The innovation-enhancing effects of network neutrality

seo economic research

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Summary

Network neutrality enhances innovations by small content and application providers (CAPs), but it also provides benefits for large CAPs and internet service providers (ISPs). Network neutrality affects innovation incentives positively by effectively reducing market power of internet service providers and increasing connectivity between end-users.

The Ministry of Economic Affairs asked SEO Economic Research to describe what the essential economic mechanisms are through which network neutrality fosters innovations by new and small innovators. The results presented in this study are based on desk research, primarily on findings in the blooming economic literature on network neutrality.

Traffic management in best-effort routing, such as payments for priority lanes and blocking competing services and applications, reduces competition between ISPs and increases the entry barriers for CAPs, in particular for small CAPs. The reason is twofold. First, an ISP has incentives to reduce competition by differentiating itself from other ISPs by offering priority lanes only for certain large content and application providers, with which other ISPs do not contract. Other ISPs have the same incentives. Through prioritization, ISPs can avoid the commodity trap – the internet as a homogenous product – and charge higher connection fees to end-users. A lower level of competition reduces innovation incentives of ISPs because they do not need to compete for end-users by innovative services. Second, paying for priority lanes or facing anticompetitive practices of ISPs increases the market entry costs for CAPs. These costs discourage innovations by both new – as they do not enter the market – and incumbent CAPs. Network neutrality helps eliminate these market imperfections and hence increase competition between ISPs and the innovation activity of both ISPs and CAPs.

Network neutrality also stimulates connectivity between end-users and CAPs. On the one hand, more end-users connect to the internet because of innovations mainly by small CAPs. On the other hand, larger connectivity makes providing innovative content and applications more attractive for both small and large CAPs as they convert the benefits from connectivity (so-called network externalities) into financial benefits. More specifically, connectivity represents economic value for CAPs *directly* as they can achieve higher revenues from direct payments. Moreover, CAPs benefit *indirectly* through more advertising revenues as their services become more attractive for advertisers. On top of this, the value of the internet connection *itself* increases for end-users as they get access to more content and applications. Therefore, they are willing to pay more for an internet connection and, as a consequence, ISPs also benefit from larger connectivity, which fosters the innovation.

Network neutrality stimulates innovations through these mechanisms. Up till now, in an open – that is, neutral and unrestricted – internet, a large number of fundamental innovations were primarily developed by initially small, often individual, innovators. The *World Wide Web*, *eBay*, *Facebook*, *Skype*, *Google*, *Yahoo*! or *Apache* all are primary examples. These innovators offered their applications online and let end-users decide whether the applications were useful for them. These circumstances were necessary for a boom of diverse and successful innovations. If these

circumstances are maintained, small innovators can remain the providers of a diversity of applications and content, out of which new fundamental innovations can emerge.

Table S.1 Network neutrality (NN) reduces market power and fosters innovations at the edges

Market inefficiencies in telecommunications markets	Can NN correct market inefficiencies?	NN stimulate innovations…
Market power of internet service providers	Yes, for both ISPs and CAPs	Of both ISPs and CAPs
Network externalities	Yes, mainly for small CAPs	Mainly for small CAPs, but ISPs and large CAPs can also benefit from NN

Source: SEO Economic Research

As a result of their success, some of these initially small innovators have achieved high amount of visits and grew into online 'powerhouses' with large market shares. These large CAPs benefit less from network neutrality, since they would need priority lanes to increase the value of larger connectivity and thus their advertising revenues. However, prioritization on best-effort routing is not permitted under network neutrality. Nonetheless, network neutrality has some positive effects on their innovation incentives as it avoids costs of prioritization. First, if buying a priority lane is beneficial for a CAP, it needs to negotiate and contract with several ISPs, which process entails large transaction costs that are absent under network neutrality. Second, network neutrality helps avoid other types of market inefficiencies, such as the overcharging by ISPs and the overuse of network capacity as several (or even all) large CAPs have incentives to buy priority lanes.

1 Introduction

Contrary to ISP's claims that net neutrality regulations would have a chilling effect on their incentives to invest, we cannot dismiss the possibility of the opposite. (Choi & Kim, 2010)

The ISP adjusts capacity to the level of traffic: net neutrality is likely to favor innovation at the edges while hindering the development of applications from large content providers. (Reggiani & Valletti, 2012)

Since the beginning of the millennium, economists, legal experts, and policy makers have been discussing the effects of neutral network structures on – among others – innovations by network providers and end-users. Does network neutrality – the open and non-discriminatory functioning of the internet – provide incentives in both sides of the market?

Recently, governments in several countries in and outside the EU consider whether sufficient arguments can support the introduction of network neutrality to law books. For the first time in Europe, in 2011 the Dutch government added net neutrality regulation to the telecommunications law, with the enforcement as of 2013. Certainly, political reasons, such as freedom of opinion and expression and to gather information, formed a relevant argument in this decision. However, recent experiences in the mobile internet market provided evidence for the existence of discriminatory practices, which could have negative economic consequences. The economic reasons behind guaranteeing neutral networks in the Netherlands were twofold: net neutrality (i) intensifies competition and (ii) stimulates the development of innovative services, content, and applications by new and small innovators.

In the current report, SEO Economic Research focuses on the second argument and analyzes whether network neutrality can foster such innovations in the coming period and what the added value of unrestricted internet content and applications is to the economy and society. The results presented in this study are based on desk research, primarily on findings in the economic literature on network neutrality.

The structure of the study is as follows. In Chapter 2, network neutrality and the discriminatory practices are briefly introduced. This chapter presents the recommendation of the European Commission about regulating traffic shaping and the net neutrality regulation in the Netherlands. In Chapter 3, an analysis follows about the innovation-enhancing effects of net neutrality regulation. Incentives for innovations at the core of the market (i.e. by internet service providers) and at the edges (i.e. by content and application providers) are considered separately. The analysis also reflects on the characteristics of the Dutch broadband market. Appendix A provides an analytical framework to assess the social costs and benefits of net neutrality regulation in comparison to a situation where traffic shaping practices may occur. The direct, indirect, and external effects of net neutrality regulation are listed, and where possible, illustrated by numbers.

2 Network Neutrality Regulation: Institutional Background

The network neutrality debate has been booming since the beginning of the millennium. Consequently, several paragraphs were added to the EU telecom regulatory framework that aim at reducing the negative consequence of traffic shaping practices. Based on political arguments, existing and foreseen examples, and their expected negative consequences on competition and innovation, network neutrality has been added to the Dutch Telecommunications Act.

The network neutrality discussion has started in the early 2000s, as it became technically possible for network providers to discriminate data of different content and application providers. Discrimination can be both harmful and beneficial. Therefore, a debate between policy makers and academics emerged all over the world about what type of discrimination should be allowed and what needs to be prohibited.

Several reasons for discrimination are listed, among others incentives to invest in next generation networks to meet customers' demand and the need of better quality of services for innovative content and applications (Cave & Peitz 2013, Cave *et al.* 2009, Sweers & Brouwer 2011). Network operators and internet service providers are in favor of discrimination for these reasons. However, discrimination has negative consequences on the functioning of internet markets. For instance, discrimination increases the potential for the abuse of dominance, thus hindering innovations at the edges and reducing consumer choices. Very strict network neutrality would prohibit any form of discrimination practices based on the claim that all data bits need to be treated equally on the basis of first come, first served.[1] In between very strict net neutrality and full discrimination, several different opinions are formulated about which type of discrimination is rather beneficial and should be allowed. For instance, should discrimination by applications, classes of application or only by application-agnostics be permitted (Van Schewick, 2010b)?

In this chapter, the current view of the EC on net neutrality and the recently introduced Dutch regulation are described.

2.1 Traffic Shaping Practices

Due to technological developments, quality of service (QoS), thus discrimination of data has recently been made possible. Quality of service is a set of technologies that allows the efficient management of network traffic by measuring bandwidth and observing changes in technical conditions or congestion.Traffic management can take several forms:

- Technical traffic management: Traffic shaping can occur for technical reasons, such as congestion management and providing the security and integrity of the internet (e.g. Spam, Ddos attacks or botnets);

[1] See the opinion of proponents of net neutrality; for instance, Susan Crawford (http://bit.ly/13WOwhh, scrawford.net), Timothy Wu (http://bit.ly/13WOu91, timwu.org).

- Prioritization: Traffic shaping can discriminate data of certain applications, between application classes, or even more general, without knowing the purpose of a data package (application-agnostic discrimination, see Van Schewick 2010b). The underlying reason is that different types of data require different network quality. For instance, emails are very sensitive to data losses but less sensitive to delays, while video or voice over IP are very sensitive to delays. Discrimination of application classes would then imply that video and voice applications receive priority while emails only best effort routing and a suitable bandwidth. If discrimination is possible, network providers can ask payments for priority services from content and application providers.
- Anticompetitive traffic-shaping practices: Traffic shaping can take place due to abuse of dominance, for instance in the form of blocking of or degrading the quality for certain (competitive) services, legal content, or applications.

Some forms of traffic shaping practices have benefits while others have costs. Therefore, not all forms of traffic management based on QoS need to be prohibited. Law generally allows the first type of discrimination as it increases the efficiency, security, and integrity of the internet.

When there is evidence for abuse of dominance, the last type of traffic management is prohibited by competition law. For instance, the anticompetitive practices of operators that hold monopoly fixed telephony networks can be ex post evaluated based on competition law. However, in competitive markets, such as mobile telephony, these practices may not provide sufficient ground for applying competition law. In these cases blocking and quality degradation may occur within the legal boundaries, even though these practices reduce competition and consumer choices. To avoid or detect such situations, more stringent net neutrality regulation may be desirable.

The ongoing intensive debate relates to the second and third type of discrimination. Scholars and governments, even within the EU, differ in their approach about which practices should be allowed and which practices need to be prohibited.[2] The following sections describe the regulatory approach of the EU, in particular, regulation in the Netherlands.

2.2 Regulation Relating to Traffic Shaping in Europe

The European Commission (EC) recommends several guiding rules related to traffic shaping practices. There is, however, no direct net neutrality regulation recommended by the EC.[3] Nonetheless, the EC requires that the welfare of consumers as well as properly functioning networks and sustainable competition on services, including access, content, and applications need to be guaranteed.

With respect to traffic shaping practices, existing ex-ante and ex-post regulation and the revision of the telecommunications regulatory framework have been in use so far in order to achieve these goals.[4] In particular, three groups of regulation relate to traffic management.

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2 The focus of this study lies on the effects of net neutrality as it is regulated in the Netherlands. A full description of these opinions is beyond the scope of this study.

3 European Commissioner Neelie Kroes has recently announced that the EC would take steps towards a systematic European net neutrality regulations. See http://bit.ly/13WLk5c ('Kroes announces net neutrality policy', Telecompaper, June 4, 2013).

4 See Larouche (2011) for a critical analysis of regulation relating to network neutrality in the EU and the USA.

First, in 2002, the community law set ex-ante regulation in order to reduce market power, and thus indirectly, to avoid the abuse of dominance in telecommunications markets (see Access and Framework Directives).[5] [6] According to these directives, market segments are determined, in which network operators have significant market power (e.g., access and interconnection, Article 4 of the Access Directive), network operators are obliged to open up their networks for access and interconnection to rivals, and interoperability needs to be guaranteed (Article 5 of the Access Directive). National regulatory authorities, such as the Telecommunications, Transport and Postal Services Department of ACM (former OPTA) in the Netherlands, enforce ex-ante regulation specified to the market characteristics of countries.

Second, competition law protects against certain anticompetitive practices, following the abuse of dominance, such as blocking or quality degradation. Hence when abuse of dominance can be verified, competition law provides an ex-post remedy. Competition authorities, such as the Competition Department of ACM (former NMa) in the Netherlands, enforce competition law.

Finally, and more specifically in relation to traffic shaping, the Framework and Universal Service Directives[7] and, in particular, their amendments in 2009[8] recommend some level of transparency (if traffic shaping occurs), non-discrimination, and minimum quality of services (see Box 2.1). The national regulatory authorities can decide how much they implement these rules.

These rules cover many but not all traffic shaping practices that can have negative consequences on competitions and consumer choice. For instance, as practice shows, these rules are insufficient to avoid the blocking of competing VoIP services by vertically integrated mobile network operators: neither ex-ante nor ex-post regulation applies in this case, while the last group of regulation provides guidelines rather than binding rules. If switching between competing service providers is cheap, then consumers can choose a service provider that offers a broader range of services. However, telecommunications markets are not always characterized by low switching costs.

Nonetheless, after a public consultation in 2010, the EC found insufficient evidence that discriminatory practices that are not covered by these rules would hinder the EC's policy goals. For such evidence deeper economic analyses are needed. Therefore, the EC did not require more stringent measures besides close monitoring by the national regulatory authorities (BEREC 2012a, Trainar, 2011, Van Eijk 2011).

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5 European Commission (2002a, 2002b, 2009b).
6 Policies that aim at reducing market power reduce the likelihood of the abuse of dominance indirectly. However, some policies directly aim at the abuse of dominance, for instance, the prohibition of blocking and quality degradation.
7 European Commission (2002b, 2002c).
8 European Commission (2009a, 2009b).

Box 2.1 EC regulation relating to traffic shaping practices

Transparency
The amendment of the Universal Service Directive, Article 21(3):

> *"Member States shall ensure that national regulatory authorities are able to oblige undertakings providing public electronic communications networks and/or publicly available electronic communications services to inter alia: […]*
> *(c) inform subscribers of any change to conditions limiting access to and/or use of services and applications, where such conditions are permitted under national law in accordance with Community law,*
> *(d) provide information on any procedures put in place by the provider to measure and shape traffic so as to avoid filling or overfilling a network link, and on how those procedures could impact on service quality."*

Article 20(1)(b) also requires that this provision needs to be guaranteed by end-user contacts.

Minimum quality of service
The amendment of the Universal Service Directive, Article 22(3):

> *"In order to prevent the degradation of service and the hindering or slowing down of traffic over networks, Member States shall ensure that national regulatory authorities are able to set minimum quality of service requirements on an undertaking or undertakings providing public communications networks.*

As previously, Article 20(1)(b) requires that this provision needs to be guaranteed by end-user contacts.

Non-discrimination
Framework Directive (Articles 2(b) and 8(4)(a)) and its amendment (Article 8(4)(g)):

> *"2(b). The national regulatory authorities shall promote competition in the provision of electronic communications networks, electronic communications services and associated facilities and services by ensuring that there is no distortion or restriction of competition in the electronic communications sector, including the transmission of content.*
>
> *4(a). The national regulatory authorities shall promote the interests of the citizens of the European Union by ensuring all citizens have access to a universal service specified in Directive 2002/22/EC (Universal Service Directive).*

4(g). …by promoting the ability of end-users to access and distribute information or run applications and services of their choice."

The Body of European Regulators for Electronic Communications (BEREC) agrees with the regulatory principles of the EC and sees network neutrality as a relevant topic in its work program. Therefore, BEREC invited a public consultation about network neutrality in 2012.

BEREC argues that if competition between network operators and internet service providers is sufficient, merely transparency and low switching costs for consumers are needed (BEREC 2012a). If competition is insufficient, then more stringent measures, such as the current access regulation or minimum QoS are necessary to avoid the negative welfare consequences of discrimination. Furthermore, BEREC agrees that some forms of traffic shaping are beneficial and favors an application-agnostic approach and case-by-case consideration before any intervention would take place (BEREC 2012b).

Stakeholders participating in the consultation roughly agree with the arguments of BEREC (BEREC 2012b). However, network operators, in particular, have a preference for ex-post instruments over ex-ante remedies, because, as they argue, the latter is accompanied by high regulatory costs: network operators bear ex-ante regulatory costs but not ex-post regulatory costs. On the other side of the discussion, mainly content and application providers find ex-post regulation insufficient, as competition law cannot always undo the harm already done by discrimination. At least preventive and proactive monitoring is required to preserve the open and neutral structure of the internet. As BEREC is of the opinion that enhancing competition should be the primary goal of the EC, it intends to further analyze whether transparency and low switching costs are indeed sufficient regulatory measures to achieve open and neutral networks.

2.3 Net Neutrality Regulation in the Netherlands

For the first time in the EU and after Chile for the second time in the whole world, network neutrality has been set in the Dutch law books. In June 2011, Article 7.4a about traffic shaping practices had been added to the Dutch Telecommunications Act (Box 2.2)[9] and network neutrality regulation got into force in January 2013. This decision was based on several reasons.

First, political reasons, such as freedom of opinion and expression and the right to gather information, formed a relevant argument in this decision.[10] Second, economic reasons also underlined the decision of the Dutch government. In particular, discriminatory practices applied or announced in the last few years and their economic consequences formed arguments for net neutrality regulation. For instance, in 2009, T-Mobile in Germany announced that subscribers using Skype on their iPhone might be disconnected. After receiving strong criticism, T-Mobile decided not to ban Skype-usage but to charge an extra tariff for users of Voice over Internet Protocol (VoIP).[11] Similarly, in 2011 KPN announced that it would charge extra tariffs for end-users in case they use competing VoIP or sms services and video streaming on 3G.[12] Finally, Vodafone blocked its competitors, Viber's, VoIP services in 2011.[13] [14] In several other European countries, such as the UK, Italy, Spain, or Sweden, one or several major operators set tariffs for users of certain competing applications, such as VoIP (Bonneau *et al.* 2013).

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9 See http://bit.ly/13WMspi ('Telecommunicatiewet', Overheid.nl, in Dutch). The bill on net neutrality is available in English: http://bit.ly/13WMzRS ('Dutch Telecommunications Act', Government.nl).

10 In accordance with Article 10 of the European Convention on Human Rights (see http://bit.ly/13WMGN6, Council of Europe).

11 http://bit.ly/13WMKfU ('T-Mobile lifts Skype ban, but imposes surcharge', Fierce Wireless, June 3, 2009).

12 http://bit.ly/13WMT31 ('KPN's plans for tiered data pricing provoke outcry', Fierce Wireless, April 29, 2011).

13 http://bit.ly/13WMXzU ('Viber says blocked by Vodafone DPI', Telecompaper, May 25, 2011).

14 For an extensive list of mobile cases see: http://bit.ly/13WN66c ('VON Europe - Non-exhaustive Indentification of Restrictions on Internet Access by Mobile Operators', Scribd).

Based on these examples and their (potential) negative economic consequences on competition and thus consumers' choices, the Dutch government formulated two economic arguments for maintaining neutral networks: net neutrality (i) intensifies competition and (ii) stimulates the development of innovative services, content, and applications by new and small innovators.

Box 2.2 Network neutrality in the Dutch Telecommunications Act

Article 7.4a

1. Providers of public electronic communications networks via which Internet access services are delivered and providers of Internet access services shall not hinder or slow down applications or services on the Internet, unless and to the extent that the measure in question with which applications or services are being hindered or slowed down is necessary:
   a. to minimise the effects of congestion, whereby equal types of traffic must be treated equally;
   b. to preserve the integrity and security of the network and service of the provider in question or the end-user's terminal;
   c. to restrict the transmission to an end-user of unsolicited communication within the meaning of Article 11.7(1), provided that the end-user has given its prior consent for this to be done;
   d. to implement a legislative provision or court order.
2. If an infraction of the integrity or security of the network or the service or a terminal of an end-user, as referred to in (b) of the first paragraph, is being caused by traffic coming from the terminal of an end-user, the provider, prior to taking the measure which hinders or slows down the traffic, must notify the end-user in question, in order to allow the end-user to terminate the infraction. Where the required urgency means that this is not possible prior to the measure being taken, the provider must give notice of the measure as soon as possible. The first sentence shall not apply where this concerns an end-user of a different provider.
3. Providers of Internet access services shall not make their charges for Internet access services dependent on the services and applications, which are offered or used via said services.
4. Specific rules with regard to the provisions in paragraphs 1 to 3 may be provided by way of a general administrative order. The proposal for a general administrative order as provided for under this paragraph shall not be made earlier than four weeks after the draft has been submitted to both Houses of the States General.

In order to prevent the degradation of service delivery and the hindering or slowing down of traffic via public electronic communications networks, minimum requirements regarding the quality of service of publicly available electronic communications services may be imposed by or pursuant to a general administrative order on providers of public electronic communications networks.

The first three paragraphs of the article on net neutrality specify the allowed and prohibited practices, and the relating obligations of internet service providers (ISPs). The new telecommunications law prohibits traffic shaping practices that are not justifiable for necessary reasons, such as congestion, security, and integrity (Paragraph 1). This paragraph specifically prohibits anticompetitive traffic shaping practices. If traffic shaping occurs for justifiable reasons (i.e. technical traffic management), ISPs are obliged to inform end-users about such events (Paragraph 2). Furthermore, ISPs are not allowed to charge broadband access tariffs for end users and content and application providers (CAPs) based on the content of services, in this way prohibiting price discrimination based on applications and prioritization (Paragraph 3).[15] However, end-users may receive differentiated tariffs for packages with different volume and quality. In this way, network operators let end-users pay for their desired speed and data 'limit' and consequently receive investment incentives for network rollouts.

2.4 Summary

Due to technological developments, quality of service (QoS), thus discrimination of data has recently been made possible. Discrimination can be both harmful and beneficial. Therefore a debate between policy makers and academics emerged all over the world about what type of discrimination should be allowed and prohibited.

The debate relates particularly to traffic shaping practices that discriminate data of certain applications, between application classes or even more general, without knowing the purpose of a data package (application-agnostic discrimination). Furthermore, the discussion relates to anticompetitive traffic-shaping practices, which are also not fully covered by current regulatory measures.

The European Commission finds that discriminatory practices should be limited to the benefit of consumer and in a way that it guarantees the proper functioning of networks and sustains retail competition. To provide consumer protection, ex-ante regulation that requires access to and interconnection between networks and ex-post competition law have already been applied. Moreover, paragraphs have been added to the Framework and Universal Service Directives of the community law that recommend transparency, and some level of non-discrimination and minimum quality of service. The idea of more stringent regulation is not supported in the lack of evidence. However, close monitoring is recommended.

The Body of European Regulators for Electronic Communications (BEREC) agrees in broad lines with the recommendations of the EU. However, BEREC stresses that – even in the presence of competition – low switching costs are needed for consumers to be able to choose a provider with a broader range of services. This is a necessary requirement to avoid anticompetitive practices, such as blocking or quality degradation.

Besides political reasons, such as freedom of expression and access to information, economic arguments and evidence in Dutch mobile telecommunications formed argument for network neutrality regulation in the Netherlands. In 2011, net neutrality regulation was put in the Dutch law book in . Based on these arguments and evidence, the modified telecommunications law specifies the allowed and prohibited traffic shaping practices more than recommended by the EC. Discriminatory practices are forbidden unless traffic shaping is justifiable for technical reasons, such as congestion, and the security and integrity of the internet. In these cases, internet service providers are required to provide information for end-users about the occurrence of such events (transparency).

15 This rule can also be seen as a type of ex-ante price regulation.

3 Innovation-enhancing effects of net neutrality regulation

Network neutrality has a positive effect on reducing market power of internet service providers and on avoiding the abuse of their dominance. Consequently, innovation is fostered in all layers in the market. Network neutrality increases particularly the incentives of small innovators, hence positive network externalities can be internalized at the benefit of end users and innovators.

A positive consequence of the net neutrality debate is the blooming economic literature on this topic. After the first period of mainly policy-related articles, papers appear with deeper economic analyses (see also reviews: Schuett 2010, Krämer *et al.* 2012, and Reggiani & Valletti 2012). These studies still remain mainly theoretical. The literature clarified several points, in particular about innovation incentives. However, findings of these studies could not ease the net neutrality discussion: up to now, no straightforward answer could be formulated in this field.

In this chapter, the innovation-enhancing effects of net neutrality regulation are mapped. First, the relating policy goals are discussed, followed by the incentives to innovate by internet service providers and content and application providers. These incentives are undermined by the presence of market failures. Therefore, relating market failures are described, followed by analysis on the effectiveness of net neutrality regulation in eliminating these market failures. Then a short analysis is presented reflecting the new challenges around net neutrality.

3.1 Policy Goal: Maximum Welfare in the Long Run

A general principle that underlines policy goals is that welfare needs to be as high possible. *Welfare is the sum of consumer and producer surplus*. For maximum welfare, it is desirable that tasks are performed efficiently. Efficiency can be distinguished in the short and the long term (e.g., Bennet *et al.* 2001).

Short-term (or static) efficiency is defined in the standard economics literature as the welfare level at which all firms are on their production possibility frontier (i.e., productive or cost efficiency). *Long-term (or dynamic) efficiency* is defined as expected future welfare that includes investments and innovations. More reliable products (i.e., increased capacity in communication networks) or innovative services and application (such as VoIP) positively affect these expected future revenues.

Consumers benefit from both types of efficiency: in the short term from more favorably priced products and in the long term from more product choice or more reliable services. There is, however, a potential trade-off between static and dynamic efficiency. As a result of a higher short-term efficiency, firms are able to allocate inputs better and produce at lower costs. For instance, more intensive competition can achieve this outcome and lead to lower (efficient) prices. This efficient price is equal to the marginal cost of production, from which consumers benefit the most. However, this low price may provide insufficient incentives for firms to invest and innovate, thus lowering long-term welfare. As Bennet *et al.* (2001) argue, in the long run outcomes that maximize dynamic efficiency at the expense of static efficiency usually outperform outcomes that maximize static efficiency at the expense of dynamic efficiency. Therefore, the former can be preferred over the latter.

In some situations, markets cannot perform tasks efficiently and the market outcome is not the socially most desirable one as it leads to lower welfare. These situations are called market failures. Telecommunications markets are characterized by several market failures. Examples that are relevant in the context of network neutrality are market power and network externalities. These market failures will be explained in Section 3.3. According to an economist's approach, policy intervention is desirable if it can reduce market failure (without introducing government failure) and hence can achieve a better efficiency state or avoid an undesirable state.

In short, a regulatory measure needs to take the level of total welfare, in particular in the long run, *and* the possible market failures into consideration. In the following sections, the incentives for innovation will be mapped in the light of these policy goals.

3.2 Innovations at the Edges and at the Core

It is a common sense that the internet is successful due to the available services, content, and applications. However, opinions differ about what drives these innovations and who innovates the most: companies that provide the infrastructure or end-users? On this basis, two forms of innovation can be distinguished (Kocsis & De Bijl 2007):

- Innovation at the core: the core refers to the platform layer of the internet, that is, the intelligence inside of the network. Therefore, innovators at the core refer to *internet service providers* (ISPs). ISPs include vertically integrated network operators and service providers without a network. As is frequently used in the net neutrality literature, we will refer to them jointly as ISPs. Innovation at the core then relates primarily to traditional electric communications services, such as voice over IP or online television.
- Innovation at the edges: the edges correspond to the application layer, that is, the functionality that end-users can implement themselves. Innovators at the edges refer to content and application providers (CAPs) that do not provide internet access services (i.e., that are not ISPs). Due to different incentives, two groups of innovators can be distinguished:
  - *Large innovators at the edges*: innovators whose services have many end-user visits or face high fixed costs (e.g., Google, eBay, Skype).
  - *Small innovators at the edges*: innovators whose services have fewer end-user visits or face low fixed costs (e.g., end-to-end innovators).

Even though internet service providers are innovative with respect to traditional telecommunications services (e.g. transport or telephony; OECD 2009), a large number of fundamental innovations has been primarily developed at the edges by initially small, often individual innovators (for instance, the *World Wide Web*, *eBay*, *Facebook*, *Skype*, *Google*, *Yahoo!*, *Apache*, see Odlyzko 2004). As Van Schewick (2010a) argues, this could happen because of the general and application-blind nature of the former internet architecture. This architecture has created room for many innovators to develop innovative services and content that require *no or little investment costs*. As long as networks were application-blind (i.e. not controlled by network operators), innovators decided to offer their applications online and let end-users decide whether these applications were useful for them. The success of these innovations was based on *experimentation* or "trial and error" (Brynjolfsson 2010).

Furthermore, innovators of these applications were not necessarily motivated by profits. Similarly to open source software, innovators have *non-monetary incentives*, often intrinsic (motivation coming from "within") or extrinsic in nature (e.g. signaling quality in the job market, self-education, and own use, see Bijlsma *et al.* 2009). As Van Schewick and also Lee & Wu (2009) argue, these circumstances were necessary for a boom of diverse and successful innovations. If these circumstances are maintained, a similar trend can be expected to continue in the future: end-users will remain the innovators of fundamental applications and a diversity of content.

In the previously mentioned examples, innovators achieved large market shares in their segments because of their success. Consequently, the further development of these initially small innovations became more capital intensive, thus requiring more monetary funding. There are three main sources of such revenues. First, new business models have appeared recently that are based on *advertising revenues* (Van Schewick 2010a). The success factors of the advertising model are more eyeballs, large connectivity (i.e., a large network of users), and a low level of congestion. In that respect, this business model shows strong similarities to the business model of the media (Van Eijk 2012). Large innovators at the edges base their revenues on these models. Alternatively, innovators may ask *payments* for their content and applications *directly* from end-users.[16] Examples of that are on-demand internet streaming media, for instance, *Netflix* or *Pathé Thuis*. Finally, these innovators more regularly merge or are taken over by large profit-oriented organizations (e.g. recent acquisition of Skype by Microsoft). In this way, the mother organizations can offer such services in a bundle.

Innovations at the core relate primarily to the provision of traditional telecommunications services, such as data transport, voice, or television. These innovations are also capital intensive. Internet service providers provide funding for these services via two channels. First, they charge *tariffs to end-users* for connectivity. In general, these tariffs cover a bundle of the above-mentioned services. It means that end-users pay directly for certain services or applications. In addition, in some countries, internet service providers are allowed to *differentiate tariffs based on application and content* and charge for priority lanes.[17] This practice in prohibited in a net neutrality regime.

As the above description of incentives suggests, incentives to innovate depend on the presence of network neutrality. But innovation incentives are also related to the presence of market failures. In what follows, first the link between market failures and innovation incentives will be established. Then the capability of net neutrality regulation on the elimination of market failures will be analyzed.

16 Note that larger CAPs (e.g., Google) still base the success of their innovations on experimentations.
17 Note that network operators need additional funding to finance investments in network capacity. The analysis of such incentives is beyond the scope of this study.

3.3 Market Failures Reduce the Incentives to Innovate

If markets cannot perform tasks efficiently, market failures are present. If market failures exist and remain uncorrected, market processes will typically result in efficiency loss and thus lower welfare than it would be maximal: prices are higher and quality and capacity are lower than in the potentially most efficient market outcome. In these cases, policy intervention may be desirable.

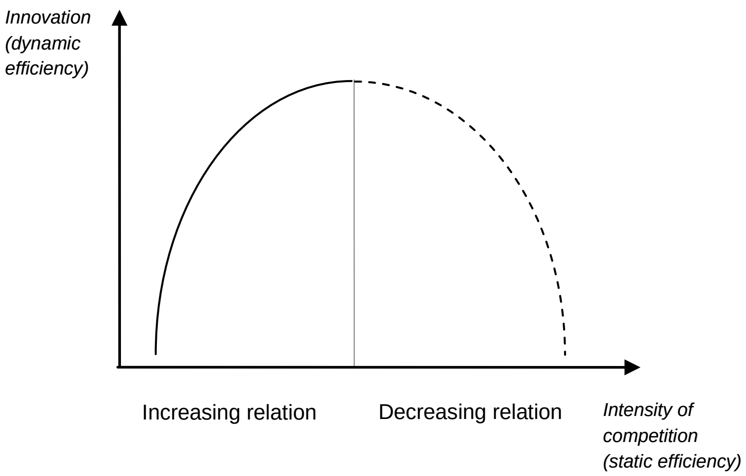
Specifically, two market failures exist in telecommunications markets that influence incentives to innovate. These market failures are market power and network externalities. The following sections elaborate on them.

3.3.1 Market Power Reduces Innovation Incentives

Incentives to innovate depend on the market structure at hand. The more intensive competition is between internet service providers and content and application providers, the easier innovative services can enter the market.

In general, a certain level of competition between internet service providers is necessary for innovation at the core. Such innovations relate to traditional telecommunication services, such as VoIP or online television. As Aghion *et al.* (2005) argue a movement from a monopoly situation to competition increases innovation incentives. The reason for that is that in a concentrated market firms not only compete on price but also with innovative services (see Figure 3.1). As in the broadband market only a small number of firms compete with each other for providing broadband services, this market is characterized by the left-hand side of the bell-shaped curve in Figure 3.1: the more intensive the competition, the more innovative internet service providers are.[18]

Figure 3.1 Competition stimulates innovations in concentrated markets

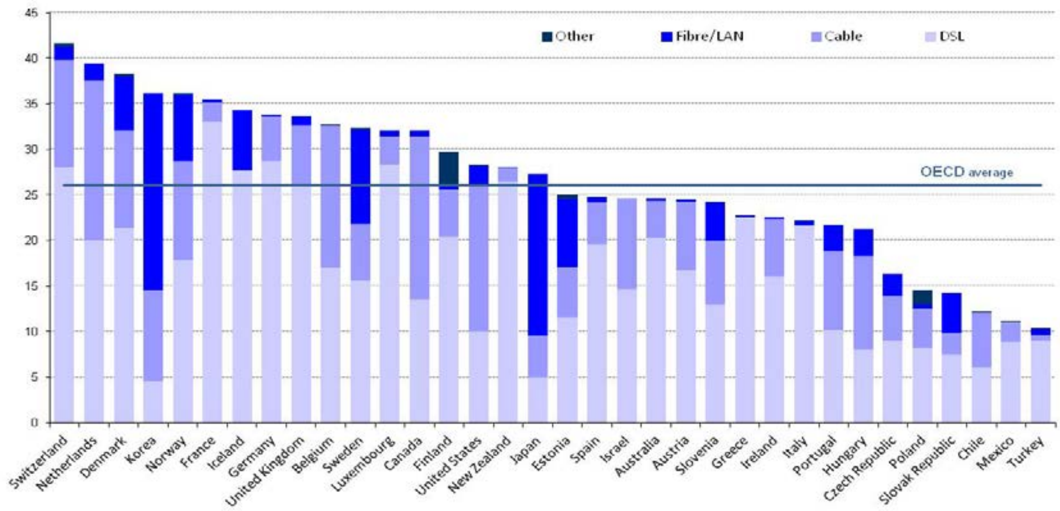


Source: Aghion *et al.* (2005)

[18] If competition is too intensive, firms primarily compete on prices and have less and less monetary incentives to innovate. This situation is illustrated by the right-hand side of the figure. If prices drop to the minimum, that is the marginal cost of production, firms are left with no financial means to spend on innovative services.

What kind of market structure can characterize the market for broadband access and content and application providers? Two types of *competition at the broadband-access* level, that is, between ISPs, can be distinguished: competition between network operators (intra-platform competition) and competition on the network by different forms of wholesale access (inter-platform competition).

Figure 3.2 Fixed infrastructure competition in present only in a few European country



Source: OECD; Fixed broadband subscriptions per 100 inhabitants, by technology, June 2012

Prioritization reduces intra-platform competition

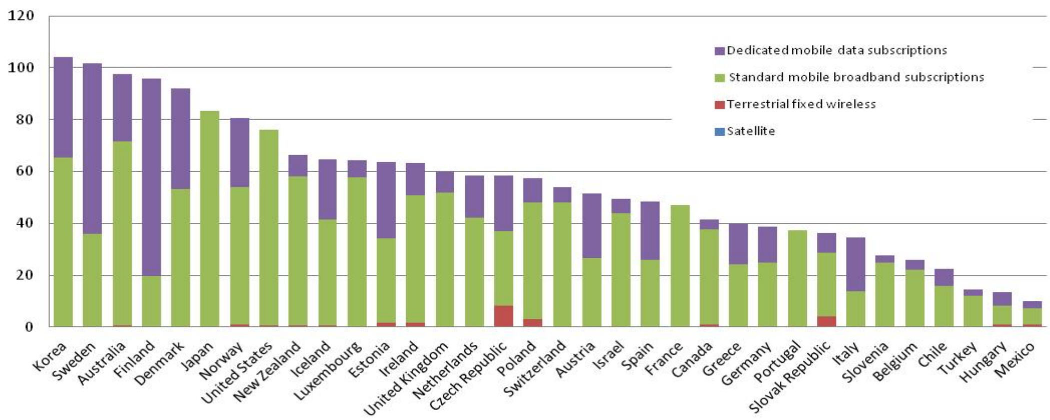
To what extent is competition on broadband services present *between network operators*? Without exception European fixed telephony companies have a network on which broadband services are provided. In several European countries, such as the Netherlands, cable companies (*UPC* and *Ziggo*) also have national coverage and compete with fixed telephony companies for providing internet services (Figure 3.2). In other European countries, for instance in France and Germany, there is little infrastructure competition and fixed telecom companies dominate the market. Recently, the broadband penetration of mobile companies has been increasing substantially. However, this penetration is lower in Europe than in other OECD countries (with the exception of Scandinavia; see Figure 3.3). Furthermore, mobile networks are not yet seen as perfect substitutes of fixed networks (De Bijl, 2011a, Cave & Hatta, 2009).

In addition, the EC sets the objective that by 2020 all European households need to have broadband access up to 30 Mbps and 50 percent of households up to 100 Mbps.[19] This requires a further rollout of next generation, in particular, fiberglass networks totaling approximately 270 billion euro investment costs (Cave & Peitz 2013). These costs have not 'sunk' yet, unlike investment costs in the existing copper networks. Therefore, economies of scale will once again play an important role in telecommunications (the concept of *Telecom 3.0* by Noam, 2010). Even in the presence of competing – fixed and mobile – infrastructure, market concentration can be

[19] http://bit.ly/13WNcLl ('Smart Growth Europe 2020', European Commission).

expected that may lead to new (natural) monopolies. Hence Telecom 3.0 is accompanied by new regulatory challenges. The analysis of these challenges is beyond the scope of this study.

Figure 3.3 Wireless broadband penetration is below 60 percent in most EU-countries

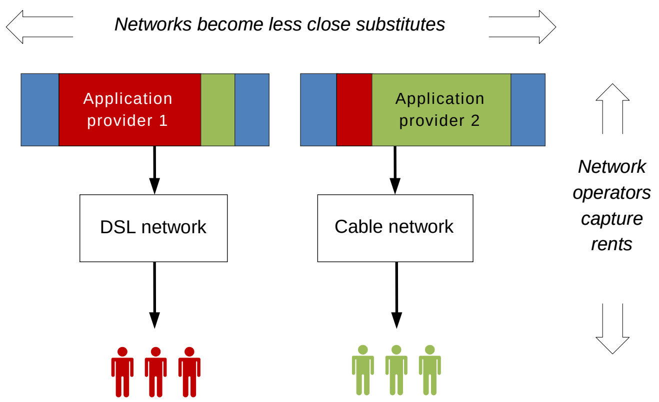


Source: OECD; Wireless broadband subscriptions per 100 inhabitants, by technology, June 2012

Furthermore, broadband internet is a commodity for competing infrastructures. Therefore, network operators have incentives to avoid the commodity trap – that is pure price competition – by differentiating themselves from each other, and hence increasing their market power over their own consumer based. There are two form of differentiation: horizontal and vertical.

Traffic shaping can be seen as a form of horizontal differentiation: internet service providers create niche markets to protect or gain market shares by for instance specialization or exclusive contents (see Figure 3.4). As Nurski (2012) argues in her empirical study on the broadband internet market in the UK, utility derived from online content indeed determines end-users' choice of ISP. In this way, ISPs are able to charge differentiated prices for end-users and can extract more benefits from them (De Bijl, 2011a, Kocsis & De Bijl 2007).

Figure 3.4 Traffic shaping leading to product differentiation and rent capturing



Source: Kocsis & De Bijl (2007)

Vertical differentiation is another form of price differentiation and the extraction of end-users' benefits. This practice is permitted under a net neutrality regime. Firms differentiate themselves vertically if they provide different quality at different prices. Fixed telephony and cable companies often provide different qualities of service, often caused by historical technological developments. For instance, in the Netherlands, *KPN* has a larger market share in the bandwidth between 10-30 Mbps while cable companies have larger market shares for 30-100 Mbps.[20] The presence of heterogeneous end-users can be a rational for vertical differentiation (Njoroge *et al.* (2012). For instance, a group of end-users only use the internet for emails and searching for information, while another group of end-users can be developers of video applications. The former group of end-users may be satisfied with a lower quality internet access at a lower price while the latter group requires higher quality internet access and is willing to pay for that. Finally, let's note that vertical differentiation is also a means to achieve higher revenues that can finance investments in network capacity and quality.

In short, intra-platform competition is present in some European countries (e.g. in the Netherlands) as fixed telephony network operators compete with cable companies. However, even competing ISPs have incentives to distinguish themselves from each other and hence increase market power over their consumer base. Prioritization and price discrimination based on quality are means for that. As long as intra-platform competition is absent, ISPs' incentives to innovate are low.

Inter-platform competition is currently sufficient

Due to access and interconnection obligations required by the European telecoms framework, *competition on existing networks* has increased since 2002. Access regulation allowed for the entry of competing internet service providers. For instance in the Netherland, several entrants have been competing on *KPN*'s network, some of which has grown in their market share (e.g. *Tele2*). However, due to scale effects, a trend of acquisition by *KPN* has been ongoing (e.g., *Tiscali*, *XS4All*, *Freeler*, and *Demon*), concentrating the market of broadband access.

Competition between CAPs is less intense if ISPs have market power

In the absence of entry barriers, *competition between content and application providers* can foster innovations at the edges. Relating entry barriers are for instance the switching costs between internet service providers: end-users are often locked in a fixed-term contract or prefer multi-play packages instead of internet access only.

As long as end-users find it expensive or complicated to switch to another ISP, internet service providers have market power over their end-users. Therefore, an ISP can protect its market share for downstream services, in particular voice or TV, by blocking competing voice or TV services. And such services are available in the market (De Bruyckere & Niezink 2013). A typical example of competing sms services is *WhatsApp,* of voice service *Skype* or *Viber*, of video services *Hulu, Netflix* or *LoveFilm* in the US and UK or *Ximon* or *Pathé Thuis* in the Netherlands.

However, if entry barriers are absent and one internet service provider (ISP) blocks a certain service, content or application, the other ISP has incentives *not* to block it, as by providing this service it can differentiate itself from the former ISP. Consequently, the former ISP may

[20] http://bit.ly/13WNlya ('Marktcijfers derde kwartaal 2012', ACM, March 5, 2013).

reconsider its blocking strategy (Kocsis & De Bijl 2007). The lack of anticompetitive practices stimulates competition and the entry of innovative services, content, and applications.

In markets where firms have significant market power, for instance incumbent fixed telephony operators, these practices are avoided by ex-ante regulation. However, in markets where firms have no significant market power, such as the retail service provision of mobile operators, no ex-ante regulation applies. As examples in the practice show, these network operators have incentives to block such competing services.

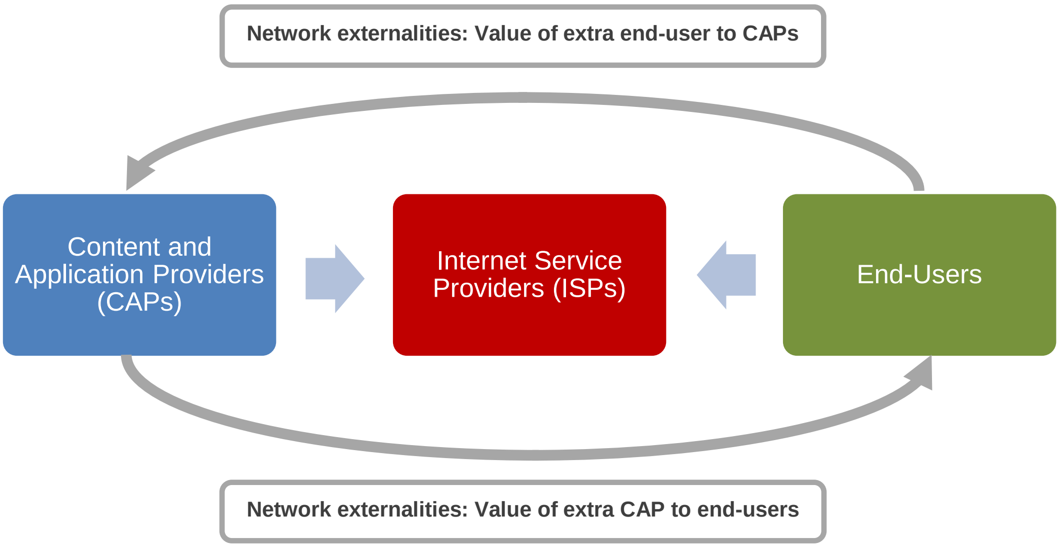
Summary
Competition for broadband services is currently sufficient to achieve short-term efficiency. The incentives to innovate by internet service providers (innovation at the core) are, however, ambiguous. First, the rollout of next generation networks is considered necessary to increase further long-term efficiency, that is, welfare in the long run. Due to economies of scale, it may lead to mergers and acquisitions, thus concentrated infrastructure companies. Furthermore, ISPs have incentives to avoid the commodity trap of broadband internet services by differentiating themselves from each other. Traffic shaping and quality differentiation are two means to do that. Finally, even competing internet service providers can hinder competition between content and application providers by anticompetitive practices, particularly when switching costs are high. Such entry barriers reduce competition between CAPs and thus innovation incentives.

3.3.2 Network Externalities Are Not Fully Captured by Innovators

In network industries, the benefits a group of stakeholders can achieve depend on the size of the market. For instance, someone with a mobile subscription can benefit from larger penetration as more subscribers can call her. When a consumer buys a new mobile subscription, she may not take these benefits into consideration. This market failure is called network externalities. If network externalities are not fully captured, welfare is reduced: less people will join the network and less innovative products will enter the internet. Network externalities can be internalized by larger penetration or connectivity, which needs to be accompanied with sufficient network capacity. This mechanism is explained in this section.

Network externalities are somewhat more complex in the market for internet content, applications, and services than in traditional telephony. Internet can be characterized as a two-sided market. In a two-sided market, two sets of agents meet and interact through a platform: decisions made in one side influence decisions to be made on the other side. In that sense, each side exerts externalities on the other side (Figure 3.5). This translates to the following mechanism in internet markets:

Figure 3.5 Network externalities between the two sides of the internet



Source: SEO Economic Research

The two agents are the end-users on one side of the market and content and application providers (CAPs) on the other side.[21] The platform is the network on which broadband services are provided by ISPs.[22] In this context, network externalities are present: when end-users buy access from an ISP, they may not consider the value of an additional CAP connected to that ISP. And vice versa, CAPs may not take into account the added value of an extra end-user when they connect to the internet. Economides & Tag (2012) call this type of network externalities *cross-group externalities*.

Due to cross-group externalities, content providers benefit from more end-users since they represent more visits and thus more advertisement revenues or direct payments (e.g. *Netflix* or *Pathé Thuis*). End-users also benefit from more content and application providers because they benefit from diversified content and applications. Consequently, cross-group externalities can be internalized by larger connectivity between end-users and CAPs.

Currently, the average penetration in fixed networks is 26 subscribers per 100 inhabitants in the OECD countries (see Figure 3.2). In the mobile networks the same penetration is 56.6 (see Figure 3.3). In the Netherlands, fixed broadband penetration is the second highest within OECD countries with 39.4, while mobile penetration is also above average (58.5). It implies that most of the OECD countries have to increase connectivity to benefit from network externalities.

Finally, a related problem needs to be mentioned here: *congestion*. Congestion arises in the internet because end-users do not consider the impact of their data traffic on the internet usage of other

21 It needs to be noted that CAPs, as defined in Section 3.2, are also end-users as they buy internet access from ISPs. In that sense, there is an overlap between CAPs and end-users. Distinguishing between CAPs and end-users is difficult also because CAPs can be the users of other content and applications. However, for the sake of exposition, CAPs are distinguished from end-users only.

22 Such consideration of the internet corresponds to the network architecture described by Van Schewick (2010a) and Cave & Peitz (2013). According to these descriptions, internet has several layers: an applications layer, a platform layer (Internet and transport) and a link layer (infrastructure or core). These layers are interlinked.

end-users. The same applies for content and application providers. Therefore, the social costs of congestion are higher than only the costs network operators need to bear.

As a consequence, the network can easily become congested, in particular, if consumers increase their usage of applications that require large bandwidth. Congestion reduces the incentives of end-users and CAPs to develop innovative content and applications as more applications create even a higher level of congestion. This may be an obstacle for experimentation. Therefore, less congestion is desirable to foster innovation. A characteristic of the Dutch market is that fixed networks have sufficient capacity and that congestion is mainly present in the mobile networks.

3.3.3 Summary

In the market for electronic communications, two types of market failures are present: market power and network externalities. As Table 3.2 shows, these market failures reduce incentive to innovate both at the core and at the edges. Consequently, regulation that is able to correct these market failures can achieve a higher level of innovation. Instruments that intensify competition, increase connectivity, and stimulate sufficient network capacity are seen as effective means. In the following section, the focus will be put to network neutrality regulation and its effectiveness in correcting these market failures.

Table 3.2 Effects of market failures on incentives to innovate at the core and the edges

Market failures	Effects on innovation incentives at the core	Effects on innovation incentives at the edges	Preference for innovation
Market power in providing broadband services (i.e., avoiding commodity trap, economies of scale)	–	–	More intensive competition between ISPs and CAPs
Network externalities in two-sided markets	–	–	Internalizing externalities by larger connectivity and sufficient network capacity

Source: SEO Economic Research; – means a negative effect.

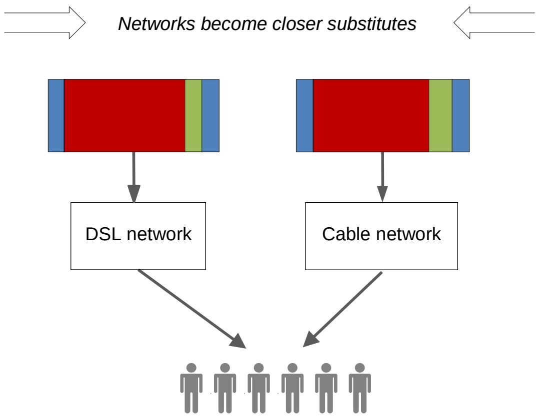
3.4 The Positive Effects of Net Neutrality in Reducing Market Failures

As was shown in the previous section, electronic communications markets are characterized by market failures that reduce incentives to innovate. The question in this section is through which mechanisms and to what extent net neutrality regulation can correct these market failures. As before, the different market failures will be considered separately.

3.4.1 Net Neutrality Can Help Reduce Market Power and Avoid the Abuse of Dominance

Network neutrality can reduce market power and help avoid the abuse of dominance through two main mechanisms. First, net neutrality, as for instance defined in the Dutch Telecommunications Act, does not allow prioritization, as a typical form to achieve horizontal differentiation. Therefore, net neutrality prevents horizontal differentiation, hence fosters competition between ISPs and increases incentives to innovate at the core (see Figure 3.6).

Figure 3.6 Network neutrality reduces incentives to differentiate



Source: SEO based on Kocsis & De Bijl (2007)

Under such net neutrality regulation, network operators can still avoid the commodity trap by differentiating themselves from each other based on quality. This type of differentiation provides network operators profits that incentivize investments in next generation networks.

Second, network neutrality regulation, as defined in the Netherlands, does not allow anticompetitive traffic shaping practices. Blocking or quality degradation may lead to the exclusion of competing CAPs. As net neutrality eliminates these practices, it stimulates innovations at the edges and the entry of competing CAPs (Kocsis & De Bijl 2007). According to Lee & Wu (2009), net neutrality ensures low-cost market entry for CAPs.

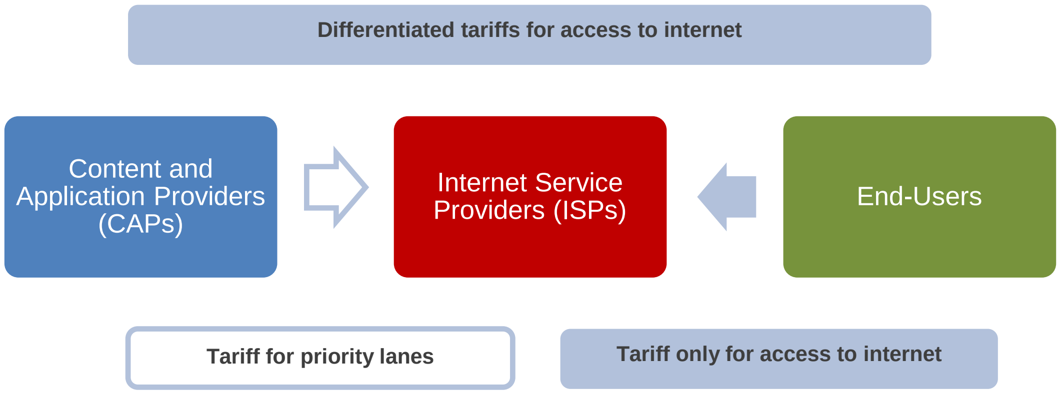
3.4.2 Net Neutrality Internalizes Network Externalities Caused by Small Innovators

Network externalities can be internalized by setting a proper tariff structure that increases the benefits from larger connectivity without overusing network capacity (e.g. Shy 2001). In case of the internet, it implies well-designed direct payments from end-users to CAPs as well as payments to platforms. As network externalities are positive externalities, end-users are willing to pay more for an internet connection that makes a larger number of applications and services available. Also, end-users are willing to pay for good quality content and applications and for those services from which a larger connected consumer base can make use of. Consequently, ISPs and CAPs can charge a higher price for end-users without reducing total welfare. Also, large CAPs are willing to pay more to ISPs since they can capture larger advertising revenues and direct payments if more end-users are connected or if accessing these end-users is seamless. In this section, these payment models are described and the impact of network neutrality on making these payment models function effectively is analyzed.

At the moment, several *CAPs require direct payments from end-users*. Typical examples are on demand video streaming services, such as *Netflix* or *Pathé Thuis*. With such payments, CAPs can internalize network externalities efficiently. Therefore, direct payments fulfill two goals: increase incentives to innovate and internalize network externalities. Under net neutrality regulation, such as set in the Dutch telecommunications law, these types of payments are allowed.

On top of that, ISPs charge *broadband access fees* for both sides of the market. As both sides may contribute to data traffic, the tariff structure has an important role in increasing connectivity and reducing congestion (Schuett 2010). Two structures can be distinguished: one-sided pricing and two-sided pricing. In the case of *one-sided pricing*, every end-user, inclusive CAPs, pays the same tariff for accessing the internet. This tariff structure corresponds to a net neutrality regime. As argued earlier, end-users are willing to pay a higher access fee as they can benefit from a larger consumer base of the internet. These higher access fees provide incentives to *innovate at the core*.

Figure 3.7 Two forms of two-sided pricing in the internet: differentiated access tariffs and prioritization



Source: SEO Economic Research

In the case of *two-sided pricing*, ISPs could differentiate tariffs between end-users and CAPs. Two forms of price discrimination can be distinguished (see Figure 3.7). First, ISPs can sell broadband access at differentiated prices in a way that end-users buy different packages based on volume or quality. This type of two-sided pricing is allowed in a net neutrality regime. Second, ISPs can sell access to all end-users and priority lanes for certain content and application providers. This pricing regime reflects prioritization and is prohibited under net neutrality regulation, for instance in the Netherlands.[23]

To understand how net neutrality can enhance innovation, it needs to be considered how these broadband access-pricing schemes relate to innovation incentives. The first theoretical articles on net neutrality do not distinguish between CAPs according to size (number of eyeballs or innovation costs) or required quality. Yet, some relevant conclusions can be drawn from these studies about innovation incentives in general. Network neutrality stimulates innovation at all layers if advertising rates are sufficiently high to generate ad revenues for CAPs *and* end-users are not too price sensitive so that higher access fees can generate sufficient revenue for ISPs (Musacchio *et al.* 2009).

23 In the Netherland, prioritization concerns the general purpose lanes, that is, best-effort routing. However, discrimination in managed lanes is allowed.

However, if ad rates are very high (i.e. provide sufficient incentives to innovate at the edges) and end-users are less price-sensitive, prioritization may increase innovation incentives at the core for the following reason. By raising the access fee, ISPs would lose revenue from end-users but can compensate that loss by setting a (higher) fee for CAPs. Surprisingly, even a negative fee for priority lanes can be effective. If ad rates are low, implying that CAPs cannot make sufficient advertising revenues to finance innovations, ISPs can compensate them by setting higher access fee for consumers. ISPs would do that to increase the value of internet for end consumers by stimulating more content and applications (Musacchio *et al.* 2009).

In favor of net neutrality, Musacchio *et al.* (2009) also show that prioritization creates an additional negative externality. As the number of IPSs with which CAPs need to contract increases, CAPs need to pay more for priority lanes in total. This total payment reduces the innovation incentives of a CAP, thus the value for end-users and advertisers. Consequently, the CAP receives less revenues. When charging a fee for priority lanes, ISPs take only the direct effects of higher prices on CAPs incentives into consideration and may not consider these indirect effects. Consequently, ISPs charge a too high fee. These high costs reduce further the innovation incentives of CAPs and end-users will eventually face a lower product variety. This mechanism translates to a negative externality: the ISP charging for priorities gains its full benefits, but the costs due to decreased variety of innovation and lower willingness to pay of end-users are borne by other ISPs.

Furthermore, Lee & Wu (2009) and Hermalin & Katz (2007) show that one-sided pricing reduces transaction costs that relate to negotiation and contracting between CAPs and ISPs in case of prioritization. These costs reduce innovation incentives of CAPs and ISPs and end-users will eventually face a lower product variety. Under net neutrality, these costs can be avoided and innovation incentives are preserved.

Finally, it needs to be mentioned here that anticompetitive practices that block certain applications or degrade the quality for these applications reduce the number of available CAPs and thus the benefits from network externalities. Net neutrality provides a solution against these practices.

More recent articles differentiate between CAPs, mainly in terms of size. *Small innovators at the edges* clearly benefit from net neutrality, that is, one-sided pricing or differentiated access prices. Economides & Tag (2012) argue that one-sided pricing is beneficial for CAPs as it leaves CAPs with more surplus. Reggiani & Valletti (2012) consider a monopoly ISP and differentiate between small and big CAPs: there are a few large CAPs with heavy traffic and many small with light traffic. Bourreau *et al.* (2012) consider a similar situation but with competing infrastructures. Both papers find that prioritization favors large CAPs. Therefore large firms receive higher profits than small innovators and become even larger compared to small firms.

Large innovators at the edges benefit more from traffic shaping. As Reggiani & Valletti (2012) and Bourreau at al. (2012) argue, prioritization increases the innovation incentives of large CAPs. Large CAPs require better connection quality and are willing to pay more for that. They do so since they can capture larger advertising revenues if accessing a larger number of end-users is seamless (Reggiani & Valletti 2012, Hermalin & Katz 2007).

Innovators at the core, that is, the ISPs, can achieve a higher profit by differentiating prices. In a two-sided market, the ISP has the ability to balance its revenues from the two sides: CAPs and end-users. The revenue loss for a reduction of one tariff can be compensated by the revenue gain from the increase of the other tariff. This is the so-call *waterbed effect* (Genakos & Valletti 2012). The waterbed effect translates to the following mechanism in case of prioritization. If an ISP charges a higher price for CAPs for priority lanes, it can charge a lower price for end-users for broadband access and vice versa. The ISP can optimally set a higher price for the side which is less price sensitive and lower price for the more price-sensitive side.

Which side is more price sensitive, is an empirical question. The only evidence in that respect is Nurski (2012) who reports that end-users have a relatively elastic demand for broadband access in the UK. She estimates price elasticity to be on average -3.3, which is an implication for broadband access being a commodity. Currently, no evidence is available about the price sensitivity of CAPs. However, it is known from the economic literature that higher willingness to pay often reduces price sensitivity. In the presence of increasing advertising revenues, CAPs' willingness to pay increases, so may reduce their price sensitivity. For sufficient advertising revenues, CAPs' price sensitivity may drop below the price sensitivity of end-users. In this case, ISPs can increase the price of priority lanes instead of the price of broadband access. Consequently, prioritization internalizes network externalities more efficiently and at the same time, increases ISPs incentives to innovate.

On the contrary, Bourreau at al. (2012) find that prioritization is not always beneficial for innovators at the core. They claim that prioritization is less beneficial for ISPs if competition between ISPs is strong or investment costs are large. If prioritization is allowed, the ISP compensates a higher tariff for priority by low broadband fees. Lower access fees increase demand that leads to congestion. To accommodate the increased demand from end-users, investments in capacity are required. Once investment costs are high, it leaves ISPs with little financing to innovate. To preserve such incentives, ISPs can rather differentiate prices according to volume and speed (see upper side of Figure 3.7; also Enck & Felten 2011).

The waterbed effect has a substantial role in determining prices when connectivity is not complete, which is currently the case in practice as most of the EU broadband markets have not reached full penetration.

Finally, the problem of *congestion* needs to be mentioned here. Three, rather similar, articles analyze the effects of price discrimination on innovation incentives in the presence of congestion: Choi & Kim (2012), Cheng *et al.* (2011), and Krämer & Wiewiorra (2009). They show that under a net neutrality regime, waiting times for traffic by CAPs becomes longer than if prioritization is possible. According to Choi & Kim, this situation is disadvantageous for high-cost providers since congestion remains a problem for them. Consequently, they innovate less. Prioritization may provide such incentives.

Prioritization, however, cannot solve congestion itself. If all CAPs buy priority lanes, the outcome is a prisoners' dilemma: CAPs pay for priority lanes but cannot win market shares as all CAPs do the same. In this case, only ISPs increase their benefits and congestion remains a problem (Cheng *et al.* 2011). Furthermore, as bigger innovators become even larger under congestion (Reggiani & Valletti 2012), the question is still open whether congestion may lead to the crowding out of small innovators.

Two ways seem more effective in solving the problem of congestion. Without further network investment, technical traffic management can ease congestion in a network (see similar results in the extensive literature of roads or airports, e.g. Sullivan 1983). The most effective solution is, however, investments in network. Differentiated tariffs – both by volume and quality and by prioritization – incentivize *investment in quality and capacity* (Bourreau at al. 2012, Musacchio *et al.* 2009, Economides & Hermalin 2012). However, according to Enck & Felten (2011), differentiated and even increased access charges alone are effective means to provide these investment incentives. Investments in next generation networks reduce congestion, for the benefit of all innovative services. Less waiting times reduce also entry costs for new CAPs (Krämer & Wiewiorra 2009). It needs to be noted here that network operators so far have been investing in network capacity and quality, despite network neutrality. An example of such investments is the recent 4G auctions in the Netherlands.[24]

3.4.3 Summary

Net neutrality, as for instance defined in the Dutch Telecommunications Act, reduces the possibility for IPSs to differentiate themselves from each other and to achieve profits at the cost of consumers. Less differentiation between ISPs increases competition among them, which stimulates innovations at the core. Net neutrality fosters also innovation at the edges as anticompetitive practices are prohibited.

Direct payments between CAPs and end-users and differentiation based on volume or quality are seen as effective means to internalize network externalities. These payment models are permitted under network neutrality regulation. In addition, net neutrality is always beneficial for small CAPs but reduces the innovation incentives of large CAPs. However, net neutrality can also affect innovation at the core and for large CAPs positively as it lowers transaction costs and helps avoid other types of market inefficiencies, such as overcharging of CAPs (as an additional externality) and overuse of capacity (prisoners' dilemma).

Finally, the congestion remains a problem under net neutrality, however, without investment in network upgrades, prioritization cannot solve congestion either. Technical traffic management and investments in network quality and quantity are more effective in that respect. Differentiated tariffs – both by volume and quality and by content (i.e. prioritization) – incentivize such investments. These results are summarized in Table 3.3.

[24] Besides incumbent network operators, large CAPs also invest in rolling out network. See e.g. Google in the US.

Table 3.3 Net neutrality (NN) can reduce market failures and enhance innovations

Market failures	*Positive effects of NN on eliminating market failures*	*Positive effects of NN on enhancing innovations*
Market power in providing broadband services (i.e., avoiding commodity trap, economies of scale)	- Prohibiting prioritization reduces horizontal differentiation between ISPs => more intense competition between ISPs	- More competition between ISPs increases incentives to innovate at the core
	- Eliminating anticompetitive practices reduces entry barriers for innovators at the edges => more intense competition between CAPs	- Lower entry barriers stimulate innovations at the edges
Network externalities in two sided markets	- Prohibiting prioritization increases potential ad revenues for small CAPs	- Higher incentives to invest by small CAPs
	- Eliminating anticompetitive practices increases the value of a connection due to more small CAPs	
	- Prohibiting prioritization reduces transaction costs for all CAPs and ISPs	- Large CAPs and ISPs also benefit from net neutrality, although their incentives are better preserved under prioritization
	- Prohibiting prioritization helps avoid additional market inefficiencies (e.g. overcharging of CAPs, overuse of networks)	

Source: SEO Economic Research

3.5 New Challenges under Net Neutrality Regulation

As Van Schewick (2010a) describes, the internet architecture has several layers among which the infrastructure is only one layer. Values relating to the information flow from and to end-users are created in all layers of the internet. In this value chain, every link can perform as a bottleneck (Van Eijk 2012). It means that when stakeholders are restricted in traffic shaping, the problems can shift to other links or layers in the value chain.

Researchers have already discussed such discriminatory practices. Odlyzko (2009) draws attention to pricing policies of search engines and thus to search neutrality. Recently, there is a boom of theoretical literature on search neutrality. Sahel (2011) warns about agreements between internet service providers and the producers of devices which will potentially hinder device neutrality. For instance mobile network operators allow the usage of devices (e.g. *iPhone*) only if certain applications are not used (e.g. *WhatsApp, Skype* or *Viber*). Such discriminatory practices increase the market power of internet service providers and reduce innovation incentives.

3.6 Broad Welfare Effects of Net Neutrality

Implementing a policy, such as network neutrality regulation, entails costs and benefits not only in the market for content and applications, but also for stakeholders elsewhere in the economy and for the society at large. To assess the overall costs and benefits of network neutrality regulation, Appendix A provides an analytical framework, the so-called Social Cost Benefit Analysis (SCBA), in which the broad welfare effects of net neutrality are listed. Under the basic assumption that net neutrality leads to more innovation – particularly by small CAPs – a comparison is made between the situation where this policy is effectuated and a situation where prioritization and anticompetitive traffic shaping may occur. By doing so, net neutrality is evaluated – qualitatively – not just in terms of content and application innovation, but also its derivative effects in other markets (so-called *indirect effects*) and its inherently non-quantifiable effects (the right to freedom of information and expression). Moreover, the framework provides an overall picture of how these effects are distributed among stakeholders. See Appendix A for the outcome of this analysis, and for more background on the methodology.

3.7 Summary

Network neutrality, as for instance defined in the Dutch Telecommunications Act, increases competition, therefore provides incentive for innovations at the core and the edges. Small innovators at the edges benefit more than large CAPs. These smaller innovations are seen as the drivers of the success of the internet.

A regulatory measure needs to take the level of total welfare, in particular, in the long run *and* the possible market failures into consideration. Hence, the starting point is that internet markets are characterized by market failures, in particular, market power and network externalities. These market failures reduce the incentives to innovate.

Net neutrality reduces the market power of internet service providers and, consequently, more innovations are developed at the core as firms compete with innovative services. In addition, net neutrality regulation prohibits anticompetitive practices, for instance blocking or quality degradation (see Table 3.3). Consequently, competition increases also at the level of CAPs.

Net neutrality is always beneficial for small CAPs but reduces the innovation incentives of large CAPs. However, net neutrality can also affect innovation at the core and for large CAPs positively as it lowers transaction costs and helps avoid other types of market inefficiencies, such as overcharging of CAPs (as an additional externality) and overuse of capacity (prisoners' dilemma).

Congestion remains a problem under net neutrality, however, in the lack of investments in network upgrades, prioritization cannot solve congestion either. Technical traffic management and investments in network quality and quantity are more effective in that respect. Differentiated tariffs – both by volume and quality and by content (i.e. prioritization) – incentivize such investments.

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Appendix A Costs and Benefits of Net Neutrality

The effects of net neutrality regulation reach beyond the market for content and applications. Net neutrality affects other stakeholders, such as network operators investing in next generation networks, advertisers, or the professional users of innovative content and applications, and creates value that cannot be priced. This appendix provides a framework to assess the relating social costs and benefits of net neutrality regulation.

In 2011, the Netherlands accounted for the highest internet penetration per inhabitant within the OECD countries: 83 percent of households disposed a broadband internet connection (CBS 2012). Broadband access prices varied in the last years, but the quality of the connections has been increasing considerably since 2004. Households use the internet more intensively to buy products online, to listen to the radio, or to watch television (TNO 2012). Furthermore, the ICT sector grew notable. The telecom industry contributed to the Dutch GDP growth by 25 percent between 1970 and 2009 (Brennenraedts *et al.* 2012). The revenues of large content and application providers also increase substantially (Enck & Felten 2011).

As these facts show, the telecom industry, including the internet, has a considerable role in consumer welfare and the growth of the Dutch economy. Regarding the role of the internet, these contributions came about in the presence of neutral networks, before discriminatory practices were able to emerge. Hence the question arises whether under network neutrality regulation, these trends are expected to continue in the future. In other words: *what is the added value of unrestricted internet content and applications to the economy and society?*

Implementing a policy delivers benefits not only to the market of content and applications, but to the economy as a whole. To achieve these benefits is, however, not for free. To assess the overall costs and benefits of net neutrality regulation, this appendix provides an analytical framework, the so-called Social Cost Benefit Analysis (SCBA). The SCBA aims to quantify and, if possible, monetize the welfare effects of such a policy by comparing the situation where the policy – net neutrality – is effectuated (the so-called *project alternative*) with the 'business as usual' (BAU) state of the world, that is, when prioritization and anticompetitive traffic shaping may occur. As data and empirical evidence are rare, this study present primarily an extensive list of effects that can be expected as a consequence of network neutrality. This study also aims at providing a framework for future research and the ex-post evaluation of net neutrality when observations from a longer period and more empirical evidence are available.

In the first section of this appendix, the analytical framework of SCBA is described. In sections 2, 3, and 4, the direct, indirect, and external effects of net neutrality regulation in comparison to prioritization and anticompetitive traffic shaping are listed, and where possible, illustrated by numbers. In Section 5, the overall effects are summarized.

Appendix A.1 Analytical Framework: the Cost Benefit Analysis

In a Social Cost Benefit Analysis (SCBA) all costs and benefits of investments or policies are systematically evaluated and, where possible, monetized to make them comparable. In addition, SCBA provides an overall picture of how the effects are distributed among stakeholders.[25] In principle, SCBA has the ambition of including and monetizing all the effects of a policy, including societal and environmental effects.

The SCBA aims to quantify and, if possible, monetize the welfare effects of investments or policies by comparing the situation where the investment or policy is effectuated – the so-called *project alternative* – with a 'business as usual' (BAU) state of the world.[26] Its broad welfare perspective entails that the SCBA takes stock of all (possible) welfare effects, not just the effects that can be quantified and monetized. This way, all relevant advantages and disadvantages of an investment project or policy are recorded.

In a SCBA, the *willingness-to-pay* of firms and households is estimated for each impact of the project or policy. This is done market-by-market, with special care to avoid double-counting. If possible, existing markets are used, where the *willingness-to-pay* can be observed from choices made by suppliers and customers. For impacts that are not related to markets, other methods such as surveys may be used. The value of impacts is calculated year-by-year, for a period of decades. The future costs and benefits are translated into net present values (NPV) using discounting.

The non-quantifiable effects of a project are listed as *Pro Memorie* (PM) items, using '+' (positive effect of unknown magnitude), '-' (negative effect of unknown magnitude), '+/-' (ambiguous effect) and '?' (unknown effect) signs to indicate the consequences for the distinguished stakeholders and the (net) effect for society at large.[27] These PM items must be weighed up in political-administrative terms against the sum of the effects that are expressed in monetary terms.

A Cost Benefit Analysis (CBA) can be conducted at several levels of detail. Different extensions to the name Cost Benefit Analysis are used to point out the extensiveness of the analysis conducted, e.g., *Cost Analysis*, *Indicative CBA* and *Quick Scan CBA*. The most complete form is the Social Cost Benefit Analysis.

To conduct such a SCBA is, however, beyond the scope of this study since this study is limited to desk research and there is, as yet, virtually no quantitative data on the (welfare) economic effects of net neutrality (see Box A.3 for an overview of broader economic impact studies, namely those on the economic effects of internet and other telecom technology in general).

[25] In this SCBA stakeholders are defined as actors with an interest in digital applications and content and broadband networks, specifically in relation to net neutrality. In SCBAs a distinction is made between true welfare effects and simple transfers of welfare between two or more stakeholders. In the latter case, pure distributional effects, the net societal effect is '0'.

[26] This is operationalized as the most likely outcome should an investment or policy *not* be implemented, e.g., an alternative investment or flanking policy respectively. Therefore BAU does not translate to 'simply doing nothing'. In this CBA, the business as usual scenario translates to the net neutrality regime in other EU countries, i.e., traffic shaping is allowed although there are transparency requirements (see also footnote 31).

[27] The difference between ambiguous and unknown effects is that the former relates to two or more opposing effects (i.e., both benefits and costs) while for the latter the direction of the effect is undetermined.

Box A.3 Current studies on the economic effects of (broadband) internet and telecom

The majority of studies on the economic impact of (broadband) internet, or telecom technology in general, focus on three categories of effects: macroeconomic growth (e.g., contribution to Gross Domestic Product (GDP) growth), firm performance (e.g., innovation activity) and consumer welfare (i.e., increased consumer surplus).

Several studies provide empirical evidence for a positive effect of telecom (OECD 2010, Röller & Wavermann 2011) and (broadband) internet infrastructures (Czernich et al 2011, Greenstein & McDevitt 2011, Holt & Jamison 2009, and Koutroumpis 2009) on economic growth, usually measured by an increase in GDP per capita. These studies provide data for a myriad of OECD-countries and cover periods from as early as the 1970's to as recent as 2009. Dialogic (Brennenraedts *et al.* 2012) conclude from their literature review that approximately 25 percent of long term GDP growth can be accounted for by the telecom infrastructure itself (5 percentage points) and the use thereof (20 percentage points).[28] Labor productivity – i.e., gross added value per hour work – has doubled since 2000 in the postal and telecom sector out of which the innovative telecom market accounts for the larger share. This productivity increase is also almost double of the average of all industries.

Some evidence is available about the impact of broadband internet on consumers and other markets. The impact of internet on consumer welfare is addressed by Dutz *et al.* (2012), who find that the net consumer benefits from broadband in U.S. households were approximately 32 billion dollar in 2008. Finally, Bertschek *et al.* (2012) are unable to prove that broadband internet has a significant impact on firms' labor productivity, yet they provide strong and robust empirical evidence that it does have a positive and significant effect on firms' process and product innovation activity. Contrarily, Freeman (2002) finds empirical evidence that the ICT sector, including the internet, significantly increased demand for labor, hours worked, hourly payments, and improved labor search, thus mechanisms by which the market brings labor demand and supply together.

These studies underline the economic importance of internet and other telecom technologies. The most important drawback of these papers is the absence of the effect of net neutrality in their estimations of the (welfare) economic effects. In other words: it is unclear from these studies whether net neutrality enhances or mitigates the economic benefits of internet and of other telecom technologies. However, if a plausible causal link can be hypothesized between net neutrality and one or several of the economic effects in the above mentioned studies, they do indicate an *indirect* (or deduced) economic importance of net neutrality. Nonetheless, the remainder of this appendix focuses on economic consequences that are attributed to net neutrality directly in current literature, rather than attempting to adjudge a portion of broader welfare effects of internet and telecom to net neutrality.

Instead, the remainder of this section adopts the analytical framework of the SCBA to list the welfare effects that are directly or indirectly related to net neutrality by existing studies and to assess what they entail for society at large and individual stakeholders: costs ('-'), benefit ('+'),

[28] See Grajek (2012, p. 3) for an overview of economic effects of different categories of technology, including social networks, cloud computing and machine-to-machine (M2M) communication.

both costs and benefits ('+/-') or an unknown outcome ('?'). When applicable, quantitative evidence found in these studies is presented. This framework also aims at providing a reference for future research and the ex-post evaluation of net neutrality when observations from a longer period and more empirical evidence are available.

The rows in Table A.4 summarize the (hypothesized) costs and benefits of net neutrality, divided in direct effects, indirect effects and external effects of net neutrality.

Direct effects are costs and benefits for the owners/vendors/operators and the consumers of the goods and services that the investment project or policy – in this case net neutrality – primarily affects. In this analysis the *primary market* is the market for (mobile) internet content and applications.[29]

Indirect effects are costs and benefits that, through market transactions, are passed on to producers and consumers outside the primary market. These effects manifest themselves as altered prices for other goods and services, higher or lower profits for companies in other markets than the primary market, and/or changes in taxes. In this case secondary markets include those for networks/internet access and labor.

Finally, *external effects* concern the costs and benefits caused by the investment project or policy that end up at stakeholders although no markets, and therefore no prices, exist for these effects. Primary examples of external effects are environmental effects and noise pollution, but also the least 'tangible' effects – the right to freedom of information and expression.

The columns of Table A.4 illustrate how effects are distributed among eight stakeholders:

- ISPs as network operators;
- ISPs as content and application providers (CAPs);
- Large CAPs;
- Small CAPs;
- Advertisers and media agencies;
- Professional users of content and applications (content and application integration);[30]
- End-users of content and applications;
- Government/regulator.

All project effects – direct, indirect or external – are differences between a situation *with* net neutrality (i.e., the project alternative) and a situation *without* net neutrality when prioritization and anticompetitive traffic shaping practices may occur (i.e., the BAU state of the world).[31]

29 *Market* is defined as where supply meets demand, regardless of whether a financial transaction is applicable.

30 E.g. companies using of CMS (Content Management Systems), web shops, and APIs (Application Programming Interfaces) such as YouTube and Google Maps for their websites.

31 In the BAU scenario, there is European legislation that stipulates transparency about traffic shaping for technical or security or integrity reasons, as anchored in Article 7.4(a)(2) of the Dutch Telecommunications Act as well as in legislation in other EU countries (see Box 2.1). In other words, there are no additional benefits from or costs of transparency in the project alternative.

Table A.4 Analytical framework for the welfare effects of net neutrality

Project Alternative: Net Neutrality	Stakeholders: Internet Service Providers as network operators	ISPs as content and application providers	**Large** Content and Application Providers	**Small** Content and Application Providers	Professional users (content and application integration)	Private end-users	Government/regulator	**Total national**
Direct effects								
Net benefits from more and better content and applications								
Indirect effects								
Net benefits from more and better internet connections								
Payment for priority lanes								
Employment								
Transaction costs due to contracting/negotiation								
Regulatory costs								
External effects								
Freedom of information and expression								
Total per stakeholder								

Source: SEO Economic Research

Appendix A.2 Direct Effects

Net neutrality regulation affects the market for internet content and applications directly via innovations. For instance, if innovations increase the value of the available amount, variety, and quality of content and applications for end-users – both private and professional – their willingness to pay for content and applications also increases. Consequently, ISPs and CAPs can set higher prices for these services in order to cover the relating innovation costs and increase their profitability.

This section presents the effects of network neutrality regulation on these net benefits of innovative content and applications. The effects represent comparisons between the situation of network neutrality regulation with the 'original' (BAU) situation when prioritization and anticompetitive traffic shaping may occur (although European legislation about transparency about traffic shaping is applicable, see footnote 31). A positive (negative) effect means that the relating utilities, revenues, or profits increase (decrease) or that the relating costs are reduced (increased) vis-à-vis a situation with prioritization and anticompetitive traffic shaping.

The first and currently only paper that investigates net neutrality empirically is Nurski (2012). She builds up a structural empirical model to test ISPs' preferences for prioritization and anticompetitive traffic shaping practices in the UK. First, she estimates end-users' valuation and choices of CAPs and ISPs in a two-stage model. Based on these estimates, she computes two simulations – one for prioritization and another for anticompetitive traffic shaping – to analyze the benefits of two competing ISPs, two competing large CAPs, and end-users from these practices. Nurski's study provides insight about end-users valuation on innovative content and applications and advertising revenues. To keep her analysis tractable, she uses assumptions. For instance, in her simulation, she does not consider the effects of traffic shaping on the amount and quality of innovations, in particular by small CAPs. Therefore, one needs to be careful to draw overall conclusions from this study. But there are no empirical studies that would assess these effects either (Nurski 2012, p. 26). Consequently, the analysis of direct effects is mainly based on theoretical results.

The following costs and benefits determine the social value from more and better content and applications:

- End-users' utility from the use of content and applications;
- Direct payment for content and applications;
- Indirect payment: disutility from advertisements;
- Advertising revenues;
- Costs of innovations.

In the following sections, the effects of net neutrality on these costs and benefits are analyzed.

Utility from the Use of Content and Applications

End-users value innovative products higher, which yields them higher utility. Whether more or better content and applications are available, depends on the innovation incentives for CAPs. As was discussed broadly in Chapter 3, three factors stimulate internet-based innovations: competition between ISPs and CAPs, more financing, and the possibility of experimentation.

Network neutrality increases the competition between ISPs and CAPs. First of all, because anticompetitive traffic shaping practices are prohibited and consequently, vertically integrated ISPs are more limited to exclude competing CAPs from the market. Second, net neutrality reduces entry barriers for new CAPs. Competition increases innovativeness via two channels: (i) CAPs need to compete with more innovative services (Aghion *et al.* 2005); and (ii) more intense competition between ISPs also increases connectivity, thus partly internalizing cross-group network externalities (see Section 3.2.4). As a consequence of more intense competition, the amount of innovators and the quality of innovations increase.

Regarding financing, the overall effect of net neutrality is somewhat less positive. Even though large CAPs do not need to pay for priority lanes to ISPs and avoid the contracting costs of these agreements, they lose ad revenues. Conversely, small CAPs are likely to win advertisers as their market share increases or reduces less under net neutrality than it would under prioritization. Finally, net neutrality makes experimentation more attractive for innovators, thus increasing the quality of innovations.

Based on the above arguments, net neutrality increases the amount and quality of innovation and thus the utility of end-users from the use of innovation.

Disutility from Advertisement

In online platforms, individuals can be better targeted by advertisements (Evans 2009). Despite this development in the advertising market, end-users have an even stronger resistance against online advertisements than ads in the offline media (McCoy *et al.* 2007). Consequently, the more advertisements end-users are confronted with, the more disutility they receive. Advertisements will certainly be more visible in the internet. But it is unclear whether net neutrality or traffic shaping will stimulate them more (see further on). The effect on end-users' disutility is also ambiguous.

Direct Payments for Content and Applications

The prices that CAPs charge to end-users for content and applications depend on the end-users' willingness to pay, the price elasticity of content and applications for end-users and advertisers, and the intensity of competition between CAPs. Net neutrality regulation influences these market characteristics in the following way.

First, because net neutrality increases the amount and quality of content and applications, end-users are willing to pay more for them to CAPs. Consequently, direct payments can increase. Second, CAPs are also platforms in two-sided markets with end-users and advertisers at the two ends. CAPs can balance the payments between these sides to achieve higher benefits (the previously mentioned waterbed effect, see Musacchio *et al.* 2009). More specifically, a lower price for end-users can be balanced by higher advertising rates and *vice versa*. CAPs can set tariffs most efficiently if they increase prices in the less price sensitive side and lower the price at the other side. It is empirically undetermined whether end-users or advertisers are more sensitive. Therefore, it is unknown whether net neutrality leads to higher prices for end-users and higher revenues for CAPs.

Finally, net neutrality increases competition between CAPs for two reasons. First, because anticompetitive traffic shaping is forbidden, vertically integrated ISPs cannot exclude CAPs from the market by blocking their competing services. Second, the literature suggests that prioritization poses an entry barrier for competing CAPs and increases the difference between the profitability of small and large CAPs. Net neutrality eliminates this entry barrier. More intense competition caused by network neutrality reduces the price of content and applications, including the content and applications of ISPs. The overall effect of net neutrality on direct payment is, therefore, ambiguous.

Advertising Revenues

Large CAPs have changed their business models to cover innovation costs by relying on substantial advertising revenues. For instance, *Facebook* generated 1.2 billion dollar ad revenue in the first nine months of 2010 (Enck & Felten 2011). Advertising revenues depend on the amount of visits on a website and ad rates. As a CAP captures more eyeballs, it becomes more attractive for advertisers. Several factors determine the number of visits on a CAP's website: quality of lane, quality of innovation, and larger connectivity.

Advertising volume

First, the quality of lane increases the website attractiveness. Quality increases when a CAP buys a priority lane and when network operators invest in network upgrades (Nurski 2012). Net neutrality prohibits the first option (i.e., no additional gains for large CAPs) and limits the second option (for the argument see Appendix A.3). Hence, net neutrality reduces eyeballs.

Nurski (2012) calculates the effect of priority lanes on advertising revenues of *You Tube*, one of the largest CAPs. The estimated ad rate per visit, based on data about advertising revenues, is between 2.4 and 2.8 dollar. Nurski estimates that under net neutrality, in 2009, *You Tube* had 19 million unique visitors per month, providing approximately 45-53 million dollar monthly ad revenue. By buying a priority lane from British Telecom, its market share would increase by 3.4 percentage points, from 23% of households consuming YouTube to 26%. It implies an additional 2.4 million unique UK visitors. This increase in market share yields in additional advertising revenues between 7 and 8 million dollar. *YouTube*'s ad revenue is less by this amount if buying priority lanes is not allowed. A note needs to be made here. This result, which is based on simulations, does not take into consideration that the number of visitors can change for other reasons. For instance, also broadband penetration grows as the number of small CAPs also increases.

Second, a CAP can steal eyeballs from its competitors and, by doing so it can increase its market share. By providing better quality content and applications, a CAP can achieve a higher market share. Net neutrality can stimulate the quality of innovative services and increase the visit on those CAPs' websites that provide better quality.

A relating effect is that under net neutrality, a prisoners' dilemma, caused by prioritization, can be avoided. Under prioritization, several CAPs can buy priority lanes, by which they do not win market share from each other. Finally, net neutrality increases connectivity because the internet with more and better content and applications becomes more attractive for new end-users. Increased connectivity means more eyeballs. The overall effect of net neutrality on eyeballs is ambiguous.

Advertising rates

Ad rates also determine advertising revenues. Two mechanisms can influence ad rates. First, as was argued earlier, CAPs are platforms that balance their profits between advertisements and direct payments. Currently it is unknown which market segment is less price sensitive and can accommodate higher rates more easily. Second, net neutrality increases competition between CAPs, which lowers the ad rates to advertisers. The overall effect of net neutrality on ad rates is ambiguous.

In short, the overall effect of net neutrality on ad revenues – in comparison to traffic shaping – is larger on small CAPs and ambiguous on large CAPs. According to the economic literature, large CAPs lose advertising revenues as a result of net neutrality. These articles, however, do not consider the effect of increased broadband penetration in the presence of competing small and large CAPs. This increase in connectivity can have a positive effect on the ad revenues of both types of CAPs. Hence, it partly offsets the negative impact of network neutrality on revenues for large CAPs and increases the positive impact of net neutrality on revenues for small CAPs.

As from the social perspective, advertising revenues are transfers between CAPs and advertisers and the overall social effect is zero.[32] There is an additional effect, and that concerns revenues for media agencies. Because media agencies are intermediaries between advertisers and media outlets, they win as advertising expenditures increase. The sign of the effect of net neutrality on that is ambiguous.

Costs of Innovation

The innovation costs of CAPs depend on whether they innovate more and how much each innovation costs. Since network neutrality increases the amount and the quality of innovations by small CAPs, their innovation costs also increase. There is also a volume effect that increases small CAPs' innovation costs: under net neutrality there simply are more small CAPs than under traffic shaping. Large CAPs may innovate less, thus their innovation costs reduce.

The cost of an innovation is, however, unknown. Some innovations include large fixed costs, for instance of technology, intellectual property rights, or creative skills. Other content and applications require lower costs to develop. As the 'unit costs' of innovation are unclear, the assumptions about innovation costs for small and large CAPs are tentative.

Appendix A.3 Indirect Effects

Network neutrality regulation influences the performance of other markets than that for content and applications. Most importantly, it affects the market for internet connections. For end-users, more or better internet connections carry added value. Network operators can improve connections by investing in next generation networks (NGNs). For that, network operators need to set prices to CAPs and end-users in a way that incentivizes these investments. In addition, the content and applications provided on these networks increase end-users' valuation of the connection (Nurski 2012). Beside the benefits from internet connections, net neutrality may influence the employment of innovative CAPs and ISPs. Changes in other types of costs, such as transaction costs due to contracting between ISPs and CAPs and regulatory costs, also affect the social value of network neutrality regulation.

Theoretical findings presented in Chapter 3 and the earlier mentioned empirical article of Nurski (2012) are the starting point in analyzing the net benefits from internet connections. However, there are no empirical studies that asses the other indirect effects of net neutrality, in particular, the effects of net neutrality on employment (Nurski 2012, p. 26). For these effects, the analysis relies on theoretical findings and other relating empirical studies.

32 For any voluntary welfare transfer – like the transaction between advertisers and CAPs – an argument can be made that it will not occur unless the private benefits of the transaction for the payer (in this case the advertiser) are bigger than the transaction price (including transaction costs). In other words: the advertiser's willingness to pay is presumably larger than the ad rate, so he derives producer surplus from the transaction. These types of 'second-order' effects of welfare transfers are excluded from this analysis.

Net benefits from More and Better Internet Connections

The following costs and benefits determine the social value of an internet connection:

- End-users' utility from internet connections;
- Payment for internet connections;
- Costs of investments in NGNs.

In the following sections, the effects of net neutrality on these costs and benefits are analyzed.

Utility from Internet Connections

End-users' utility from an internet connection increases by four channels:

- More or better innovations by small CAPs;
- More or better innovations by large CAPs;
- Higher technical quality of lanes;
- Higher internet penetration (network effect).

Utility from more or better innovation by small and large CAPs

Utility derived from online content contributes in a positive and significant way to the utility of broadband access (Nurski 2012, p. 16). It means that end-users take into account the utility they will get from using their internet connection to access content providers, when choosing a broadband offering.[33] Therefore, individuals that consume more online content, have a higher utility for broadband internet. As was argued earlier, net neutrality increases the available amount and quality of content and applications. Consequently, end-users derive higher net utility from being connected to the internet than in the case of prioritization. This result is primarily driven by the increasing innovativeness of small CAPs. A counter effect that reduces end-users' valuation is that larger CAPs will be less innovative as a result of net neutrality.

Utility from using a technically better quality internet connection

Technically better quality lanes increase end-users' utility (Nurski 2012) and end-users are willing to pay for that. Better quality can be achieved by less congestion and priority lanes. Traffic management and investment in network capacity lower the level of congestion. Priority lanes can be achieved by investments in network upgrades. The question is how net neutrality affects congestion and investment incentives.

First, let's look at the situation when no investment takes place and congestion may occur in peak moments. As was argued in Section 3.4.2, when networks are not upgraded, net neutrality regulation affects congestion negatively because it increases the waiting time of data packages. But prioritization can also cause a congestion problem, in particular when several CAPs are willing to buy priority lanes. In this case, prioritization leads to an overuse of networks. This situation reflects a prisoners' dilemma: for all contracting CAPs buying a priority lane is a dominant strategy. In total, net neutrality has a negligible effect on congestion and thus on end-users' utility.

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33 Nurski (2012, p. 16) shows that the utility derived from online content contributes in a positive and significant way to utility of broadband internet: consumers take the utility they will get from using their internet connection to access content providers into account when choosing between ISPs. In other words, consumers indeed care about connection speed in the consumption of online content – especially with regard to playing online games and communication services (e.g., VOIP and chat). – and consider this when they choose their ISP.

The second situation is when networks are upgraded by more capacity or to a better quality. Net neutrality partly erodes investment incentives because ISPs cannot charge CAPs for a priority lane. The argument is based on the earlier described two-sided market nature of internet and the waterbed effect. If CAPs are less price sensitive than end-users, an ISP can set its tariff structure the most efficient way by charging a higher price for the priority lane in the less elastic segment of the market, that is, to CAPs. As Nurski (2012) argues, the price elasticity of end-users regarding demand for access is high: -3.3 in the UK. The price elasticity of CAPs drops below this value if they can achieve higher advertising revenue, thereby increasing their willingness to pay for the priority lane. However, if prioritization is not possible, the ISP can only set prices for internet access, which is then the more price sensitive segment of the market.[34] In this way, it loses revenues and invests less in network capacity and quality than it would do under prioritization. Consequently, net neutrality reduces end-users' utility from technically higher quality lanes.

There is another relevant factor that influences network investments: the intensity of competition between network operators. It could be argued that net neutrality – as it leads to increased competition between network operators (see Section 3.3.1) – has a positive influence on (next generation) network investments as well as a negative influence.

Utility from higher internet penetration: a network effect

As Nurski (2012) argues, more and better content and applications increases the value of an internet connection. Consequently, end-users that did not have internet access before may also connect, thus increasing internet penetration. Higher internet penetration (or larger connectivity) provides additional benefits to end-users that are connected to the internet. This is a network effect. As was argued at the direct effects, net neutrality increases the amount and quality of innovation by small CAPs but reduces innovation by large CAPs. The overall effect on the utility from the use of content and applications is still positive, so is the effect on penetration.

Summary

In short, net neutrality has the following effects on the components of end-users' utility in comparison to prioritization:

- A greater utility from internet connection as a result of more and better supply of content and applications;
- A reduced utility from internet connection as a result of an absence of content and applications in a priority lane;
- A reduced utility from internet connection as a result of degraded technical quality (less investment and more congestion);
- A greater utility from internet connection as a result of higher internet penetration and thus stronger network effects.

Since net neutrality has opposing effects on end-users' utility from internet connection, the overall effect is ambiguous.

34 In practice, the argument applies to both end-users and CAPs as they both need to pay for internet access.

Payments for Internet Connections
How much ISPs can charge for end-users to access the internet depends on the end-users' willingness to pay, the price elasticity of broadband access, and the intensity of competition between ISPs. Net neutrality affects these elements in opposing ways, which will be shown in this paragraph. However, the overall societal effect of access payments is zero as these payments are transfers between ISPs and end-users.

First, larger connectivity makes the network more valuable for end-users. Hence, they are willing to pay more for that. Net neutrality increases connectivity, thus end-users' willingness to pay and potential access payments.

Second, as Nurski (2012) argues, the price elasticity of end-users regarding demand for access is relatively high, -3.3. It means that a 1% decrease of the price leads to 3.3% increase of connection and *vice versa*. As net neutrality prohibits charging tariffs for priority lanes, ISPs need to charge higher access fee to end-users to be able to finance investments in NGNs (the waterbed effect, see Section 3.4.2). Because demand for access is price elastic, higher prices reduce access revenues.

Finally, net neutrality increases competition between ISPs, which lowers the access fee. In the case of elastic demand for access, it provides ISPs with higher access payments. In short, the overall effect of net neutrality to access revenues of ISPs is ambiguous.

Costs of Investments in Next Generation Networks
As was argued just earlier, net neutrality reduces investment incentives in network upgrades. Consequently, investment costs of network operators are also lower than in the case of traffic shaping. These lower investment costs translate to a positive effect.

In the previously mentioned empirical study on consumer choices vis-à-vis net neutrality, it is shown that the sale of a priority lane to content providers is, overall, beneficial for ISPs (Nurski 2012, p. 21). It is estimated that the ISP selling the priority lane would gain 26 million pound in revenues (an increase in market share of 0.27%) at the expense of a revenue loss of 14 million pound for other ISPs (a collective decrease in market share of 0.16%). Hence, total industry revenue would increase from traffic shaping, by 12 million pound. This shows that, in this aspect, net neutrality is unfavorable for ISPs and, therefore, harmful for their capacity to invest in NGNs.

Conversely, *Diffraction Analysis* argues that 'tollbooth arrangements' – i.e. sharing revenues between IPSs and CAPs – would hardly influence network investment decisions by ISPs.[35] Apart from the uncertainty whether content providers would be able to pay such fees, *Diffraction Analysis* concludes that revenue-sharing agreements would cover only a negligible part of investments in next-generation broadband access (Enck & Felten 2011).[36] ISPs can expect larger revenues from their core businesses, that is, broadband access and other telecoms services. In

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35 The rationale for revenue-sharing agreements is that content providers should share part of their revenues with network operators as a compensation for network investments resulting from traffic increases caused by content providers (Felten 2013).

36 Enck & Felten (2011) calculates that a 10% revenue share agreement would cover only 3.5% of investments in next-generation broadband access by British Telecom.

other words, they conclude that revenue-sharing agreements between ISPs and CAPs would have almost no impact on investment in (broadband) networks.

Payments for Priority Lanes

In a regime where prioritization is possible, CAPs pay a fee for priority lanes to ISPs. Consequently, under net neutrality CAPs do *not* need to pay these fees (at least not for general lanes, see footnote 23) and their costs reduce. On the other hand, the revenues of ISPs decrease with the same amount. The overall effect is null.

With net neutrality regulation an additional externality can be avoided (Musacchio *et al.* 2009). Under prioritization, a CAP needs to pay to several ISPs, which increases its costs and reduces its innovation incentives. Consequently, the value of its innovation reduces for end-users and indirectly to advertisers. When setting a price, ISPs take only the effects of their own prices into consideration, but not these indirect effects. Therefore, ISPs overcharge CAPs. The social costs of this externality are internalized by net neutrality. Consequently, this externality influences the size of the effect per stakeholder but the overall social effect remains zero.

Transaction Costs Due To Negotiation and Contracting

If prioritization is possible, those CAPs that are willing to buy priority lanes need to negotiate the relating fee and contract with local ISPs individually. In a market with several ISPs and CAPs, negotiation and contracting imply high transaction costs. As was argued in Chapter 3, under net neutrality regulation, CAPs and ISPs avoid these costs (Lee & Wu 2009 and Hermalin & Katz 2007). Therefore, net neutrality has a positive effect on transaction costs for parties involved.

Employment

In a cost benefit analysis, benefits of increased employment only exist if the jobs created by the investment project or policy are occupied by people who were formerly unemployed or were formerly in a job where they were less productive. In other words, a project only creates these benefits if it solves labor market imperfections.

As Freeman (2002) argues in his empirical paper, the ICT sector, including the internet, significantly increased demand for labor and hours worked, and he expects these changes to continue as internet access increases over time. Furthermore, it can also be expected that since small CAPs prosper under a net neutrality regime, they signify a larger number of jobs than they would under traffic shaping. As cases from the last few decades of the internet show, some of these small CAPs grew large and this tendency is also expected in the future. The opposite applies for large CAPs: employment there is lower than it could be under prioritization.[37]

There is however, no empirical evidence about whether the jobs created by small CAPs meet the requirements mentioned above (i.e., additional jobs or enhanced productivity), just as it is uncertain that less jobs at large CAPs mean (permanent) unemployment. It is also highly likely

[37] As goes for all effects, these are differences between net neutrality and a BAU scenario. It does not necessarily mean that net neutrality causes job loss at large CAPs but rather that large CAPs are likely to prosper more in a situation where traffic shaping is permitted.

that large CAPs and small CAPs get their employees from the same pool of labor so that there is transfer of personnel between both as a result of net neutrality (e.g., from large CAPs to small CAPs). Further research is required to test these effects.

Regulatory Costs

Regulatory costs increase as net neutrality regulation need to be implemented and enforced. For instance, infringements of anticompetitive practices or potential agreements between ISPs and CAPs need to be detected by monitoring.[38] As net neutrality regulation has already been included in the Dutch telecommunications wet, only the relating costs of legislation are 'sunk' (that is, irretrievable should net neutrality be revoked). Regulatory costs are negative effects of net neutrality regulation.

Appendix A.4 External Effects

Network neutrality regulation creates additional social value, which cannot be evaluated in monetary terms. One source of social benefits is mentioned here: the freedom of expression and access to information. In a neutral network in which information is not discriminated by origin and content, end-users – private or professional – can freely share their information and also get access to other end-users' shared information. The freedom of expression and access to information is indeed seen as an important political motivation behind the Dutch net neutrality regulation.

Appendix A.5 Summary

Network neutrality regulation aims at stimulating innovations in the market for content and applications, but it also affects other markets and stakeholders, such as network infrastructures, advertisers, and professional users of internet content and applications. The effects of such a policy can be assessed by a Social Cost Benefit Analysis (SCBA). For an SCBA, an extensive list is required of the social costs and benefits that stakeholders are faced with by moving from potential traffic shaping practices to net neutrality. This section presents this list. Furthermore, it also provides a framework for future research and the ex-post evaluation of net neutrality when observations from a longer period and more empirical evidence are available.

Table A.5 presents the social costs and benefits of network neutrality in comparison to a situation where traffic shaping practices are allowed. Some effects in the table are ambiguous as the opposing effects cannot be weighed against each other due to a lack of data and empirical evidence. Moreover, since effects cannot be netted unless they are quantified, it is not possible to assess the overall national effect (i.e., a row total) or the overall effect per stakeholder (i.e., a column total) if opposite effects occur. Consequently, the overall effect of net neutrality is also ambiguous.

[38] On the other hand, it could be argued that net neutrality – since it fosters innovation and entry by small CAPs – also enhances the countervailing power of small CAPs *vis-à-vis* ISPs. This potentially reduces the need for enforcement and therefore regulatory costs.

Table A.5 Overview of theoretical and empirically tested welfare effects of net neutrality

	Stakeholders							
Project Alternative: Net Neutrality	Internet Service Providers as network operators	ISPs as content and application providers	**Large** Content and Application Providers	**Small** Content and Application Providers	Professional users (content and application integration)	Private end-users	Government/regulator	**Total national**
Direct effects								
Net benefits from more and better content and applications								
• Net user benefits (consumer surplus)					+	+		**+**
• Net producer benefits (producer surplus)		-	-	+				**+/-**
Indirect effects								
Net benefits from more and better internet connections								
• Net user benefits (consumer surplus)					+/-	+/-		**+/-**
• Net producer benefits (producer surplus)	+/-							
Payment for priority lanes	-		+					**0**
Employment	(-)	(-)	(-)	(+)				**(+/-)**
Transaction costs due to contracting/negotiation	+		+	+				**+**
Regulatory costs							-	**-**
External effects								
Freedom of information and expression					+	+		**+**
Total per stakeholder	**+/-**	**-**	**+/-**	**+**	**+/-**	**+/-**	**-**	**+/-**

Source: SEO Economic Research; Effects show changes of costs and benefits from moving from BAU (i.e., prioritization and anticompetitive traffic shaping) to net neutrality; +: positive effect; -: negative effect; +/-: ambiguous effect (both benefits and costs); ?: unknown effect; (): uncertain additional effect.

Yet, some preliminary conclusions per stakeholder can be drawn. First of all, *end-users* will benefit from net neutrality because more and better quality content and applications will be available. Their net benefits (or: consumer surplus) is equal to the utility they derive from the use of such content and applications, minus the 'costs' for consumption – either monetary costs (direct payment for content and applications) or the disutility from having to watch and/or listen to advertisements. The net benefits for end-users are positive since consumption would not occur if, from the user's perspective, the (monetary) costs of consumption outweigh the benefits. However, the net user benefits from more and better internet connections – the derived utility from internet connections minus the connection fee – are undetermined as literature and empiricism suggest that both alternatives (net neutrality and traffic shaping) bring about benefits for users. Finally, users benefit from increased freedom of expression and access to information *vis-à-vis* the traffic shaping scenario.

CAPs (both small, large and ISPs as CAPs) accrue or lose producer surplus when their revenues (advertising revenues and, in case of paid-for services, direct payment for content and applications) and/or their costs of innovation change. These net producer benefits are positive for small CAPs in a net neutrality regime, seeing as they have better business opportunities compared with traffic shaping. They benefit from more revenues (direct payment and/or advertisements) and, as a result, there are also *more* small CAPs in a NN regime.[39] The net producer benefits for large CAPs (and for ISPs as CAPs) are negative since their competitive position is better – and therefore their market shares higher – if traffic shaping is allowed.

The net producer benefits for *network operators* – the change in revenues from internet connections[40] minus the costs of investing in (next generation) networks – are ambiguous since it is unknown how net neutrality influences the price that they can charge their customers.[41] Finally, both CAPs and ISPs benefit from net neutrality as the transaction costs relating to prioritization are avoided.

[39] Assuming that small CAPs are *on a whole* efficient and that there are no entry or exit barriers (i.e., efficient small CAPs enter the market, inefficient small CAPs exit the market), these revenues outweigh their innovation costs.

[40] The change in revenues from internet connections is the outcome of a change in the internet connection fee (price) multiplied by the number of connections (volume). The former is unknown, the latter is likely to increase.

[41] If net neutrality has a significant impact on their capacity to invest in (next generation) networks, it is likely that the investment costs for network operators are (perforce) lower under net neutrality.

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