as explained in the previous section.

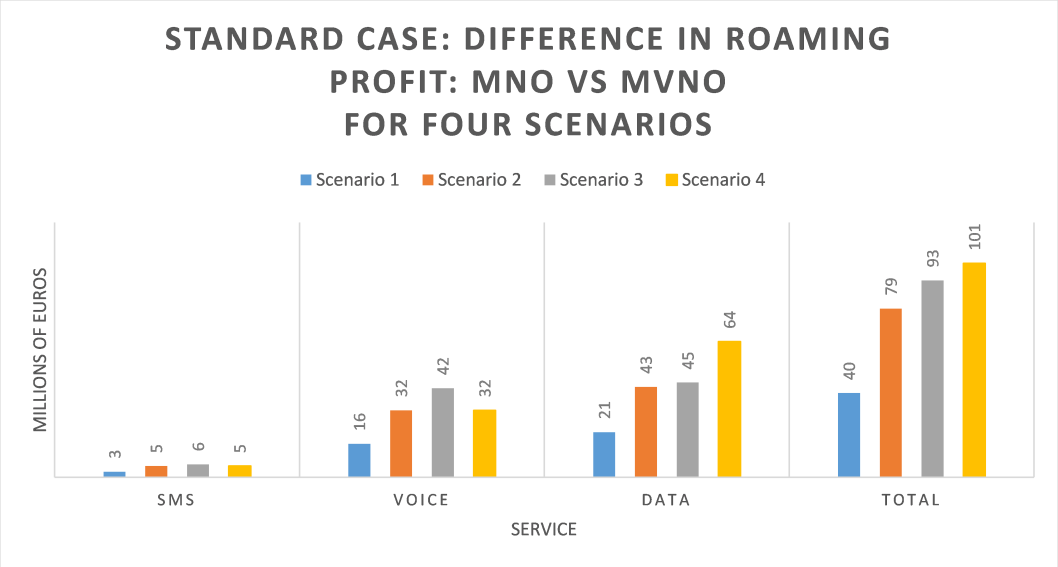


Figure 6.10: The difference in roaming profit between an MNO and an MVNO per service for four scenarios.

The absolute numbers increase if the volumes increase, since the inbound revenue is unit-based. This difference can also be expressed as a percentage of the roaming profit of an MNO or an MVNO. This percentage is calculated per service and can be seen in table 6.6. This percentage is the same for every scenario. One can see this by writing down the calculation. (The percentage is not written down for SMS relative to the SMS roaming profit of an MVNO, because for an MVNO the SMS roaming service costs more than it generates.)

$$\% \text{ of roaming revenue MNO} = \frac{\text{inbound revenue}}{\text{outbound revenue} + \text{inbound revenue - outbound cost}}$$

$$\% \text{ of roaming revenue MVNO} = \frac{\text{inbound revenue}}{\text{outbound revenue - outbound cost}}$$

If the O/D ratio increases, all factors increase. All revenues and costs increase by the same percentage, since they are all unit-based. Thus, for example, if the O/D ratio increases by 50%, all factors are multiplied by 0.50. Both the numerator and denominator are multiplied by 0.50. Thus, the outcome stays the same for all scenarios. This percentage is however important because it can be compared to the percentages in the past, or in other assumption cases that will be discussed in the following sections. In total the difference in profit between an MNO and MVNO is 283% relative to the total roaming revenue of the MVNO. This means that the difference in roaming profit is approximately 2.8 times the roaming profit of the MVNO. It is however only 0.7 times the profit of the MNO.

Table 6.6: The difference in roaming profit between an MNO and an MVNO as a percentage of the roaming profit of an MNO or of an MVNO.

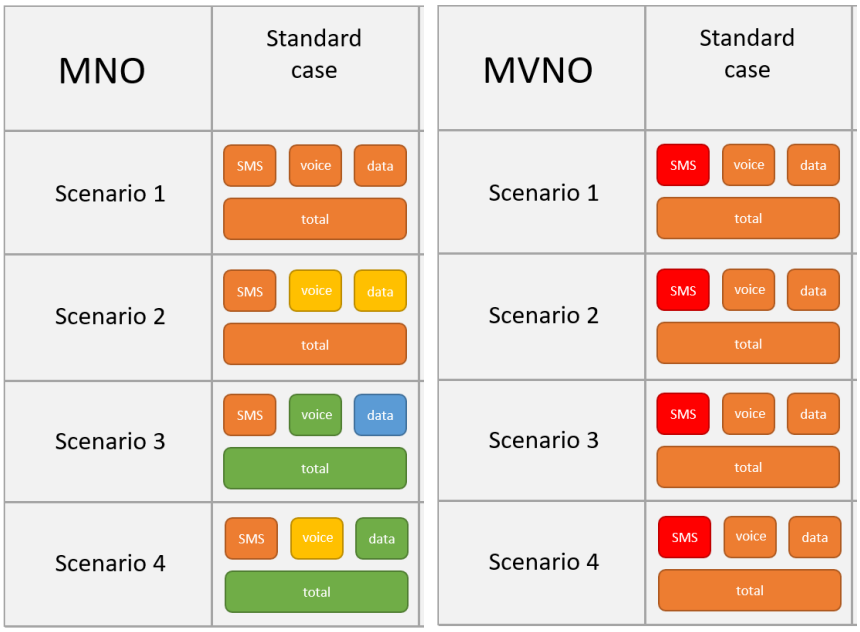
	SMS	voice	data	total
as % (MNO)	105%	67%	77%	74%
as % (MVNO)	-	202%	333%	283%

6.3.4 Discussion

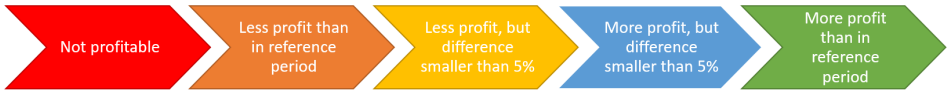
In this section the revenues and costs of the RLAH period (Q3 '17 - Q2 '18) were analysed for the different scenarios defined in section 6.1. The roaming revenue was expressed as a loss or gain in comparison with the revenue in the period before the roaming like at home regulation (Q3 '15 - Q2 '16). An MNO actually makes more profit in three out of four scenarios than it did in the reference period. An MVNO never makes more profit than in the reference period. This is due to the inbound revenues. If the O/D ratio increases, not only the outbound volumes increase for an MNO, but also the inbound volume. The revenues from the inbound services make up for the lower outbound roaming revenues and increased outbound roaming costs.

A second conclusion is that SMS outbound roaming service actually costs more than it gains. For an MNO, the SMS roaming service is profitable, due to the extra inbound roaming revenues. But for an MVNO, who does not have these inbound roaming revenues, SMS roaming services are not profitable. On average an SMS causes a loss of €0.000382. It is forbidden to sell a good at loss. This is an extra motivation to increase the domestic price for SMS. However, if in the subscription for which an outbound roaming SMS is not profitable, the costs are reallocated to the three services such that the price of an SMS becomes lower, and the prices per minute and per MB become higher, all three services can become profitable.

The percentage gap between the MNO and MVNO is the same for every scenario. This is because if the O/D ratio increases, the inbound revenue, the outbound revenue and the outbound cost all increase by the same factor. The more the O/D ratio increases, the higher the absolute difference between the MNO and MVNO becomes. But they both earn more. The difference in total roaming profit is approximately €40 million if the volumes do not increase and €100 million if the volumes of SMS and voice calls double and the volumes of data services double. This is approximately 74% of the total roaming revenue of the MNO and approximately 2.8 times the total roaming profit of the MVNO. In figure 6.11 the conclusions are summarised for the standard case.



(a) conclusions for an MNO (b) conclusions for an MVNO



(c) colour scale

Figure 6.11: Conclussion of standard case for an MNO an for an MVNO

6.4 RLAH scenario analysis: extra revenues if maximum inbound fee is charged

Two types of roaming traffic exist: inbound roaming and outbound roaming. Inbound roaming generates revenues for the operator, while outbound roaming is an expense for the operator. A detailed explanation of inbound and outbound roaming can be found in section 2.1.3. The fee the providers charge to each other is capped by the roaming regulation. In the previous assumption case data from BIPT for Belgian operators is used. It is noticeable that Belgian providers on average pay the maximum charge to the FSP for outbound roaming while the Belgian providers do not charge the maximum fee to the foreign service providers (FSP) for inbound roaming. An overview of the charges per service can be found in table 6.7. For data the price cap changes again in Q1 '18. That is why 2 prices are given for data services.

Table 6.7: Assumption case 1: The outbound cost the DSP is charged by the FSP and the inbound cost the DSP charges to the FSP compared to the regulated cap. (€)

	SMS	voice	data
outbound cost reference scenario	0.010	0.032	0.0077 / 0.0060
inbound revenue reference scenario	0.006	0.030	0.0077 / 0.0060
regulated cap	0.010	0.032	0.0077 / 0.0060

The inbound roaming charges are now adjusted so that the Belgian providers also ask the maximum fee for inbound roaming. This is assumption case 2. The other input parameters remain the same as in the standard assumption case that was discussed in the previous section. Increasing the inbound roaming fee to the cap can be a solution for the providers to minimise the profit loss compared to the reference period, instead of increasing the domestic retail prices or the roaming prices in the rest of the world. The analysis is done for all four scenarios, combined with this assumption case, for an MNO and an MVNO separately. The focus is the difference in profit compared to the standard case.

6.4.1 MNO

In figure 6.12 the extra revenues, and extra profits, are visualised per service and for every scenario. The percentage change can be found in table 6.8 and is the same for every scenario. (If the O/D ratio increases the numerator and denominator are multiplied by the same number.) Providers already charge the maximum fee for data services, so the revenues will not change for data services. The SMS roaming profit increases by 70% in all scenarios. The voice call roaming profit increases by 4.5% in all scenarios. The total roaming profit increases by 5.26%. 3.30% is due the change in SMS inbound roaming revenues and 1.96% is due to the change is voice inbound roaming revenues. The absolute number of the increase is different for each scenario. The extra revenues are the highest when the SMS and voice volumes are the highest (scenario 3). This results in a total increase of approximately €7 million.

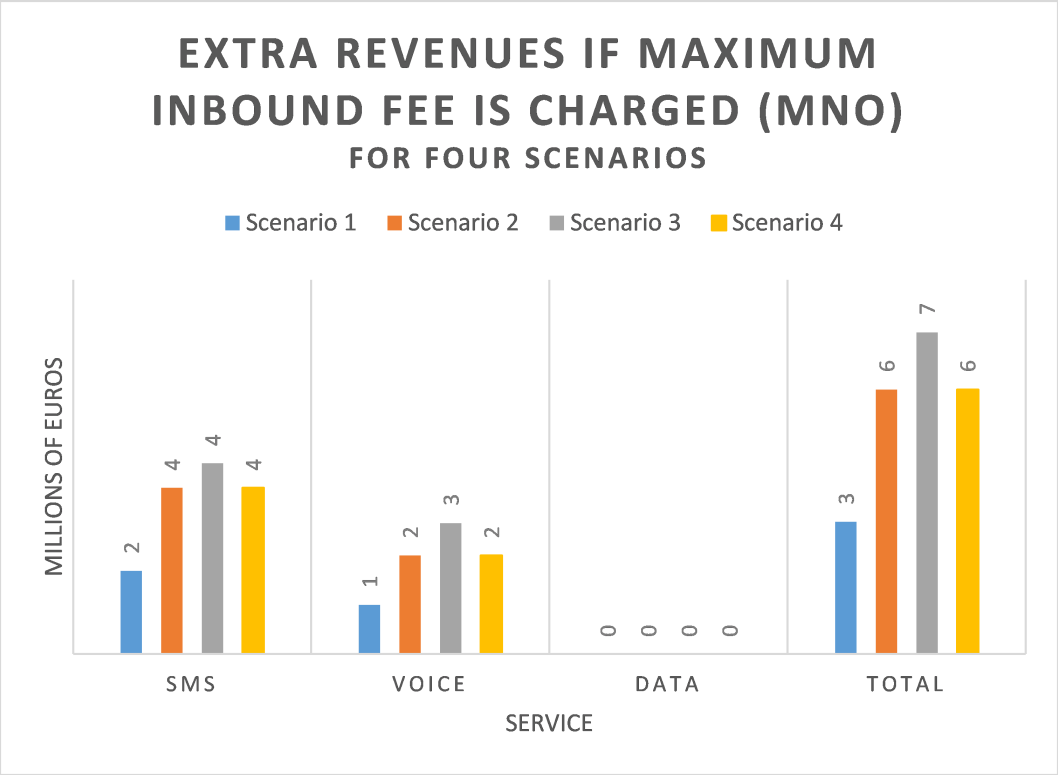


Figure 6.12: Extra revenues (compared to the standard assumption case) if maximum inbound fee is charged for the four scenarios.

Table 6.8: Extra revenues if the maximum inbound fee is charged for the five scenarios as percentage of the roaming profit of that service before the fees were changed.

SMS	voice	data	total
70,18%	4,46%	0,00%	5,26%

6.4.2 MVNO and gap with MNO

The revenues for an MVNO do not increase, the ones for an MNO, however, do. This enlarges the gap between them. The percentage difference can be seen in table 6.9. These percentages are different for every service, but the same for every scenario. The difference in roaming profit between the MNO and the MVNO relative to the roaming profit of the MVNO is now 3 times the roaming profit of the MVNO. This was only 2.8 in the standard assumption case. The gap became larger.

Table 6.9: The difference in roaming revenues between an MNO and an MVNO as a percentage of the roaming revenue of an MNO or of an MVNO if the maximum fee is charged to the FSP for inbound roaming.

	SMS	voice	data	total
as % (MNO)	103%	68%	77%	75%
as % (MVNO)	-	216%	333%	303%

6.4.3 Discussion

In the standard assumption case (the previous section), the Belgian providers did not charge the maximum fee for inbound roaming to the FSP, while on average, they did pay the maximum fee for outbound roaming. In this section the extra profit charging the maximum fee would cause are analysed. The fee per SMS sent increases with 0.4 cents, the fee per minute voice call by 0.2 cents. For data services, the cap was already charged, thus the roaming revenues do not change for data services. Increasing the inbound roaming fee per unit only has effect on the MNO. Nothing changes for the MVNO. This means that the gap between an MNO and an MVNO increases even more. The difference in roaming profit between an

MNO and an MVNO is now 3 times the roaming profit of the MVNO. In the media, some concerns were raised about the domestic retail prices. They worry that the providers will increase the domestic retail price to cover the potential revenue loss. Increasing the inbound roaming fee can be another solution. In the third scenario, in which subscribers use as much abroad as at home, the extra roaming profit is approximately €7 million.

A summary of the results of the scenarios for an MNO is given in figure **??**. In this table the profitability of the operator is indicated with a colour scale. The roaming profit for voice calls is now higher than in the reference period (Q3 (15 - Q2 '16) in scenario 2. This also happened in scenario 4. In scenario 2 the total roaming profit also changed. It is still lower than in the reference period, but the difference is smaller than 5% of the total roaming profit in the reference period. The table for an MVNO is still the same as in section 6.3.3 because the new assumption has no effect on the profit of MVNOs.

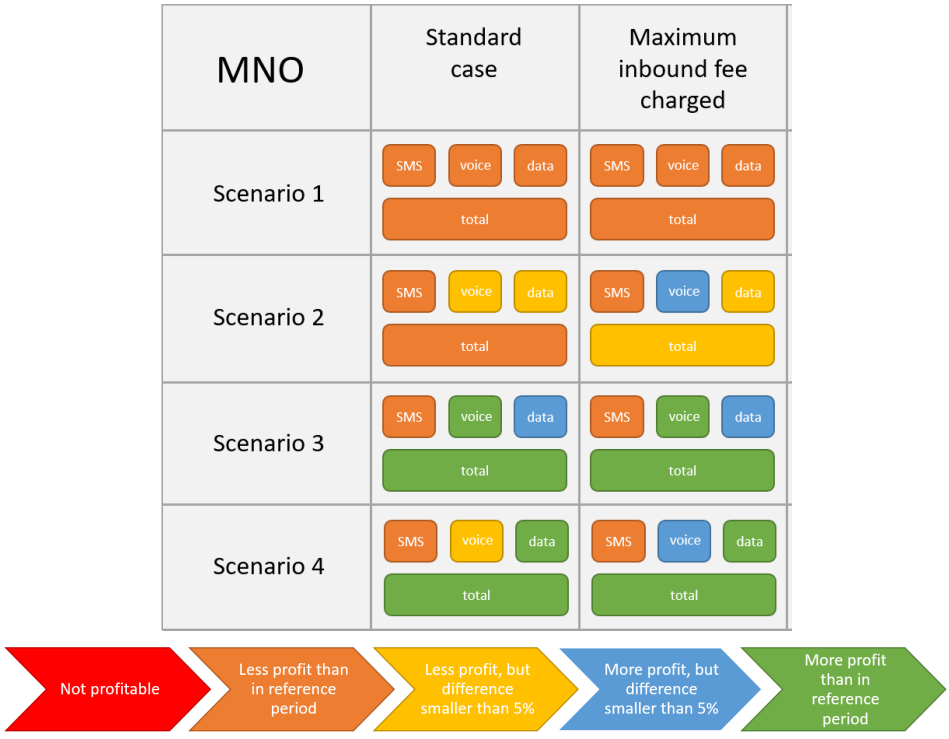


Figure 6.13: Roaming profit when max inbound fee is charged for an MNO compared to pre-RLAH (assumption case 2)

6.5 RLAH scenario analysis: increasing trend for I/O

In this section the third and fourth assumption case are analysed, each in combination with all four scenarios. In the two previous assumption cases (section 6.3 and section 6.4) the assumption was made that the inbound - outbound (I/O) ratio stagnates after Q2 '16. In the third assumption case, the trend for the I/O ratio increases until Q2 '17. The percentage increase is assumed to be the same as the year before[8]. In the fourth assumption case, the increasing trend continues until Q2 '18. The I/O ratio for every service is summarised for every assumption case in table 6.10. The three possible trends will be referred to as: trend 0, trend 1 and trend 2.

- Assumption case 1[9]: standard case (trend 0): The I/O ratio stays the same as in Q2 '16. The trend stagnates. This assumption was used in the previous analysis.
- Assumption case 3: I/O trend 1: The increasing trend of the I/O ratio continues until Q2 '17.
- Assumption case 4: I/O trend 2: The increasing trend of the I/O ratio continues until Q2 '18.

Table 6.10: Inbound-outbound ratio per period for three different assumption cases

		SMS	voice	data
Q3 '15 - Q2 '16	trend 0, 1 or 2	1.27	1.68	2.47
Q3 '16 - Q2 '17	trend 0	1.27	1.68	2.47
	trend 1 or 2	1.51	2.15	3.59
Q3 '17 - Q2 '18	trend 0	1.27	1.68	2.47
	trend 1	1.51	2.15	3.59
	trend 2	1.79	2.76	5.21

[8]The percentage increase is then 18.69% for SMS, 28.24% for voice calls and 45.29% for data services.

[9]Assumption case 2 also followed trend 0. In this section the extra revenues compared to the standard case will be visualised. Assumption case 2 is of no importance in this section.

6.5.1 MNO

In figure 6.14 (trend 1 versus trend 0) and figure 6.15 (trend 2 versus trend 0) the impact of the assumptions on the inbound revenues is visualised. These numbers are the absolute increase in roaming profit[10] for the four scenarios if the I/O ratio is adjusted to the two new trends. For every scenario, the only variable that changes compared to the standard case, is the inbound roaming revenue. The difference in roaming profit in every scenario is hence equal to the difference in inbound revenues. There is however a difference between the four scenarios: the outbound domestic ratio. If this ratio increases, not only does the outbound volume increase, also the inbound volume will increase. The higher the O/D ratio, the higher the outbound volume (from which the inbound volume is calculated) will be. Thus, the higher the O/D ratio, the more impact the increased I/O ratio will have. This can be seen in the graphs. The total roaming profit increases by approximately €15 million if the outbound inbound ratio stays the same as in 2016 (scenario 1). The highest increase is approximately €49 million. This is when SMS and voice volumes are doubled, but data volumes are tripled (scenario 4). If the second trend is applied (assumption case 4), the total profit increases by approximately €35 million for the first scenario and by approximately €93 million in scenario 4.

[10] In assumption case 3 and 5 the original inbound roaming fee is charged. This is thus the same fee as in assumption case 1.

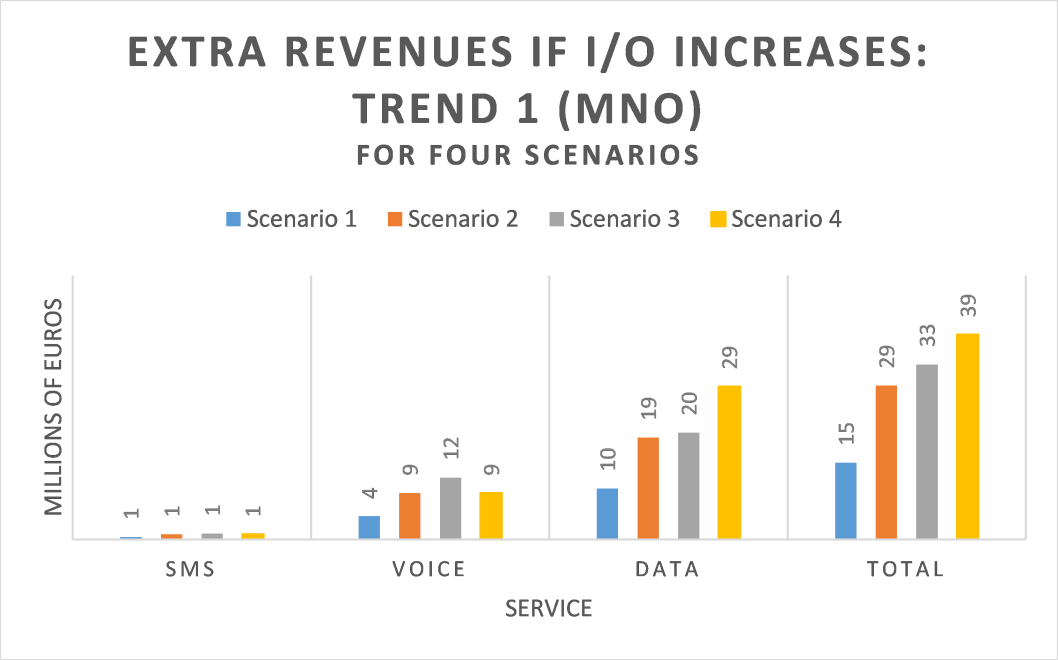


Figure 6.14: Impact of the assumption case 3: the I/O ratio follows trend 1. Results are relative to the results of the standard assumption case. These are thus extra roaming revenues per service, for every scenario.

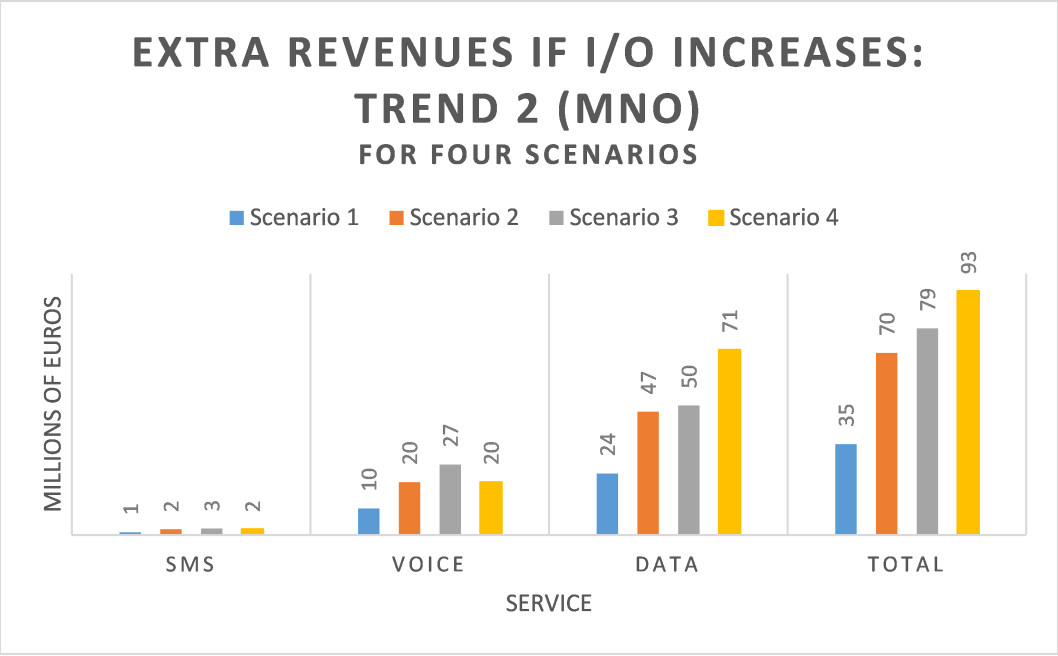


Figure 6.15: Impact of the assumption case 4: the I/O ratio follows trend 2. Results are relative to the results of the standard assumption case. These are thus extra roaming revenues per service, for every scenario.

6.5.2 MVNO and gap with MNO

The revenues of an MNO increased under the new assumptions. While the revenues of an MVNO stay the same because changing the I/O rato has to impact on the profit if an MVNO. The gap between them increased. The new relative difference for trend 1 and 2 can be seen in table 6.15 and table 6.12 respectively.

Table 6.11: The difference in roaming revenues between an MNO and an MVNO as a percentage of the roaming revenue of an MNO or of an MVNO if the I/O trend changes to trend 1.

	SMS	voice	data	total
as % (MNO)	104.40%	72.15%	82.87%	79.43%
as % (MVNO)	-	259.08%	483.83%	386.33%

Table 6.12: The difference in roaming revenues between an MNO and an MVNO as a percentage of the roaming revenue of an MNO or of an MVNO if the I/O trend changes to trend 2.

	SMS	voice	data	total
as % (MNO)	103.69%	76.88%	87.53%	84.14%
as % (MVNO)	-	332.58%	701.98%	530.40%

6.5.3 Discussion

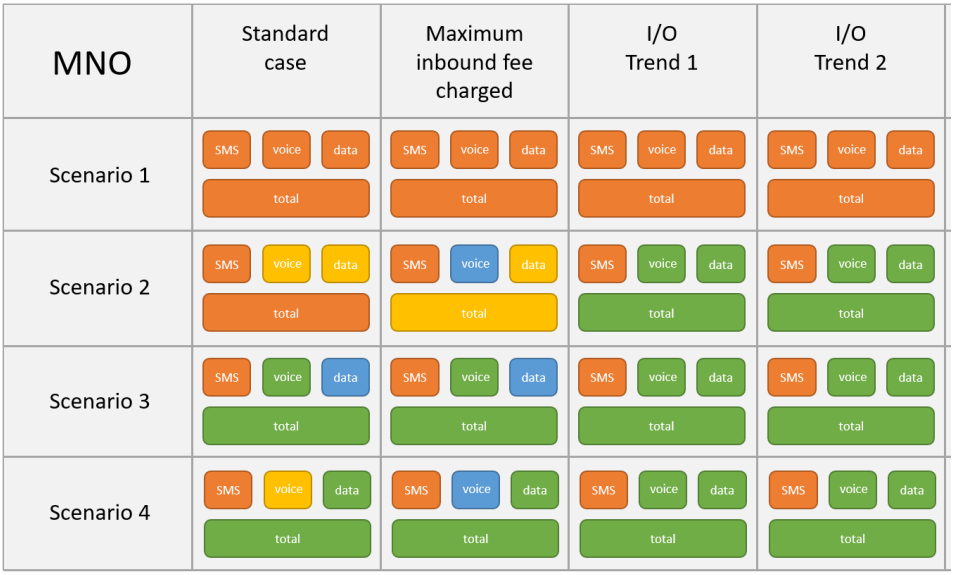
It is possible that the I/O ratio becomes even higher if the new RLAH regulation has more impact on the inbound volumes than on the outbound volumes. In this section assumption case 3 and assumption case 4 are applied to the model for all four scenarios. In these assumption cases the trends for the I/O ratio are adjusted as was described in section 6.1. These two new trends are simulated and compared to the standard assumption case.

If the I/O ratio increases, the inbound revenues increase, leading to an increase in MNO revenue. Over the various scenarios the O/D ratio changes. The higher this ratio, the higher the outbound volume. Of the I/O ratio is then the same for

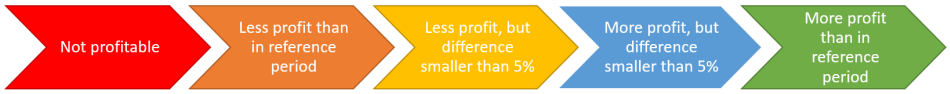
every scenario, the scenario with the highest O/D ratio will have the highest roaming revenue. If the outbound volume is higher, the inbound volume will also be higher. Thus the extra revenues are higher.

Since this assumption only has impact on the profit of the MNO and not on the profit of the MVNO, the gap between them becomes larger. The difference in total roaming profit between the MNO and the MVNO is 3.8 times the total roaming profit of the MVNO for the first trend (assumption case 3), 5.3 times the total roaming profit of the MVNO for the second trend (assumption case 4).

The table that indicates profitability can be seen in figure 6.16. For an MVNO the table does not change as the I/O assumption does not have an impact on the roaming profit of the MVNO. The roaming profit of the MNVO stays the same as for assumption case 1: the standard case. For assumption case 3 and 4 similar results can be seen. The roaming profit for voice calls is now higher than in the reference period (Q3 (15 - Q2 '16) in scenario 2, 3 and 4. For data services the roaming profit is also higher than in the reference period in scenario 2 and 3. In scenario two, the total roaming profit also changed. The total roaming profit is now higher than it was in the reference period. There has been an increasing trend in outbound usage the past years. Based on this, it is safe to assume that users will not use less volume when abroad when RLAH is active than in the previous years. In all other scenarios the MNO now makes more profit than it did in the reference period (Q3 '15 - Q2 '16). Thus the new RLAH regulation is actually beneficial.



(a) conclusions for an MNO



(b) colour scale

Figure 6.16: Conclussion for an MNO (assumption case 3 and 4)

6.6 RLAH scenario analysis: what if Belgium becomes a sending country?

When RLAH starts, the roaming volumes will increase due to the lower retail prices. Two types of roaming exist: inbound roaming and outbound roaming. For a Belgian provider outbound roaming happens when one of its customers goes abroad and uses mobile services there on the network of another operator. This operator is called the foreign service provider (FSP). Inbound roaming happens when the customers of the foreign service provider use the network of the Belgian provider. (For more information see section 2.1.3.) Outbound roaming is a cost for the Belgian operator. A fee has to be paid to the FSP for the use of its network. Inbound roaming is a revenue for the Belgian operator: the FSP has to pay the fee to the Belgian operator (see section 2.1.1). The I/O ratio is determined by the volumes of inbound and outbound traffic for every service separately. A receiving country has an I/O ratio higher than 100%. Belgium is currently a receiving country for all services. When RLAH starts, the roaming volumes will increase. It is possible that the outbound roaming volumes increase more than the inbound roaming volumes do. If this happens to the extent that the outbound roaming volumes exceed the inbound roaming volumes, Belgium becomes a sending country. This is the fifth and last assumption case. The new I/O ratio for Belgium is based on the I/O ratio of Finland. In 2014 this ratio was 55% for SMS, 77% for voice calls and 84% for data services. [21] The other input parameters remain the same as in the standard assumption case. All four scenarios are again analysed.

6.6.1 MNO

If the I/O ratio decreases, the inbound roaming volume decreases. Since inbound roaming generates revenues (and is profitable) the profits will drop. In table 6.14, the difference between the roaming profit in the RLAH period and the reference period is given as a percentage of the roaming profit in the reference period (Q3 '15 - Q2 '16). The percentage is always negative, thus the MNO loses profit in all scenarios compared to the reference period. However, the percentage is never lower than - 100%, thus the operator still makes profit. The operator makes less profit in this assumption case than in the standard case. This is caused by the low revenue per unit for outbound roaming combined with the high cost for outbound roaming. The profit per unit is higher for inbound roaming than for outbound roaming (SMS is even not profitable for outbound roaming). The average revenue and cost per unit are summarised in table 6.16.

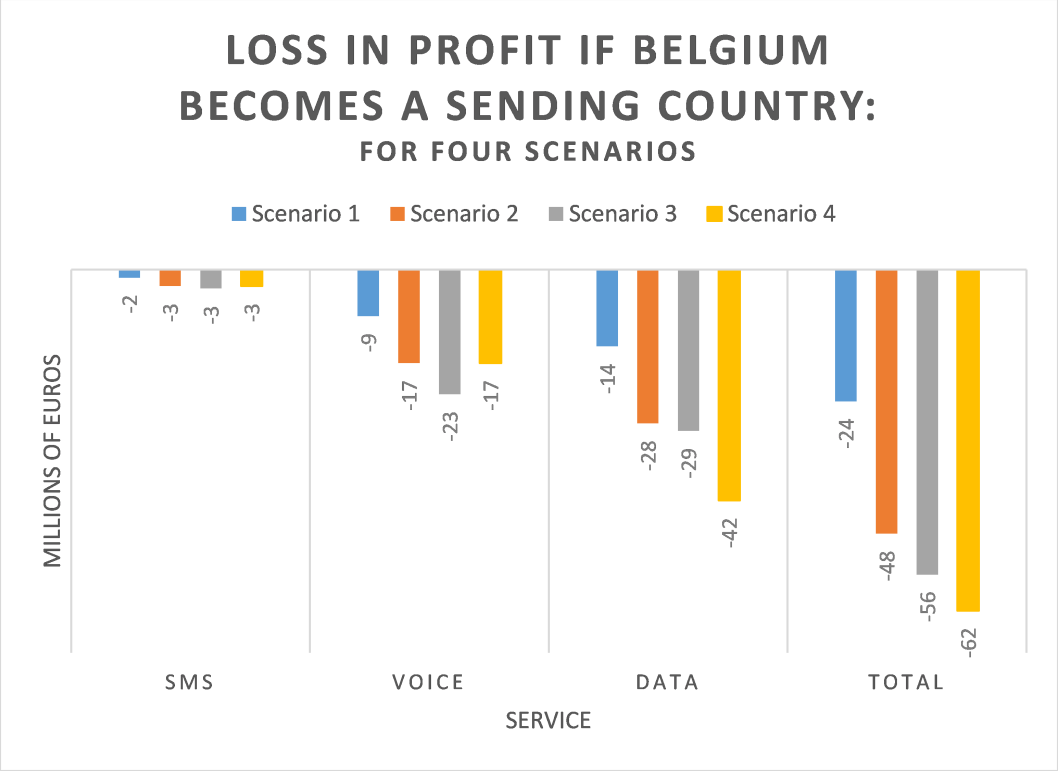


Figure 6.17: Loss in profit if Belgium becomes a sending country (compared to the standard assumption case) for the four scenarios.

Table 6.13: Loss in profit if Belgium becomes a sending country (compared to the standard assumption case) for the four scenarios as percentage of the roaming profit of that service before the I/O ratio changed.

SMS	voice	data	total
-60 %	-36 %	-51 %	-41 %

Table 6.14: The percentage difference in roaming profit between Q3 '17 - Q2 '18 and Q3 '15 - Q2 '16 for the four scenarios for an MNO if Belgium becomes a sending country.

(%)	SMS	voice	data	total
scenario 1	-92	-68	-76	-74
scenario 2	-83	-37	-52	-49
scenario 3	-81	-16	-48	-38
scenario 4	-83	-37	-27	-37

6.6.2 MVNO and gap with MNO

Changing the I/O ratio has no impact on the profit of an MVNO. The gap between the MNO and the MVNO becomes smaller, because the profit of an MNO decreases. The difference is approximately €16 million for the first scenario and €39 million for the fourth scenario when Belgium becomes a sending country. The difference with the standard case is €24 million for the first scenario and €62 million for the fourth scenario. The percentage difference is significantly lower than in the standard assumption case. The difference between the roaming profit of the MNO and the MVNO is now 1.1 times the roaming profit of the MVNO. This was 2.8 times in the standard case. This means that the profit of the MNO is approximately twice the roaming profit of the MVNO.

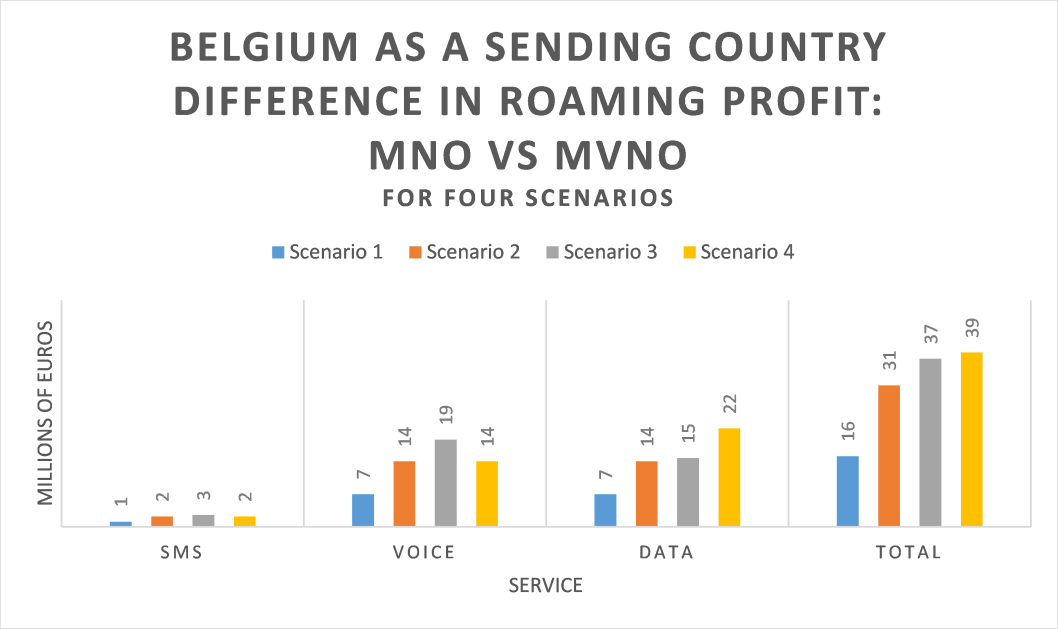


Figure 6.18: The difference in roaming revenues between an MNO and an MVNO per service if Belgium becomes a sending country (assumption case 5).

Table 6.15: The difference in roaming revenues between an MNO and an MVNO as a percentage of the roaming revenue of an MNO or of an MVNO if Belgium becomes a sending country.

	SMS	voice	data	total
as % (MNO)	113%	48%	53%	52%
as % (MVNO)	-	93%	113%	111%

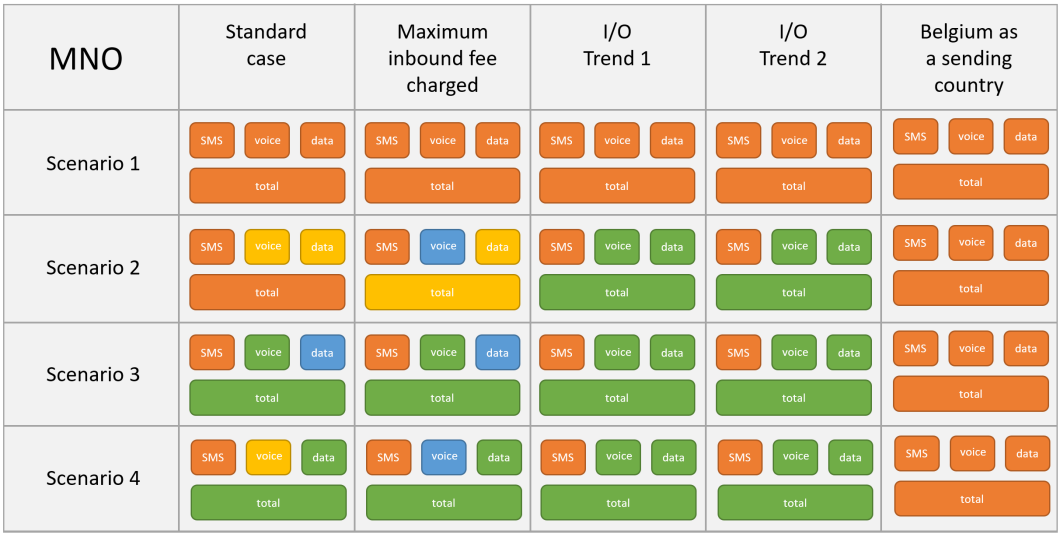
6.6.3 Discussion

The profit margin of outbound roaming is smaller than the profit margin of inbound roaming. The profit margin of outbound roaming is defined by a low revenue per unit combined with a high wholesale cost. In table 6.16 the revenue and cost of outbound roaming can be seen. The difference between them is the outbound roaming profit. The inbound roaming profit is the same as the inbound roaming revenue. The profit per unit is higher for inbound roaming than for outbound roaming. Thus, if Belgium becomes a sending country, the roaming profit will decrease. In all scenarios the roaming profit is lower than in the reference period (Q3 '16 - Q2 '17). However,

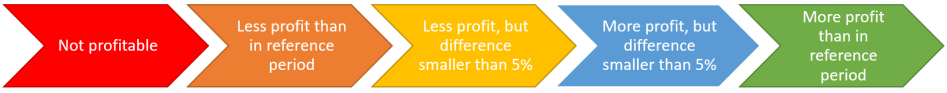
the decrease is never significant enough to make roaming services unprofitable. In figure 6.19a the table with an overview is given for the MNO. The fifth assumption case is added. For an MVNO the table is still the same as for the standard case and can be found in figure 6.11b.

Table 6.16: The percentage difference in roaming profit between Q3 '17 - Q2 '18 and Q3 '15 - Q2 '16 for the four scenarios for an MNO if Belgium becomes a sending country.

(cents)	SMS	voice	data
outbound roaming revenue per unit	0.9618	5.6896	1.266
outbound roaming cost per unit	1	3.2	0.7267
outbound roaming profit margin per unit	- 0.0382	2.4896	0.5393
inbound roaming revenue per unit	0.6	3	0.7267



(a) conclusions for an MNO



(b) colour scale

Figure 6.19: Conclussion for an MNO if Belgium becomes a sending country (assumption case 5)

6.7 Increase in domestic or RoW retail price for every scenario and assumption

In 2016 - 2017 a lot of articles were written about the abolishment of the roaming fees. Roaming like at home, too good to be true? A particular question that came to the surface is if the loss in roaming revenue for the providers will be passed on to the consumer[22]. Will RLAH cause an increase in the domestic prices? The operators can recover the potential revenue losses by increasing the domestic prices or by increasing the price for roaming in the rest of the world (RoW). In this section, these price increases are calculated for all four scenarios and all the assumption cases used in the previous sections. The price increase is based on the assumption that a provider aims for the same roaming revenue as in Q3 '15 - Q2 '16 (the reference period). The old roaming regulation still applies here. If the provider makes more profit than in the reference period, the prices do not increase.

6.7.1 Increase in domestic prices

To calculate the necessary increase in domestic price per service to obtain the same roaming revenues as in Q3 '15 - Q2 '16 the following formula is used for every service separately:

$$\text{domestic price increase} = \frac{\text{roaming profit Q3 '17 - Q2 '18} - \text{roaming profit Q3 '15 - Q2 '16}}{\text{domestic volume} + \text{outbound volume}}$$

The denominator is the volume of the domestic traffic and the outbound roaming traffic because when RLAH takes effect, customers will pay the same retail price for both types of traffic. If the denominator would be equal to the domestic volume, the profit would increase by the difference multiplied by the sum of the domestic volume and the outbound roaming volume because the outbound roaming retail price would also increases since it is equal to the domestic retail price. In this case the profit increases by more than the current difference in profit. This is not the intention of the price increases.

This calculation is done for every scenario (for a summary of the scenarios see 6.1) and for every assumption made in the previous sections. In section 6.3 the profit in the RLAH period was compared to the reference period for the standard assumption case. Two out of four scenarios actually generated more revenue than in the reference period. These scenarios are indicated by a star in table 6.17. In this table the price increase is given per service for every scenario. This is done for both an MNO and an MVNO. If the volumes would not change, the price of an MNO would need to increase by 0.0491 cents per SMS, 0.1191 cents per minute voice call and 0.0467 cents per MB. If the volumes double this price increase drops to 0.0353 cents per SMS, 0.0014 cents per minute voice call and 0.0015 cents per MB. For the others scenarios the total roaming profit is higher than in the reference period, thus an increase of the domestic retail price is not necessary. However, if the operator looks at the profit per service, they might still want to increase the domestic price to generate the same revenue as in the reference period for all services separately instead of only in total.

For an MVNO, the profit decreased for every scenario. The increase in domestic retail price is larger for the MVNO than for the MNO in all scenarios for all services with the exception of the first scenario for SMS and voice calls. The increases can be found in the same table. The MVNO should increase the domestic retail price for an SMS, because now SMS roaming is not profitable and it is forbidden to sell a good at loss. However, if the subscription costs per month for a subscriber are allocated differently to the services, it is possible that all three services become profitable.

The other assumption cases have no influence on the roaming profit of the MVNO, as explained in sections 6.4, 6.5 and 6.6. This means that the price increase is always the same. The price increase for an MVNO is therefore only mentioned once in table 6.17.

If the maximum inbound fee is charged to the DSP (assumption case 2, section 6.4), the increase in domestic prices drops. The difference in roaming profits between the RLAH period and the reference period becomes smaller (the numerator), this

is if there was a profit loss compared to the reference period. If the roaming profit was already higher than in the reference period, the difference will increase. But in this case the providers do not have to increase the domestic prices, so this has no influence on these calculations. If the volumes do not change (scenario 1), the price increase would be 0.0399 cents per SMS, 0.1138 cents per minute voice call and 0.0467 cents per MB. If the volumes double the price increase reduces to 0.0173 cents per SMS and 0.0015 cents per MB. For voice calls the profit increased compared to the reference period. Thus no increase in domestic retail prices is necessary. In the third and fourth scenario the operator already makes more roaming profit than in the reference period in total. If one takes a look at the roaming profit per service, the profit did not increase for SMS services in the third and fourth scenario. If the operators also want to recover this loss, the price should increase by 0.0108 cents and 0.0173 cents for scenario 3 and scenario 4 respectively. A summary of the price increases can be seen in table 6.18

In section 6.5, two extra assumption cases were simulated: varying I/O ratios. For both assumptions, three out of four scenarios made more revenue than in Q3 '15 - Q2 '16 in total. When one analyses the revenues service per service, one can see that the revenues for SMS dropped in all scenarios. The price increases can be found in tables 6.19 and 6.20.

In section 6.6 an analysis was done in case Belgium becomes a sending country (Table 6.21). The roaming profit drops in this case, thus the increase in domestic retail price increases.

Table 6.17: Domestic price increase (in cents) per service for every scenario for an MNO and an MVNO.

		SMS	voice	data
MNO	Scenario 1	0.0491	0.1191	0.0467
	Scenario 2	0.0353	0.0014	0.0015
	Scenario 3*	0.0314	-	-
	Scenario 4*	0.0353	0.0014	-
MVNO	Scenario 1	0.0440	0.1142	0.0521
	Scenario 2	0.0439	0.0741	0.0409
	Scenario 3	0.0438	0.0482	0.0387
	Scenario 4	0.0439	0.0741	0.0301

Table 6.18: Domestic price increase (in cents) per service for every scenario if the provides charge the maximum fee to the FSP for inbound roaming. (MNO)

	SMS	voice	data
Scenario 1	0.0399	0.1138	0.0467
Scenario 2	0.0173	-	0.0015
Scenario 3*	0.0108	-	-
Scenario 4*	0.0173	-	-

Table 6.19: Domestic price increase (in cents) per service for every scenario if the I/O ratio is changed according to trend 1. (MNO)

	SMS	voice	data
Scenario 1	0.0465	0.0970	0.0310
Scenario 2*	0.0302	-	-
Scenario 3*	0.0255	-	-
Scenario 4*	0.0302	-	-

Table 6.20: Domestic price increase (in cents) per service for every scenario if the I/O ratio is changed according to trend 2. (MNO)

	SMS	voice	data
Scenario 1	0.0434	0.0684	0.0083
Scenario 2*	0.0243	-	-
Scenario 3*	0.0187	-	-
Scenario 4*	0.0243	-	-

Table 6.21: Domestic price increase (in cents) per service for every scenario if Belgium becomes a sending country. (MNO)

	SMS	voice	data
Scenario 1	0.0569	0.1618	0.0695
Scenario 2	0.0507	0.0854	0.0463
Scenario 3	0.0489	0.00362	0.0429
Scenario 4	0.0507	0.0854	0.0241

The extra price a customer would have to pay over a year if the domestic prices increased, to cover the revenue loss relative to the reference period, can be found in appendix G.6. This price is calculated for all scenarios and for all assumptions. (*Remark: this is the price for a customer who does not roam or whose O/D ratio is equal to one. If his roaming habits differ, the price will vary. To calculate the extra price per year the assumption was made that he uses as much as at home.*)

6.7.2 Increase in RoW roaming prices

In an article of the guardian [23] the concern of increasing prices in RoW was raised. To calculate the necessary increase in the roaming prices in the the world per service to obtain the same roaming revenues as in Q3 '15 - Q2 '16 the following formula is used for every service separately:

$$\text{RoW price increase} = \frac{\text{roaming revenue Q3 '17 - Q2 '18} - \text{roaming revenue Q3 '15 - Q2 '16}}{\text{RoW volume}}$$

This calculation is done for every scenario (for a summary of the scenarios see 6.1) and for every assumption made in the previous sections. In section 6.3 the revenue in the RLAH period was compared to the reference period. Three out of four scenarios actually generated more revenue than was the case in the reference period. These scenarios are indicated by a star in table 6.22. In this table the price increase is given per service for every scenario. This is done for both an MNO and an MVNO. The increase in price is larger for the MVNO in all scenarios for all services with the exception of the first scenario for SMS and voice calls. If the volumes would not change, the RoW price charged by an MNO would need to increase by 32.28 cents per SMS, 77.19 cents per minute voice call and €1.99 per MB. Today the average retail price for roaming in the rest of the world is 32.25 cents per SMS, €1.795 per minute and €1.575 per MB. if the volumes double the increase drops to 23.67 cents per SMS, 0.90 cents per minute voice call and 6.39 cents per MB.

The assumptions analysed in 6.4 and 6.5 do not have an influence on the revenues of the MVNO. This means that the price increase is always the same. The price increase for an MVNO is therefore only mentioned once in table 6.22.

If the maximum inbound fee is charged to the DSP (section 6.4), the increase in RoW prices drops. The difference in roaming revenues between the RLAH period and the reference period becomes smaller (the numerator), this is if there was a loss. If the roaming revenue was already higher than in the reference period, the difference will increase. But in this case the providers do not have to increase the RoW prices, so this has no influence on these calculations. If the volumes do not change, the price increase would be 26.24 cents per SMS, 73.78 cents per minute and 189.98 cents per MB. If the volumes double the price increase reduces to 11.59 cents per SMS and 6.39 cents per MB. For voice calls the revenue increased compared to the reference period. Thus no increase in RoW prices is necessary. The third, fourth and fifth period already make more revenue than in the reference period in total. If one takes a look per service, the revenue did not increase for SMS services in the third and fifth scenario. If the operators also want to recover this loss, the price should increase by 7.25 cents and 11.59 cents for scenario 3 and scenario 5

respectively. A summary of the price increases can be seen in table 6.23

In section 6.5 two extra assumptions were simulated for the I/O ratio. For both assumption four out of five scenarios made more revenue than in Q3 '15 - Q2 '16 in total. When one analyses the revenues service per service, one can see that the revenues for SMS dropped in all scenarios. The price increases can be found in tables 6.24 and 6.25. If Belgium becomes a sending country, the roaming profit drops in every scenario. The price increases are most significant for this assumption and can be found in table 6.26.

Table 6.22: RoW price increase (in cents) per service for every scenario for an MNO and an MVNO.

		SMS	voice	data
MNO	Scenario 1	32.28	77.19	198.98
	Scenario 2	23.67	0.90	6.39
	Scenario 3*	21.12	-	-
	Scenario 4*	23.67	0.90	-
MVNO	Scenario 1	28.92	73.99	222.40
	Scenario 2	29.38	48.77	177.92
	Scenario 3	29.51	32.09	168.49
	Scenario 4	29.38	48.77	133.51

Table 6.23: RoW price increase (in cents) per service for every scenario if the provides charge the maximum fee to the FSP for inbound roaming. (MNO)

	SMS	voice	data
Scenario 1	26.24	73.78	198.98
Scenario 2	11.59	-	6.39
Scenario 3*	7.25	-	-
Scenario 4*	11.59	-	-

Table 6.24: RoW price increase (in cents) per service for every scenario if the I/O ratio is changed according to trend 1. (MNO)

	SMS	voice	data
Scenario 1	30.57	62.90	132.08
Scenario 2*	20.24	-	-
Scenario 3*	17.19	-	-
Scenario 4*	20.25	-	-

Table 6.25: RoW price increase (in cents) per service for every scenario if the I/O ratio is changed according to trend 2. (MNO)

	SMS	voice	data
Scenario 1	28.57	44.36	35.32
Scenario 2*	16.25	-	-
Scenario 3*	12.61	-	-
Scenario 4*	16.25	-	-

Table 6.26: RoW price increase (in cents) per service for every scenario if Belgium becomes a sending country. (MNO)

	SMS	voice	data
Scenario 1	37.41	104.85	296.34
Scenario 2	33.95	56.22	201.49
Scenario 3	32.92	24.06	187.16
Scenario 4	33.95	56.22	106.82

6.7.3 Discussion

In this section an answer to the question "How much would the domestic revenue have to increase to cover for the roaming loss?" was formulated for the cases in which the roaming profit dropped when compared to the reference period. Some providers in Belgium have already announced an increase in the retail prices. Telenet increased the domestic retail prices linearly this year but they say this increase

is not caused by the new roaming regulation [26]. Proximus increased the domestic retail prices outside the bundles. Proximus spokesman Jan Margot emphasised that the increases only apply when the limits of the bundle are exceeded, which is exceptional according to him. The site of proximus states that retail price outside the bundle becomes €0.10/MB and €0.25/min for Mobilus bundles. [27].

The calculations were also done for the case in which operators want to recuperate the profit loss by increasing the retail roaming price in the rest of the world. But the analysis of the past shows that this is not as likely to happen as an increase in domestic retail prices.

6.8 Discussion

Figure 6.20 showh the new roaming profit of MNOs and MVNOs. The comparison with the reference period is visualised in figure 6.21 according to a colour scale. The result for the MVNO is the same in all assumption cases because the difference between the assumption cases concerns about incoming roaming traffic, which MVNOs typically cannot host.

As could be seen in the analysis and in figures 6.20 and 6.21, some operators are able to maintain the current profit level in a set of circumstances. The biggest influence is the roaming volume as the roaming profit increases with increasing volumes. If the roaming volume doubles, MNOs actually make more profit than they used to. A lot of people did not roam at all or very little, especially for data services, as they were scared for large bills. It is thus important to advertise RLAH properly and encourage the subscribers to use (more) mobile services when abroad. As the roaming market will change from a low volume high price market to a high volume low price market, operators benefit from stimulating their users to roam more when RLAH takes effect. The biggest challenge for the operators will be to estimate the correct roaming volumes in the future.

Operators have to discuss new inter-operator tariffs (IOT) with foreign service provides to minimalize their costs. These wholesale charges should be discussed with the retail prices in mind. Some have more leverage than others. As MVNOs have no incoming roaming traffic, they have little leverage to negotiate better deals. For net receivers the impact of RLAH is not as big as for net senders. The costs for net senders will become very high compared to the revenue if they do not renegotiate the IOTs well.

The new roaming legislation will not only change the roaming market, the domestic market will also be affected. Providers should ensure a good quality of service (QoS) for both the domestic user and the visiting user. The operator should be equipped to handle the sharp increase in roaming volume, especially for data services, to still be able to satisfy the domestic user.

Little people take roaming tariffs into account when choosing a provider or a tariff plan. However, operators should be careful about applying for the sustainability clause or about increasing domestic retail prices, as these may well be reasons for leaving the operator.

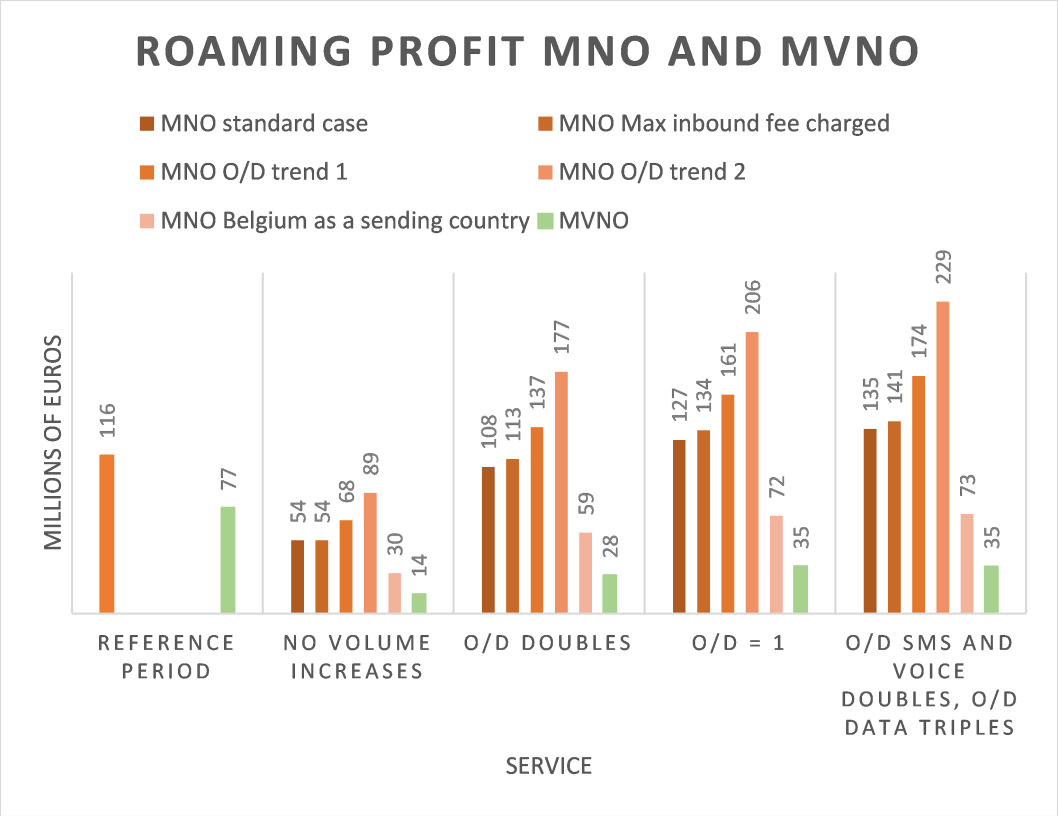
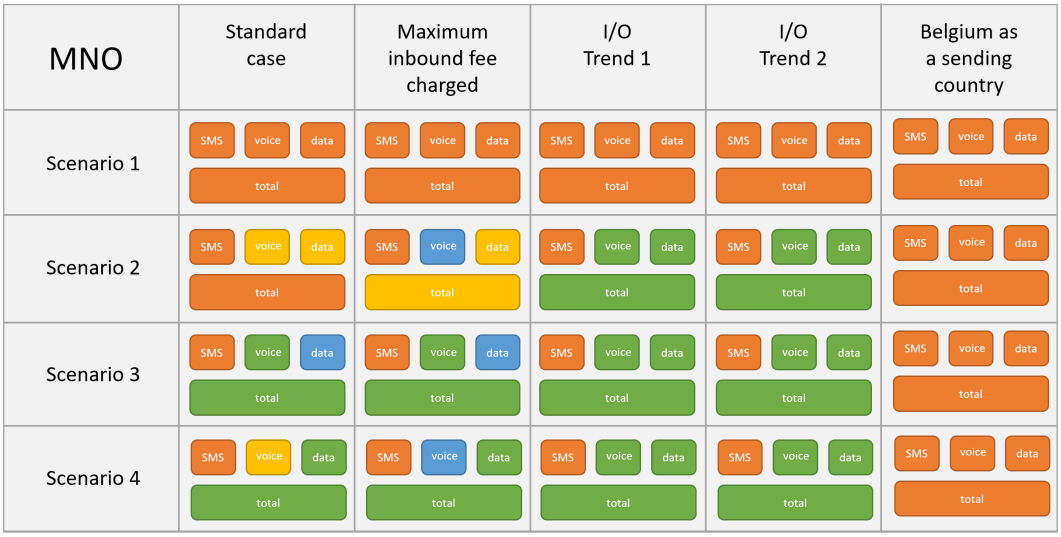
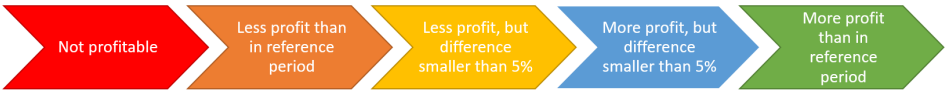


Figure 6.20: Roaming profit of an MNO and an MVNO



(a) roaming profit of MNO compared to the reference period



(b) colour scale

(c) roaming profit of MVNO compared to the reference period

Figure 6.21: Roaming profit of MNO and MVNO compared to the reference period

Chapter 7

Conclusion & future work

7.1 Conclusion

In the fall of 2015, the European commision decided that mobile operators will no longer be able to charge additional fees for mobile roaming as of June 15th 2017, which means that mobile usage (voice, text and data) will be charged equally abroad as at home or in other words roam like at home (RLAH). Though this implies that prices for consumers will drop when roaming, the costs for mobile operators however will not. A number of rather special effects may occur as roaming like at home will not impact each mobile operator equally. Various descriptive papers have been written about the roaming legislation and its impact. In comparison to these descriptive works, this thesis provides a quantitative analysis of the impact of the new roaming legislation, starting in June 2017.

An analytical model has been introduced to quantify the impact of the legislation by calculating the domestic and roaming revenues and costs. Data and trends from the past were used in the model:

- **Seasonality**

  Tourism creates the seasonal nature of roaming traffic for all services: every third quarter the volume peaks.

- **Spectacular increase in volume of data services**

  The roaming volumes for SMS and voice calls follow a slightly increasing trend

over time. The roaming volumes for data services, however, make a spectacular increase. A similar increase is visible for the domestic data traffic. Smartphones enable users to communicate via applications that use the internet, such as WhatsApp instead of SMS and Skype instead of voice calls. Wi-Fi, which is available in more and more places, and the lowering retail price for data services encourages the use of these apps.

- **Steady RoW prices**
  The European average of the retail roaming price in the rest of the world (RoW) shows a downward trend for all services. The operators did not increase the retail prices for roaming in the rest of the world to make up for the loss of revenue due to the roaming legislation.

The results of the model suggested that the impact of RLAH is not guaranteed to be negative, under a set of circumstances (e.g. roaming traffic doubling) the impact of RLAH for MNOs remains minimal. In fact if roaming volumes should increase to the extent that subscribers use the same amount of volume per day when abroad as they currently do at home, the roaming profit actually increases for MNOs.

MVNOs on the other hand are equipped worse for RLAH. Due to the absence of inbound roaming traffic and low profit margins in the domestic market, the profit loss is percentage-wise bigger for them. They lose profit compared to 2015 - 2016 under all realistic circumstances. Even more noticeable is that the SMS roaming service is not profitable at all for MVNOs. The outbound retail revenue per SMS is lower than the wholesale cost. This results in a loss per SMS sent. It is forbidden to sell services at loss. Three possible reactions of the MVNO are given:

- Raise the domestic retail price by at least 0.000382 per SMS. SMS roaming service will than no longer be unprofitable.
- Apply for the sustainability clause.
- Reallocate the domestic retail revenue per unit. SMS is often part of a bundle. The combined package is most likely still profitable.

However, every situation leads to a competitive disadvantage for MVNOs, so does doing nothing, as the MNOs have higher roaming profits.

For an MNO, SMS roaming services are profitable, however, there is not one situation in which SMS services generate more profit, or even the same profit, as in 2015 - 2016, when the old roaming regulation still applied. This is the only service for which this never happens. As SMS roaming profit is only a very small share of the total roaming profit, this will not have a big impact on the total roaming profit.

When RLAH takes effect, it is possible that the outbound roaming volumes increase more than the inbound roaming volumes do. If this happens to the extent that outbound roaming volumes exceed the inbound roaming volumes, Belgium becomes a sending country. In this case, the inbound roaming revenues drop and so does the roaming profit. Even if the data volume would triple, the provider would still lose profit compared to 2015 - 2016.

As could be seen in the analysis, some operators are able to maintain the current profit level in a set of circumstances. The biggest influence is the roaming volume as the roaming profit increases with increasing volumes. If the roaming volume doubles, MNOs actually make more profit than they used to. A lot of people did not roam at all or very little, especially for data services, as they were scared for large bills. It is thus important to advertise RLAH properly and encourage the subscribers to use (more) mobile services when abroad. As the roaming market will change from a low volume high price market to a high volume low price market, operators benefit from stimulating their users to roam more when RLAH takes effect. The biggest challenge for the operators will be to estimate the correct roaming volumes in the future.

Operators have to discuss new inter-operator tariffs (IOT) with foreign service provides to minimalize their costs. These wholesale charges should be discussed with the retail prices in mind. Some have more leverage than others. As MVNOs have no incoming roaming traffic, they have little leverage to negotiate better deals. For netto receivers the impact of RLAH is not as big as for netto senders. The

costs for netto senders will become very high compared to the revenue if they do not renegotiate the IOTs well.

The new roaming legislation will not only change the roaming market, the domestic market will also be affected. Providers should ensure a good quality of service (QoS) for both the domestic user and the visiting user. The operator should be equipped to handle the sharp increase in roaming volume, especially for data services, to still be able to satisfy the domestic user.

Little people take roaming tariffs into account when choosing a provider or a tariff plan. However, operators should be careful about applying for the sustainability clause or about increasing domestic retail prices, as these may well be reasons for leaving the operator.

RLAH does not have to be a setback for the providers, it is also an opportunity as the roaming volumes will increase significantly.

7.2 Future work

For now, the values of the input parameters were based on data gathered from three Belgian MNOs. These values are averages. An interesting next step would be to colaborate with an operator that can provide all the necessary values for the model with precision. Then, the results of the model can be compared to predictions made by operators themselves. It would also be interesting to model operators in other countries. The extremes are Spain and Finland. Spain has a lot more inbound traffic while Finland has a lot more outbound traffic. It might be interesting to include these two countries in the comparison. In this dissertation the impact of RLAH has been caluclated for Belgium if it would become a sending country such as Finland. (Even with the same ratio between the incoming and outgoing volume as Finland.) However, the other values of the inputparameters are based on data of Belgian MNOS, not on data of a Finish operator. Not enough data was available to simulate Finland or Spain correctly.

As RLAH already takes effect in June, the first volume increases will be known quite soon. It would be interesting to create a scenario and assumption case after the third quarter of 2017 based on the actual volume trends in this quarter. In this way, the results of the model can be validated with the reality. A sensitivity analysis could be performed on the parameters of the new scenario and assumption case.

More details could be added to the model. In this dissertation an abstraction was made from some costs such as labour costs, advertising costs... It would, however, be interesting to include the network costs and allocate a share of them to domestic traffic and the other share to inbound roaming traffic. In the current model inbound roaming only generates revenues, no costs. But if the volumes increase to such an extent that additional network costs would occur, these costs should be taken into account. Including the network cost also enables a better comparison between the profit of domestic traffic and the profit of outbound roaming traffic. Both will generate the same revenue per unit when RLAH is active, but the costs differ. The network cost could quantify the domestic traffic cost. The cost for outbound roaming is already included in the model.

When RLAH takes effect, the cross-country operator will experience an advantage over other operators because their is no additional roaming charge, no additional cost, except maybe internal costs, as long as the subscriber connects to the operators network abroad. This advantage has not been quantified. The model can be expanded so that it can be used to calculate the advantage for cross-country operators.

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Appendices

Appendix A

UML diagram

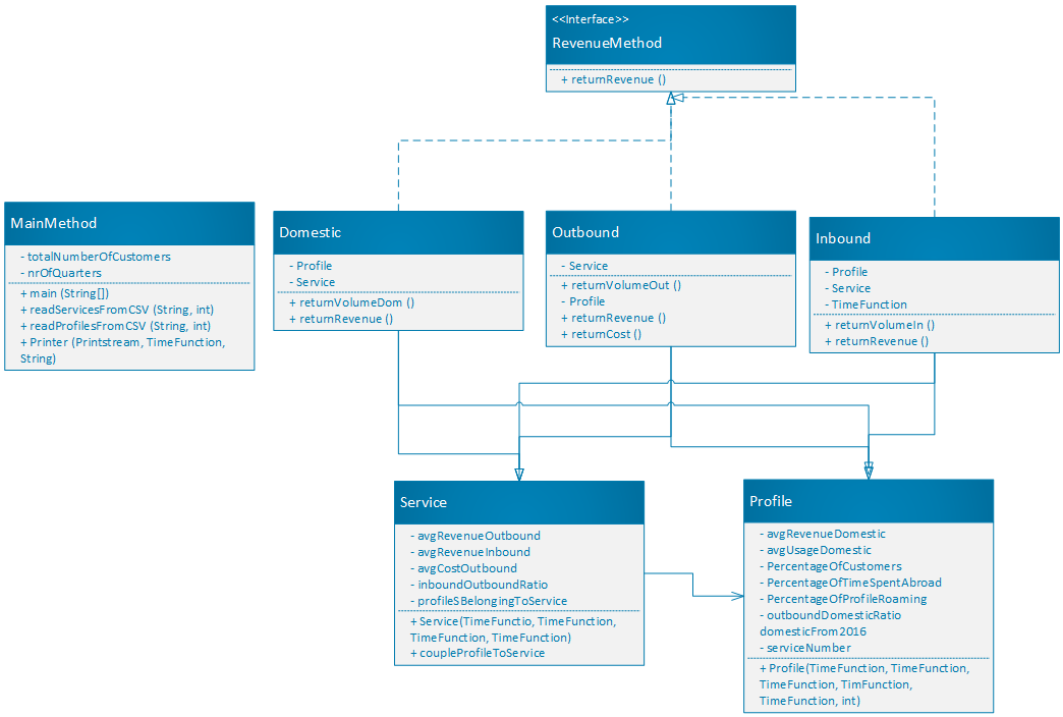

Figure A.1: UML diagram of the model

Appendix B

Customer profiles BIPT

Postpaid profiles

- Profile 1: Very few calls (without data):
  60 minutes, 50 text messages, no data
- Profile 2: Average number of calls (without data):
  120 minutes, 100 text messages, no data
- Profile 3: Few calls, little data volume:
  100 minutes, 100 text messages, 50 MB data
- Profile 4: Average number of calls, average data volume:
  120 minutes, 200 text messages, 200 MB data
- Profile 5: Lots of calls, lots of data:
  300 minutes, unlimited text messages, 1GB data
- Profile 6: Intense number of calls, intense data volume:
  400 minutes, unlimited text messages, 2 GB data

Prepaid profiles:

- Profile 7: Few calls (without data):
  50 minutes, 100 text messages, no data
- Profile 8: Lots of calls (withoud data):
  100 minutes, 150 text messages, no data

- Profile 9: Average number of calls (with data):

  50 minutes, 50 text messages, 50 MB data

- Profile 10: Few calls, lots of data:

  20 minutes, unlimited text messages, 1GB data

Table B.1: Postpaid profiles (*estimated)

		monthly volume		
	total price	SMS	voice	data
profile 1	11,67	50	60	0
profile 2	12.86	100	120	0
profile 3	12.86	100	100	50
profile 4	14.27	200	120	200
profile 5	21.01	250*	300	1000
profile 6	34.57	250*	400	2000

Table B.2: Prepaid profiles (*estimated)

		monthly volume		
	total price	SMS	voice	data
profile 7	12.29	100	50	0
profile 8	21.2	150	100	0
profile 9	11.62	50	50	50
profile 10	20.99	200*	20	1000

Appendix C

Percentage of customers belonging to a profile

.

Table C.1: Percentage of total customers belonging to a profile. Profile 1 to 6 correspond with postpaid profiles. Profile 7 to 10 correspond with prepaid profiles.

	% customers who have a **postpaid** profile	% customers
profile 1	8	6
proffile 2	14	10
profile 3	13	10
profile 4	18	13
profile 5	30	22
profile 6	17	12
	% customers who have a **prepaid** profile	% customers
profile 7	45	12
profile 8	25	7
profile 9	20	5
profile 10	10	3
		$\sum = 100$

Appendix D

Domestic revenues

.

Table D.1: The domestic revenue per text message over the years

SMS	2012	2013	2014	2015	2016
P1	0.018	0.015	0.018	0.021	0.024
P2	0.018	0.015	0.014	0.014	0.013
P3	0.018	0.015	0.014	0.014	0.013
P4	0.018	0.015	0.013	0.011	0.009
P5	0.018	0.015	0.011	0.008	0.004
P6	0.018	0.015	0.011	0.008	0.004
P7	0.018	0.015	0.19	0.023	0.027
P8	0.018	0.015	0.018	0.021	0.025
P9	0.018	0.015	0.017	0.019	0.021
P10	0.018	0.015	0.012	0.009	0.007

Table D.2: The domestic revenue per voice call made over the years

voice	2012	2013	2014	2015	2016
P1	0.131	0.107	0.129	0.152	0.174
P2	0.131	0.107	0.103	0.100	0.096
P3	0.131	0.107	0.103	0.100	0.096
P4	0.131	0.107	0.092	0.077	0.062
P5	0.131	0.107	0.081	0.055	0.029
P6	0.131	0.107	0.081	0.054	0.028
P7	0.131	0.107	0.135	0.164	0.192
P8	0.131	0.107	0.130	0.152	0.175
P9	0.131	0.107	0.122	0.136	0.151
P10	0.131	0.107	0.087	0.067	0.047

Table D.3: The domestic revenue per MB over the years

data	2012	2013	2014	2015	2016
P1	0.104	0.043	0.052	0.061	0.07
P2	0.104	0.043	0.042	0.04	0.039
P3	0.104	0.043	0.042	0.04	0.039
P4	0.104	0.043	0.037	0.031	0.025
P5	0.104	0.043	0.032	0.022	0.011
P6	0.104	0.043	0.081	0.054	0.029
P7	0.104	0.043	0.054	0.066	0.077
P8	0.104	0.043	0.052	0.061	0.070
P9	0.104	0.043	0.049	0.055	0.061
P10	0.104	0.043	0.035	0.027	0.019

Appendix E

Percentage of customers who roam

Table E.1: Calculation of the percentage of customers who roam every quarter

	% yearly volume				% customers
	SMS	voice	data	avg	
Q3 2012	42.08	34.05	40.27	38.80	45.01
Q4 2012	17.48	19.61	22.81	19.97	23.16
Q1 2013	19.04	20.26	13.48	17.60	20.41
Q2 2013	23.05	24.64	20.50	22.73	26.36
Q3 2013	40.92	34.42	39.96	38.43	44.58
Q4 2013	16.99	20.69	26.06	21.25	24.65
Q1 2014	16.97	19.42	12.05	16.15	18.73
Q2 2014	24.43	25.45	21.32	23.73	27.53
Q3 2014	42.16	34.74	43.49	40.13	46.55
Q4 2014	16.44	20.40	23.14	19.99	23.19
Q1 2015	14.86	16.81	12.25	14.64	16.98
Q2 2015	26.22	26.80	22.73	25.25	29.29
Q3 2015	42.76	35.51	42.29	40.19	46.61
Q4 2015	16.16	20.88	22.74	19.93	23.11
Q1 2016	14.47	18.34	8.96	13.92	16.15
Q2 2016	23.35	23.80	16.52	21.22	24.62

Q3 2016	48.06	35.55	57.52	47.04	54.57
Q4 2016*	14.12	22.31	17.00	17.81	20.66

Appendix F

Outbound-domestic ratio

Table F.1: The outbound-domestic ratio over the years. (in %)

	SMS	voice	data
Q3 2012	38.14	49.73	15.25
Q4 2012	30.79	55.66	16.79
Q1 2013	35.25	60.77	10.42
Q2 2013	33.02	57.23	12.26
Q3 2013	34.67	47.27	14.14
Q4 2013	26.05	51.39	16.68
Q1 2014	37.77	64.58	12.09
Q2 2014	36.99	57.59	14.55
Q3 2014	37.75	46.49	17.55
Q4 2014	29.54	54.80	18.75
Q1 2015	39.19	68.24	17.19
Q2 2015	40.10	63.07	18.49
Q3 2015	41.08	52.52	21.62
Q4 2015	31.30	62.29	23.44
Q1 2016	45.25	49.50	29.92
Q2 2016	47.91	42.14	36.21
Q3 2016	44.49	28.39	56.86
Q4 2016	34.53	47.07	44.38

Appendix G

Roaming revenues and costs

G.1 Roaming revenues from outbound roaming

Table G.1: Calculation of the revenue per text message. In 2016 the same revenue is used as in 2015. The total revenue is in thousands of euros. The total volume is in millions of text messages.

SMS	Total revenue	Total volume	revenue per unit
Q3 2012	10556.528	123.146	0.086
Q4 2012	4356.345	51.164	0.086
Q1 2013	4535.415	53.120	0.085
Q2 2013	5532.043	64.289	0.086
Q3 2013	8635.706	114.131	0.076
Q4 2013	3627.664	47.399	0.077
Q1 2014	3699.085	49.269	0.076
Q2 2014	5270.406	70.905	0.075
Q3 2014	6657.987	122.393	0.056
Q4 2014	2511.079	47.708	0.054
Q1 2015	2318.537	44.679	0.053
Q2 2015	4239.976	78.835	0.054
Q3 2015	6872.755	128.550	0.054
Q4 2015	2485.782	48.571	0.052
Q1 2016	2581.336	50.655	0.051

Q2 2016	2037.926	81.738	0.025
Q3 2016	2782.128	168.276	0.017
Q4 2016*			0.017*

Table G.2: Calculation of the revenue per minute voice call. In 2016 the same revenue is used as in 2015. The total revenue is in thousands of euros. The total volume is in millions of minutes.

voice	Total revenue	Total volume	revenue per unit (billed)
Q3 2012	28194.837	45.243	0.301
Q4 2012	16062.872	53.618	0.299
Q1 2013	15481.135	64.726	0.292
Q2 2013	18622.467	123.146	0.290
Q3 2013	20953.202	51.164	0.235
Q4 2013	13029.536	53.120	0.245
Q1 2014	12465.808	64.289	0.241
Q2 2014	16274.542	114.131	0.240
Q3 2014	17581.420	47.399	0.191
Q4 2014	10451.614	49.269	0.196
Q1 2015	9158.524	70.905	0.193
Q2 2015	13854.850	122.393	0.176
Q3 2015	16457.096	47.708	0.159
Q4 2015	10122.452	44.679	0.165
Q1 2016	8883.864	78.835	0.157
Q2 2016	9742.820	128.550	0.130
Q3 2016	9570.291	48.571	0.085
Q4 2016*			0.085

Table G.3: Calculation of the revenue per MB. In 2016 the same revenue is used as in 2015. The total revenue is in thousands of euros. The total volume is in millions of MB.

data	Total revenue	Total volume	revenue per unit (billed)
Q3 2012	5.204	18.142	0.337
Q4 2012	2.845	10.277	0.331
Q1 2013	3.954	12.049	0.328
Q2 2013	8.692	18.314	0.475
Q3 2013	12.938	35.704	0.367
Q4 2013	7.605	23.288	0.342
Q1 2014	8.835	26.024	0.357
Q2 2014	14.668	46.032	0.311
Q3 2014	15.359	93.919	0.165
Q4 2014	8.054	49.972	0.163
Q1 2015	8.538	54.329	0.158
Q2 2015	15.269	100.803	0.152
Q3 2015	26.602	187.548	0.142
Q4 2015	15.670	100.850	0.156
Q1 2016	16.996	107.265	0.159
Q2 2016	14.536	197.820	0.073
Q3 2016	26.344	688.637	0.038
Q4 2016*			0.038*

G.2 Roaming revenues from inbound roaming

Table G.4: Revenue per unit per service over the years (in €). In 2016 the same revenue is used as in 2015.

	SMS	voice (billed)	data
Q3 2012	0.029	0.135	0.105
Q4 2012	0.029	0.135	0.108
Q1 2013	0.027	0.129	0.094
Q2 2013	0.026	0.112	0.085
Q3 2013	0.019	0.091	0.084
Q4 2013	0.019	0.089	0.059
Q1 2014	0.019	0.080	0.058
Q2 2014	0.017	0.047	0.025
Q3 2014	0.016	0.042	0.025
Q4 2014	0.017	0.045	0.024
Q1 2015	0.011	0.036	0.018
Q2 2015	0.010	0.038	0.016
Q3 2015	0.011	0.037	0.016
Q4 2015	0.010	0.033	0.016
Q1 2016	0.008	0.030	0.013
Q2 2016	0.007	0.030	0.013
Q3 2016	0.006	0.030	0.013
Q4 2016*	0.006*	0.030*	0.013*

G.3 Roaming costs for outbound roaming

Table G.5: Cost per unit per service for outbound roaming over the years (in €). In 2016 the same cost is used as in 2015.

	SMS	voice (actual)	data
Q3 2012	0.031	0.114	0.087
Q4 2012	0.029	0.105	0.078
Q1 2013	0.030	0.110	0.100
Q2 2013	0.030	0.160	0.084
Q3 2013	0.020	0.116	0.128
Q4 2013	0.019	0.106	0.143
Q1 2014	0.019	0.116	0.133
Q2 2014	0.020	0.108	0.142
Q3 2014	0.020	0.053	0.050
Q4 2014	0.020	0.053	0.050
Q1 2015	0.019	0.053	0.050
Q2 2015	0.019	0.054	0.037
Q3 2015	0.019	0.053	0.039
Q4 2015	0.019	0.050	0.039
Q1 2016	0.019	0.051	0.039
Q2 2016	0.017	0.049	0.045
Q3 2016	0.018	0.052	0.048
Q4 2016*	0.018*	0.052*	0.048*

G.4 Increase in domestic Domestic increase

Table G.6: The extra price per customer profile per year a subcriber would have to pay if the domestic prices would increase to cover the revenue loss relative to the reference period. For all scenarios and all assumptions discussed in chapter 6. For MVNO the price increase is the same for all assumptions. (This is the price for a customer that does not roam. If he roams the price depends on how much volume he personally uses abroad.)

		P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
MNO	S1	1.15	2.30	2.30	4.01	11.36	18.38	1.30	2.31	1.29	7.06
	S2	0.22	0.44	0.45	0.90	1.29	1.48	0.43	0.65	0.23	1.03
	S3	0.19	0.38	0.38	0.75	0.94	0.94	0.38	0.56	0.19	0.75
	S4	0.22	0.44	0.44	0.87	1.11	1.13	0.43	0.65	0.22	0.85
MVNO	S1	1.09	2.17	2.21	3.95	11.69	19.31	1.21	2.16	1.26	7.59
	S2	0.80	1.59	1.66	3.10	8.89	14.69	0.97	1.68	0.95	6.14
	S3	0.61	1.22	1.34	2.67	7.69	12.91	0.82	1.37	0.78	5.81
	S4	0.80	1.59	1.60	2.84	7.60	12.10	0.97	1.68	0.89	4.85
Max MNO	S1	1.06	2.12	2.12	3.72	10.89	17.86	1.16	2.08	1.20	6.83
	S2	0.10	0.21	0.22	0.45	0.70	0.87	0.21	0.31	0.11	0.59
	S3	0.06	0.13	0.13	0.26	0.32	0.32	0.13	0.19	0.06	0.26
	S4	0.10	0.21	0.21	0.42	0.52	0.52	0.21	0.31	0.10	0.42
trend 1 MNO	S1	0.98	1.95	1.91	3.26	8.60	13.48	1.14	2.00	1.05	5.06
	S2	0.18	0.36	0.36	0.73	0.91	0.91	0.36	0.54	0.18	0.73
	S3	0.15	0.31	0.31	0.61	0.77	0.77	0.31	0.46	0.15	0.61
	S4	0.18	0.36	0.36	0.73	0.91	0.91	0.36	0.54	0.18	0.73
trend 2 MNO	S1	0.75	1.51	1.39	2.23	4.76	6.58	0.93	1.60	0.72	2.20
	S2	0.15	0.29	0.29	0.58	0.73	0.73	0.29	0.44	0.15	0.58
	S3	0.11	0.22	0.22	0.45	0.56	0.56	0.22	0.34	0.11	0.45
	S4	0.15	0.29	0.29	0.58	0.73	0.73	0.29	0.44	0.15	0.58
sending MNO	S1	1.51	3.01	3.04	5.36	15.87	26.15	1.65	2.96	1.73	10.09
	S2	0.92	1.84	1.91	3.56	10.16	16.74	1.12	1.94	1.09	6.98
	S3	0.55	1.11	1.28	2.72	7.92	13.51	0.80	1.31	0.77	6.41
	S4	0.92	1.84	1.78	3.02	7.49	11.41	1.12	1.94	0.96	4.31