Mobile telecommunications market structures

The effect of Tele2's market entry on the competitiveness of the mobile telecommunications market in the Netherlands

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Abstract

This study provides a first empirical test of the effect of Tele2's mobile market entry in the Netherlands. In 2012, the Dutch government decided to reserve frequency licences for an additional operator. Tele2, being a virtual operator at the time, acquired two spectrum licences in the multiband frequency auction. This enabled Tele2 to launch its own network instead of utilizing the infrastructure of other operators. A variety of difference-in-differences models is used to evaluate the impact of the fourth Mobile Network Operator on mobile prices. In line with standard economic theory, the results indicate that the market entry of an additional supplier resulted in lower mobile prices when compared to other European countries where no change in market structure occurred. While a collection of non-academic studies indicates that more concentrated mobile market structures will lower mobile prices, our estimates suggest otherwise.

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Table of contents

1. Introduction

The European Commission and national competition authorities have become increasingly interested in mobile telecommunications markets in recent times. Telecommunication networks are important for economic growth in both modern and developing economies (Datta & Agarwal, 2004). The Commission therefore contemplates a Digital Single Market (European Commission, 2017) as a key driver for economic growth and has recognized the competition-related opportunities and risks in oligopolistic mobile markets. The notion is that competitive telecommunications markets will lead to increased opportunities for businesses while reinforcing Europe's digital economy. In cooperation with national competition authorities, the Directorate-General for Competition intends to "ensure that telecoms networks and services can expand and innovate, by safeguarding a level playing field and access to the IT and telecoms market" (European Competition DG Competition, 2012).

Competition authorities, regulators and ministries have used three policy instruments to enhance or protect a mobile telecommunications market's competitiveness. Access regulation is the first policy instrument. By mandating access to the existing infrastructure, additional virtual operators can enter the market more easily. The second policy instrument is to release spectrum licences upon strict conditions. On the one hand, spectrum frequencies can be reserved for new operators to encourage entry as was done by the Netherlands in 2012. On the other hand, competition authorities can limit the amount of spectrum frequencies one operator may utilize. This prevents an operator from gaining a dominant position. Merger control is the third instrument. By requiring remedies upon approval of merger proposals, competition authorities are able to prevent losses of competitiveness in the sector resulting from consolidation.

The outcome of this approach, to stimulate entry or block exit, is disputed because changes in mobile telecommunications market structures in different countries have had mixed results. There is no magic number of competitors according to the European Commission (2014) and the sector's optimal structure (in terms of the number of operators) is subject of discussion between authorities and market players. From a consumer's perspective, consolidation may be harmful due to rising prices and less innovation. Contrarily, mobile network operators argue that consolidation will ultimately be beneficial for consumers since it allows for economies of scale. Due to lower unit costs and higher profits, operators would be able to increase their investments in new technologies, ultimately leading to higher quality services and lower mobile prices. This has resulted in the emergence of a collection of studies with the aim to identify the effect of market structure on mobile prices.

As different studies come to different conclusions, it is not straightforward how and when competition authorities should employ their policy instruments. The Commission's merger decisions confirm that the discussion on the optimal market structure is not clear cut.[1] The Commission cleared 4-to-3 mergers in Austria, Ireland and Germany subject to remedies, but unconditionally cleared 4-to-3 mergers involving the acquisition of operators that were struggling to compete in the Netherlands and Greece. At the same time, it required remedies for 5-to-4 mergers in Austria and the United Kingdom. The specific circumstances (market shares and virtual networks) were different in these cases, meaning that economic analyses are required before employing one of the policy instruments.

[1] The decisions do imply that the Commission sees 4-to-3 mergers as detrimental for consumers.

Following these cases, this study adds to the existing literature by evaluating the effects of the entry of Tele2 on the Dutch mobile telecommunications market. In December 2012, Tele2 acquired two frequency spectrum licences during the multiband frequency auction. Although Tele2 was already offering mobile services, the company had to rely on other networks to operate as a Mobile Virtual Network Operator (MVNO). The purchase of spectrum licences created the opportunity to change strategy: Tele2 could become the fourth Mobile Network Operator (MNO) in the Netherlands by building a new network (Tele2, 2012).

This study is organized in five sections. The first section will offer a literature overview on mobile market structures and the effects of investments and consolidation. The overview first gives a description of the theoretical arguments on the optimal markets structure, followed by a summary of the empirical evidence. The aim of the discussion is to describe how the mobile market structure affects market outcomes (price, quality and investments). The second section specifies the dataset that was utilized in the quantitative analyses of this study. The empirical approach is set out in the third section. The OECD's (2012) methodology for representative baskets is adopted due to complexities in mobile telecommunications prices. In addition to the basket approach, a hedonic pricing model is constructed to analyse mobile prices. The results of the analyses are presented in section five. The study is concluded in the sixth and final section with a review of the Dutch government's decision to reserve spectrum licences for a new entrant. Finally, recommendations for future research regarding mobile market structures are discussed.

2. Theoretical framework

The aim of this section is to analyse the literature on how the market structure affects the outcome in the mobile market for price, quality and investments. Theory and empirical evidence will be combined to shed light on the optimal mobile market structure from a consumer welfare perspective. Because the degree of competitiveness in a sector is partly defined by the sector's special characteristics, it is crucial to first identify the mobile market and its specific features that affect the market outcome.

2.1 Mobile market definition

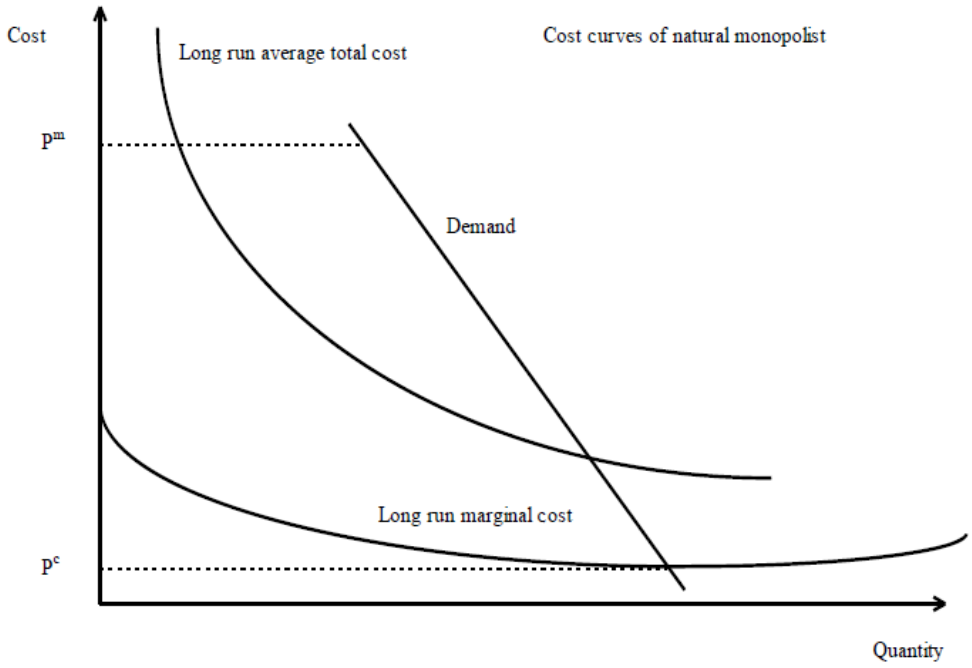
This study will follow the mobile telecommunications market definition provided by the European Commission's Directorate-General for Competition. In general, a relevant product market "comprises all those products and/or services which are regarded as interchangeable or substitutable by the consumer, by reason of the products' characteristics, their prices and their intended use" (European Commission, 1997). Applying this definition in a recent mobile merger decision yielded the following result: "In light of the above findings the Commission concludes, for the assessment of the effects of the Transaction, that there is an overall product market for the retail provision of mobile telecommunications services." (European Commission DG Competition, 2016). From this definition follows that mobile telecommunications services (e.g. data, voice and SMS) are all in one market.[2] Furthermore, the Commission confirmed the geographical national scope of the market in multiple merger cases.

2.2 Entry barriers

The mobile telecommunications market is not an ordinary market. In most European countries, the mobile market only supports a limited number of MNO's. There are usually three to four market players that operate through their own network, leading to a high level of concentration. Several circumstances constitute to these tight oligopolies. The first and foremost reason is the presence of substantial fixed costs that MNO's face. In April 2017, the Dutch Authority for Consumers and Markets published a report in which operators' fixed costs are evaluated (Authority for Consumers and Markets, 2017). The report confirmed the significance of fixed costs in the industry: the BULRIC-model estimates that for providers with about 25% market share, fixed costs make up for approximately 50% of the total network costs. Frequency licences, constructing and maintaining infrastructure and investments in new communication technologies are all significant expenses that are required for being able to effectively compete in the mobile market. Fixed costs give rise to economies of scale as the average fixed costs per user falls when a MNO attracts additional customers (Besanko, Dranove, Shanley, & Schaefer, 2013). If the average total costs decrease for the entire demand curve, one can speak of a natural monopoly as seen in figure 1. Natural monopolies are considered market failures because from a production point of view, it is efficient to have only one producer. However, as allocative and dynamic efficiency are harmed by the natural monopolist, such markets usually call for regulation to prevent excessive pricing (Decker, 2015). Although the average costs per unit keeps decreasing until a provider serves the whole market, European mobile markets are usually served by three to five MNO's.

[2] The wholesale market for "access and calls origination on mobile networks, which includes voice, SMS and data traffic." has been considered as a distinct market by the European Commission.

Figure 1



Bain (1956) showed that fixed costs and economies of scale can also impose a *Minimum Efficient Scale* in an industry. That is if economies of scale are such that small-scale firms cannot make up for their fixed costs and be profitable on the long run. Strickland and Weiss (1976) argue that a minimum efficient scale will naturally result in concentrated markets as the market can only support a few large-scale players. Furthermore, Dixit (1980) and Schmalensee (1981) theoretically show that, with fixed costs and economies of scale, incumbents can create entry barriers. By investing in production facilities (or network capabilities), firms can commit to a high level of production. The costs of these investments are sunk, while this is not the case for entrants. Entry will then be discouraged because potential entrants are not expected to reach the minimum efficient scale that is required to profitably compete on the long run. To win market share, entrants will have to offer attractive pricing, which is costly due to high average costs of small operations. Without deep pockets, it may prove difficult to reach the minimum efficient scale. Entrants will have to endure a period of substantial losses to become profitable on the long term.

Moreover, fixed costs imply a trade-off: on the one hand, a higher number of MNO's will increase competition and lower prices. On the other hand, the more players in the mobile market, the higher the loss in productive efficiency (Motta, 2004). An additional supplier will duplicate the fixed costs and incumbents will lose efficiency in terms of economies of scale. Increasing the number of competitors in a market with fixed costs will thus usually result in a higher consumer surplus at the expense of fixed costs duplication. A priori, Motta shows that the welfare effect of entry in a market with fixed costs is ambiguous. The welfare effect is dependent on the relative sizes of firms and the level of fixed costs.

2.3 Entry deterrence

Auctions have been recognized by regulatory authorities as the preferred way to allocate long-term spectrum licences (Géradin & Kerf, 2003). Spectrum licences, being scarce resources, are allocated in a transparent and objective manner if they are auctioned. Efficiency is also enhanced as the operators with the highest willingness-to-pay usually obtain licences. As a result, licence-winning bids from potential entrants are uncommon since incumbents are likely to value licences more than potential entrants (Madden, Bohlin, Tran, & Morey, 2014). By obtaining additional licences, incumbents can prevent entry and relax competition. Hoppe, Jehiel and Moldovanu (Hoppe, Jehiel, & Moldovanu, 2006) show that auctioning more licences does not necessarily increase competitiveness. They argue that incumbents prefer a concentrated market structure and dislike additional entry as profits are generally higher in concentrated markets. By internalizing the market structure in their decision-making, they are incentivized to outbid potential entrants and deter entry of potential competitors. However, regulatory authorities can discourage this strategic behaviour and accommodate entry by reserving frequency licences for potential entrants or imposing spectrum caps on current providers. This process enabled Tele2 to successfully bid for two licences in 2012.

2.4 Switching costs

In addition to aforementioned barriers to entry, the mobile telecommunications market is characterized by consumer switching costs. According to Klemperer (1987), "Homogenous products may be differentiated by switching costs after purchase.". Take two identical tariff plans from different providers for example. Before purchase, they offer the same services and we may assume that they have the same price. After purchase of one tariff plan, it is no longer identical to the other tariff plan since the other tariff plan would be accompanied by switching costs (fees for network connection, administration or number retention) Switching costs create submarkets of provider bound customers and make each provider's demand more inelastic. As a result, firms in markets with switching costs enjoy a degree of market power over their customers: they are less likely to switch after a price increase (Klemperer, 1995). Firms are only able to attract customers of other providers by offering a price sufficiently attractive for customers to incur the costs of switching. However, this may not be profitable because a firm will lose revenue on its existing client base. In a multi-period model, firms are able to raise prices for consumers "locked" in previous periods. Before taking advantage of the attached customers, firms are incentivized to win market share in the first period. In this period, the market would be more competitive than a similar market without switching costs because they take into account additional profits from attached customers in following periods (Motta, 2004). For ongoing markets with switching costs, established market players have a degree of market power.

Klemperer (1987) identifies a variety of switching costs. There could be transaction costs in the sense that it is costly to change between mobile service providers. Network connection fees are a prime example of this first category. Learning costs involve the efforts needed to adapt to a new brand of product and artificial costs are switching costs designed by the producing firm. This last category is highly relevant to the mobile market. Providers often promote quad-play service packages or offer discounts to loyal customers (Telecompaper, 2017).

Switching could then be more difficult due to decreased transparency and increased efforts to terminate multiple contracts. If quad-play switching costs lead to dominance of a single provider, foreclosure could occur (Authority for Consumers and Markets, 2017). Mobile operators can also lock subsidized handsets to their own network. Furthermore, communicating a new telephone number and gathering information about other networks are all efforts that amount to switching costs. Although there are regulatory efforts in decreasing switching costs (easier number portability and informative websites on networks), Grzybowski (2004) found that the UK mobile communications market is still charactarized with strong switching costs. A more recent study suggests that while the magnitude of switching costs is higher for small businesses, consumer behaviour is affected by costs associated with switching between providers (Czajkowski & Sobolewski, 2015). Switching costs do not only increase the market power of current providers. Klemperer (1987) argues that they may also deter entry of potential competitors since as most consumers are already "locked-in" by incumbent in previous periods. Entry of additional MNO's is discouraged because it becomes costlier to reach the minimum efficient scale.

As set out in the previous paragraphs, mobile telecommunications markets share characteristics that lead to highly concentrated market structures. Entry is discouraged by entry barriers resulting from economies of scale and can also be deterred by incumbents that raise switching costs or bid strategically during frequency auctions. Consequently, mobile telecommunications markets generally consist of a small number of (often internationally operating) MNO's with significant financial backing. Which exact number of operators will yield the best market outcomes for consumers, will be examined in the following paragraphs.

2.5 The debate on dynamic efficiency

While Motta (2004) shows that the static welfare effect of an additional competitor in the mobile market is not clear-cut, there is also uncertainty if entry is evaluated from a dynamic perspective. In Europe, competition authorities and MNO's are heavily debating the competitive impacts of consolidations and the optimal mobile market structure. Operators plead for more concentrated mobile markets. They argue that competition authorities are wrongfully focusing on the short-term price effects in their merger analyses. Instead, merger assessments should also include the long-term impacts of consolidation on efficiencies and investments (GSMA & Frontier Economics, 2015). In contrast to what competition authorities believe, consolidation could actually improve welfare according to a collection of non-academic studies. The main argument can be summarized as follows: consolidation in the mobile market will lead to higher margins due to economies of scale for MNO's. As MNO's have increased cash flows and profits, they are able to increase their investments to introduce new technologies that increase network capacity, quality and reduces unit costs (e.g. the cost price per MB) (HSBC & Orange, 2014). Ultimately, consumers will benefit from innovations through lower mobile prices and higher quality services. There is a subtle distinction between this argument and the 'regular' justification for consolidation based on economies of scale. In the general economy of scale efficiency defence, consolidation leads to increased efficiency by lowering average costs for the merging firms as they can spread fixed costs over a greater output. There is not necessarily a dynamic aspect, unlike the argument provided by mobile market players.

Competition authorities and the European Commission in particular, disagree with this view on consolidation in the mobile market. They put more weight to the short-term loss of competitive constraints between the merging entities in their analyses and find insufficient proof that higher profits are passed through to consumers through higher investments and ultimately higher quality and lower prices (European Commission, DG Competition, 2014).

Nevertheless, the Commission acknowledges that mobile mergers could yield efficiency gains and will potentially clear mobile mergers if three conditions are met. First of all, consolidation should benefit consumers in the relevant markets (European Commission, 2004). For the mobile market, MNO's should provide convincing evidence that the merger will result in improved network quality, speed, coverage or lower prices. As the Commission notes in the Hutchinson 3G UK / Télefonica UK merger case**,** a reduction in fixed costs is less likely to benefit consumers than a reduction of variable or marginal costs (European Commission DG Competition, 2016). Unlike marginal costs, fixed costs have to be incurred irrespective of the number of units sold. While fixed costs do impact the overall profit levels and possibly the number of competitors in a market, they are not relevant for pricing decisions and consumer prices subsequently. Providers should therefore actively motivate why a reduction in fixed costs would increase consumer welfare. As mentioned before, operators argue that the increase in profits resulting from consolidation enables them to increase investment.

Secondly, the claimed efficiencies should be merger specific according to paragraph 85 of the EU horizontal merger guideline. This means that a merger is much less likely to be cleared if the efficiencies are achievable through other means. Farrell and Shapiro (2001) distinguished efficiency gains in technical efficiencies and synergies. Synergies are merger-specific so that they cannot be achieved without consolidation and require significant changes to production. Technical efficiencies are efficiencies that can also be achieved by other means than merging. This last category is important for the mobile market. The fact that most of the efficiency gains from mobile mergers can also be achieved by network sharing agreements, is an important argument against mergers in the mobile market. Regarding dynamic efficiency claims, the Commission has recently argued that mobile merging parties are unlikely to experience cash flow constraints in absence of the merger (European Commission DG Competition, 2016). Investments in new technologies are not merger specific in this line of reasoning as the parties are able to finance investments on their own, even without further economies of scale. According to the Commission, the introduction of new technologies is thus not restricted without consolidation.

Thirdly, the claimed efficiencies should be verifiable and must offset the potential harm of the merger (European Commission, 2004). Claims that consolidation and improved margins will increase investments in new technologies is often not adequately supported by providers. Multiple EC merger decisions did not approve the providers' claims as the notifying parties had not demonstrated that fixed costs savings would lead improved quality through increased investments. At the same time, there is some empirical indication that mergers lead to increased mobile prices.

All things considered, it seems that the European Commission is not eager to accept dynamic efficiency claims in mobile merger cases. The Commission often doubts that the claimed dynamic efficiencies will be beneficial for

consumers or that the efficiencies are merger specific. Even if the Commission accepts that there are efficiency claims, the question remains whether they can compensate for the short-term loss of competitiveness. The main question regarding the optimal mobile market structure is not explicitly answered by the Commission. Will the short-term price change from a 4-to-3 merger be dominated by the effects of increased long-term investments? Since the Commission does not explicitly considers this trade-off, the next paragraphs will provide an illustration of the effects of changes in market structure.

2.6 Theory on the effects of entry and consolidation in mobile markets

Both the short-term price effect and the long-term investment effect of mergers have been extensively studied in the last decades. For the short-term effect, theory predicts that horizontal mergers tend to raise prices in absence of efficiency gains. Using a fairly standard Cournot model with homogenous goods, Farrell and Shapiro (1990) theoretically showed that mergers between rivalling firms generally have harmful effects for consumer welfare. In their static theoretical framework, considerable economies of scale are required for mergers to have a price decreasing effect. Different and more complicated models with capacity constraints, Bertrand competition or product differentiation confirm this finding (Tirole et al, 2003). The consensus is that a horizontal merger unilaterally increases market power as the merged entity is able to profitably raise prices or decrease quantities. Accordingly, horizontal mergers are likely to have negative impact on consumer surplus and total welfare. This unilateral effect, the ability to exert market power after a merger, does partly depend on the number of competitors. The lower the number of remaining rivals, the higher the market power of the merged entity (Grant, 1991). This should be kept in mind while assessing the mobile markets, because they can only accommodate a small number of operators due to entry barriers. Also, the higher the market shares after the merger, the higher the probability of anticompetitive behaviour. In an extension to the model developed by Farrell and Shapiro, McAfee and Williams (1992) find that mergers that strengthen the market leader, or establish a new leader, always have welfare-reducing effects under elastic demand curves. The finding that the larger the prospective merged firm, the more market power it has (and the lower the consumer welfare), was established in a Cournot setting. The model also suggests that a merger between small operators that leads to a more symmetric market is less likely to harm welfare.

Given the significant role of long-term innovation in the mobile markets, it is essential to determine the connection between competition and investments. There are two opposing classical views on this relationship. According to Schumpeter's theory (1942), large firms in oligopolistic markets are more likely to invest. Schumpeter emphasizes the role of the size of a firm and its financial constraints. He argued that large firms are better able to finance innovative projects than small firms. Moreover, once a firm controls the market, the prospect of entry requires to the monopolist to uphold investments in new technologies as the monopolist has a lot to lose. The monopolist wants to escape the competition because the profit of an efficient monopolist is always greater than the aggregate profit of two uncoordinated duopolists (Gilbert & Newbery, 1982). Furthermore, a firm with market powers will be able to deduct more profits from consumers following a new investment. The monopolist's strong market position increases its return on investments. Arrow (1962) offers a conflicting view. In his theory, a firm in a competitive market has more incentive to innovate than a monopolist due to the possibility of beating the competition. A firm can increase its profits if investments offer future cost or quality advantages in production

relatively to its competitors. Consumers will switch to the firm with the most attractive offer, incentivizing firms to innovate. A monopolist has less incentive to innovate because the monopolist is already serving the entire market. Although the monopolist can improve the quality of its product, the monopolist cannot increase his profits by stealing consumers from its competitors.

2.7 Empirical evidence on the price effects of mobile mergers

The price effects of European mobile market mergers have been evaluated with ambiguous results. The European Commission in cooperation with the Netherlands Authority for Consumers and Markets and the Austrian Regulatory Authority for Broadcasting and Telecommunications (2015) published an ex-post analysis of two mobile telecommunications mergers. Using a difference-in-differences approach, the study suggests that an Austrian mobile merger did not lead to higher prices while mobile prices in the Netherlands did relatively increase following a merger. The two case studies suggest that the effects of mobile mergers depend on the specificities of each case. The number of MNO's after the merger, potential remedies and the competitive constraints between the merging parties are all relevant factors for assessing the merger's impact. The Commission concludes that structural differences between mobile markets across countries create the necessity to evaluate mobile mergers on an individual basis.

A similar study was conducted by Csorba and Pápai (2015). Their research estimated the impact of entries and mergers on mobile voice service prices in Europe between 2003-2010. The difference-in-differences model allows for variance in structural changes between markets. This enables the authors to control for the type of entrant or the nature of the merger. The results are remarkable: the authors found no compelling evidence that entry of a third competitor would decrease mobile voice prices. Contrarily, a fourth MNO does have a negative impact on prices. The study also estimated different effects for local and multinational entrants. While the price-decreasing effect of local operator entries only lasted one year, multinational entries were found to have both a stronger and longer-lasting effect. According to the author, this can be explained by differences in strategy between multinationals and small challengers. Local entrants generally price more aggressively in order to win market share and reach a profitable scale while multinational firms can adopt a more patient approach to reach long-term goals.

In a study conducted on behalf of Telefónica, Affeldt and Nitsche (2014) offer a different perspective. In a cross-country comparison of mobile voice service prices in European markets between 2003 and 2012, they find that "there is no positive relationship between concentration (measured by the number of MNO's) and prices". While the authors employ a variety of robustness checks, their preferred estimation with country fixed effects could still be biased. The identifying assumption of a fixed effect model is that the unobservable differences between countries are time-invariant. Omitted variable bias will still occur if these differences are time-variant. When the model is extended to account for time trends, a significant negative relationship between concentration and mobile prices is estimated, meaning higher concentration gives lower prices. The authors explain this transition by the fact that on average, the concentration across countries has decreased while at the same time, there was a declining trend in costs. Without accounting for this trend, the model will almost always find a negative relationship between concentration and prices.

The Centre on Regulation in Europe (Genakos, Valletti, & Verboven, 2015) also evaluated the structure of mobile markets, using a large database containing data of 33 OECD countries between 2002-2014. The paper first discusses potential endogeneity concerns when analysing the relationship between concentration and prices and between concentration and innovation. For example, unobserved demand or cost shocks may influence both prices and market structure. Also, markets with high fixed costs (like mobile telecommunications markets) are likely to have a limited amount of entries and high prices. A lack of variation in the data then could be a problem in assessing the optimal market structure. Citing other authors (Hall & Harhoff, 2012; Jaffe, 2000), the paper explains that the relationship between competition and innovation could be two-way. Market structure may have an impact on innovation, but reverse causality may also be possible. To address these endogeneity issues, the paper conducts an instrumental variable analysis. The instrumental variable analysis exploits variation in concentration (proxied by the Herfindahl-Hirschman Index) caused by the difference in MTR between the least regulated country and the most regulated country. This is a suitable instrument as this difference is considered random and should not directly affect mobile prices. The results show that concentration in the market, an increase in HHI, has a significant positive effect on prices. On average, a hypothetical 4 to 3 merger in a symmetric mobile market would increase prices by 16.3%, while an increase in the HHI of 10 percentage points would increase prices by 20,37%. Capital expenditures, considered a proxy for investment, also increase by 19.3% at the operator level. The relatively wide 90%- confidence interval (7.9%-24.7%) for the hypothetical merger supports the Commission's view that merger effects are very dependent on a country's market circumstances.

A report by Ofcom (2016) analyses the effect of disruptive MNOs on prices and finds that prices in countries with so-called mavericks are on average about 11 to 12 per cent under the price level in countries without a disruptive MNO. Additionally, prices are about 7% to 9% lower in countries that have one more provider. Both effects combined mean that in countries with four MNOs one of which is a disruptive MNO, prices are 18 to 21 per cent lower compared to countries with three MNOs of which none is a disruptive MNO. This implicates that a four-to-three merger in which a disruptive MNO disappears, would result in a price increase of 22% to 27%.

On behalf of the European Commission, the 5-to-4 merger between T-Mobile and Orange in the UK in 2010 has been evaluated by Lear, DIW Berlin, Analysys Mason (2017). The difference-in-differences model indicates that the prices of mobile services fell (between 2% and 18%) as a result of the merger. Noteworthy is that the decrease in prices was primarily caused by price cuts in the medium and high-ends of the mobile market. The study also suggests that the merger's impact on capex was positive, increasing the level of investments. However, the estimates obtained using the ratio of capex to subscribers are insignificant. An explanation could be the significant growth in subscriber numbers that offset the rise in capex.

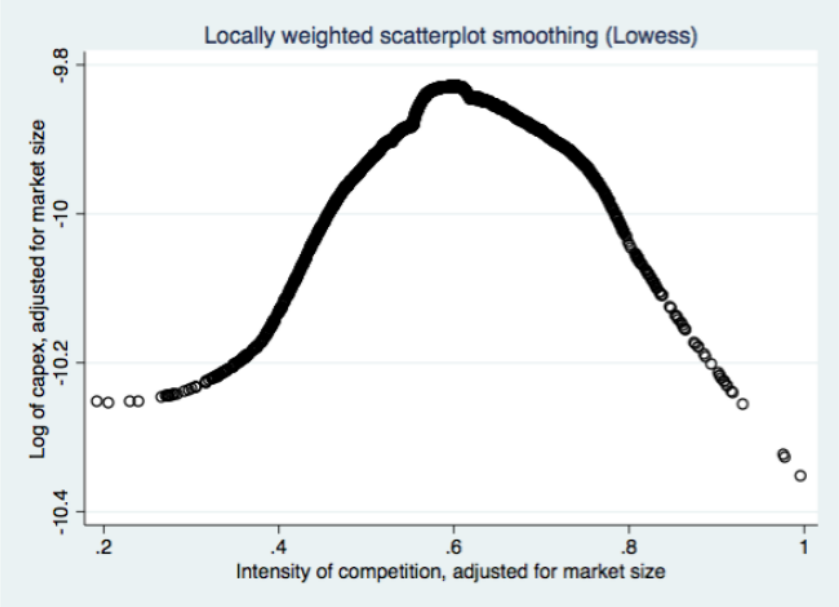
Houngbonon's (2015) analysis of entry and consolidation in France and Austria respectively not only considers static effects. It also sheds lights on potential dynamic effects of changes in the mobile market structure. The author's hypothesis states that "dynamic efficiency effects would dominate static ones if, contrary to the predictions from the static models, entry induces higher prices and the merger leads to lower prices.". The author shows in his theoretical framework that in a dynamic setting, prizes can indeed be increasing in the number of

competitors. The dynamic efficiency effect is dominating the static effect if investment in a new technology is adequately reducing the marginal costs to compensate for the loss of competitive constraints. Product differentiation in the form of investments in new technologies that lower marginal costs is the main form of competition in this framework. Both the size of innovation and investment efficiency are important as they jointly determine the benefits of investing in cost-reducing technologies. The empirical identification strategy used to test the hypothesis involves a difference-in-differences approach. Using a variety of counterfactual markets, the author estimates that entry of a fourth operator in France actually increased data prices. A 4-to-3 merger in Austria was found to have a decreasing effect on mobile data prices. This last result in particular seems interesting because an assessment of a 5-to-4 merger in Austria by the EC cautiously concluded that prices dropped by a small extent relative to countries in the control group.

2.8 Empirical evidence on the relationship between competition and innovation

Although the literature is quite divided on which innovation theory is correct, theoretical work by Belleflame and Vergari (2011) and empirics from Aghion et al (2005) suggest that the relationship between competition and investments might be defined by an inverted U-shape like in figure 2. MNO's agree with this view and argue that mobile telecommunications markets are operating at the right-hand side of the top. Schmutzler (2013), however, argues that the relationship between competition and investments is not necessarily shaped like an inverted U and that the relationship might differ between industries as the relationship is not affected by the level of pre-existing competition in a definite way. Following these findings, Houngbonon and JeanJean (2014) conducted a study in which they empirically evaluate the level of competition that maximizes investments in the mobile market. When they relate the intensity of competition, measured by 1 - the Lerner index (1 – (Pi-Ci) / Pi) to investment (logarithm of CAPEX) they find an inverted U-shaped relationship.

Figure 2



A variety of models (regular OLS, IV-analysis and fixed effects) support the inverted U-shape. From these

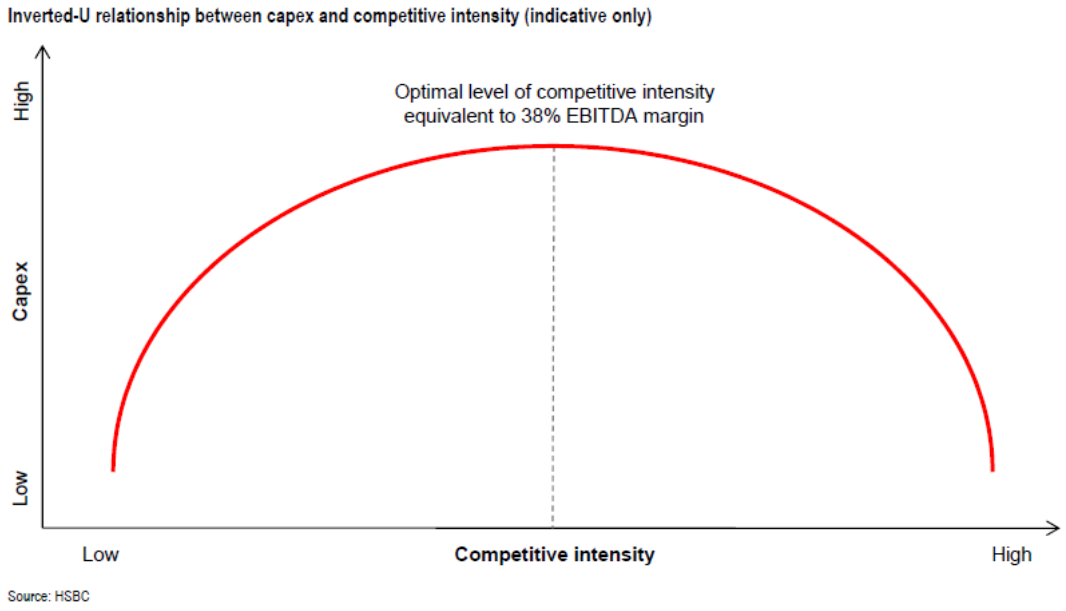
estimations follow that investments are maximized at a competition intensity between 57 and 65%. The intensity of competition is measured on the basis of the Lerner-index at the firm level: $\frac{(1-(P_i-C_i))}{P_i}$. The more competitive the market, the lower the profit margin and the higher the index. Below a competitiveness level of 57%, an increase in competition raises investments, while such an increase would lower investments when the intensity of competition is above 65%.

Additional evidence on the relationship between competition and investments has been provided by non-academic studies. In reaction to the discussion on the optimal mobile market structure, the Global System for Mobile Communications Association (GSMA) published a report criticizing the Commission's merger analyses (GSMA & Frontier Economics, 2015). The report first explains why investments are the most important contributor to consumer benefits in the mobile industry. Besides improving the quality and speed of current services, investments also enable innovation and lead to lower unit prices. Secondly, the report illustrates the frequent technology cycles that characterize the mobile industry. Different generations of technology quickly follow up on each other, as was earlier shown by Amaya and Magee (2008). They estimate an average annual exponential rate of technological progress for wireless data transportation of around 50% since 1970. Thirdly, the report aims to provide evidence that mergers and concentrated markets positively affect investments. To this end, a cross-country analysis was conducted in which the preferred fixed effects model implies that there is no positive effect of competition on investment. If investments in a four-player market are not significantly higher than in a three-player market, there could be an efficiency argument for a more concentrated market. It prevents the duplication of fixed costs as well as higher investments per user. Finally, the report criticizes competitions authorities approach' in estimating price effects of mergers. By using the Gross Upwards Price Pressure Index (GUPPI) analysis, price effects are generally overstated because margins are miscalculated according to the report. Furthermore, GUPPI analyses do not account for capacity constraints nor efficiency effects. The cross-country analysis in the report suggest that there is no clear relation between prices and competitiveness (proxied by HHI). The report therefore concludes that a more concentrated mobile market may in fact be welfare improving, even though mergers may increase mobile prices on the short term.

This view is supported by HSBC in two reports (HSBC & Orange, 2014; HSBC, 2015). The reports imply that European mobile markets are falling behind their US counterparts because they are more divided between competing operators. HSBC is under the impression that "consolidation would produce a healthier European industry able to invest more to provide European citizens with better value-for-money services." (HSBC & Orange, 2014). As was explained earlier in this section, MNO's argue that price decreases are mainly caused by dynamic efficiency gains. In turn, high margins are necessary to support the investments needed to deliver capacity at the lowest marginal cost. Supercollider was the first HSBC study that analysed investments in the mobile telecommunications market. The main message of the report is that investing is vastly more effective at lowering mobile costs than increasing competitiveness. Although the report highlights the correlation between margins and investments or investments and falling unit prices, it does not establish a clear causal effect. The causation between these variables might be reversed or there might be a third omitted variable. For instance, investments could lead to higher margins or the increase in data usage leads to both lower prices and investments. Building on the findings of the Supercollider report, HSBC analyses the impact of mergers on investments in the mobile sector in the

Supersonic report. According to this study, merged entities have both an increased incentive and ability to invest in innovative technologies. The claim is supported by an evaluation of data prices over time in a difference-in-differences model involving the price effect of a merger in Austria. Subsequently, an instrumental variables analysis considers the relationship between competitiveness and investments. From these analyses follow that the relationship between competition and investment is characterized by an inverted-U and that the maximization of investments occurs at competitive levels that correspond with Earnings Before Interest, Taxes, Depreciation and Amortization (EBITDA) margins of 38%. Consolidation should therefore be encouraged as the average European operator currently operates at the right side of the optimal competitive intensity with an EBITDA-margin of 32%.

Figure 3



The evidence of empirical price analyses shows that there is no unequivocal answer to the question whether three, four or five operators is the optimal number of MNO's. Studies conducted by competition authorities generally find negative price effects of 4-to-3 mergers. Contrarily, studies prepared for MNO's find positive or neutral effects of mergers. Additional research is therefore necessary to find out under which circumstances a market with 3 operators is preferred over a market with 4 operators. 5-to-4 mergers are found to have no negative price effects according to the included studies.

3. Data

In order to estimate the effect of Tele2's entry in the mobile telecommunications market, this study relies on a dataset provided by Tarifica. Tarifica is one of the leading providers of telecom pricing information and has served regulators and mobile operators alike for nearly four decades. Since 1997, Tarifica has continuously collected mobile tariff plan details from MNO's in 81 countries to maintain their mobile dataset. Our version of the mobile dataset provides detailed information on more than 42.000 tariff plans across 27 European countries. Tariff plans of virtual operators were not included. Each tariff plan corresponds with an individual online offer that was collected from operators' websites. The data was collected on a quarterly basis between the first quarter of 2012 and the second quarter of 2016, making 18 quarters in total. Each quarter includes the offers of all MNO's in each country for the first two years of the dataset. However, for the years 2014-2016, not all operators are observed in every quarter. There are quarters in which no tariff plans are reported as well as quarters in which only one or two operators' tariff plans are observed. Appendix A shows how the observations are distributed across time and countries.

For each tariff plan, more than 30 (both quantitative and qualitative) characteristics are observed in the dataset. Basic characteristics of each observation include the name of the plan, the provider that offers the plan, the rental fee, the amount of minutes/text messages/data included and whether the plan is a prepaid offer. The dataset also provides more sophisticated information such as connection fees, data throttling and minimum contract lengths. The out-of-bundle costs were also collected for each tariff plan. Furthermore, the dataset distinguishes between offers with and without device as well as bundled offers (fixed telephony, broadband internet or television services). It is important to note that some tariff plans were provided upon special conditions. Although some of these conditions were more relevant for this study than others (for example: there were tariff plans which provided a discount for calls after 18:00 while others provided free music streaming services), they were not considered due to their diversity. It was not possible to account for them in the analyses. A complete description of the variables in the dataset can be found in appendix B.

3.1 Descriptive statistics

To preserve this study's readability, only the monthly rental statistics are displayed in Table 1. The monthly tariff plan fees (including VAT) are displayed in each country's own currency. Considering the standard deviations of monthly mobile prices, we can confirm that there is great diversity in mobile tariff plans. The minimal monthly price is null in every country as the dataset contains prepaid tariff plans. 17,5% of the considered tariff plans fall under this category. Furthermore, 10,8% of all tariff plans included a mobile device. The average price of a tariff plan in the Netherlands was around €32 per month between 2012 and the first half of 2016. The most expensive tariff plan in the data during this period was €152, almost five times the average price. Connection fees ranged between €0-30 and were €13,63 on average.

Table 1

Summary for variables: rental
by categories of: country (country)

country	N	mean	median	min	max	sd
AUT	929	19.04126	15	0	74.9	15.42665
BEL	1179	25.65042	20	0	140	20.47999
BGR	906	20.32316	12.9	0	147.6	23.38222
CZE	1214	719.7801	601	0	4450	593.6776
DEU	1710	38.02274	30	0	200	28.89046
DNK	1001	244.512	199	0	1245	186.6173
ESP	1272	21.85384	18	0	99.9	17.81704
EST	418	13.09592	8.95	0	194.9	18.29951
FIN	1841	22.38349	22.8	0	96.5	13.02349
FRA	2992	42.97948	35	0	3500	94.35433
GBR	5804	29.36594	27	0	79.99	14.89246
GRC	2152	49.93088	35	0	246.5	42.17913
HRV	332	111.5443	55	0	669	138.9557
HUN	1577	7398.172	5390	0	29990	6039.654
IRL	1397	45.54481	40.66	0	106.73	26.2905
ITA	817	26.59113	20	0	150.24	24.42372
LTU	505	34.75511	24	0	300	50.23445
LUX	364	30.87148	25	0	90	24.71324
LVA	226	7.255796	5.55	0	30	6.353449
NLD	7412	32.87914	30	0	152.5	20.04388
NOR	337	287.8813	249	0	1099	218.7887
POL	3080	70.38778	55.45	0	332.7	52.10609
PRT	1151	23.14326	15.9	0	107.11	21.94089
ROU	1000	18.87096	12	0	125	17.67611
SVK	369	22.5474	16	0	135.38	21.45551
SVN	488	16.62082	14.99	0	77	12.67777
SWE	1913	309.0674	249	0	1999	258.3309
Total	42386	348.2594	31	0	29990	1819.239

3.2 Inconsistencies in the dataset

Although the Tarifica database did contain detailed information regarding tariff plans, we did run into some inconsistencies. The dataset was susceptible to typographical errors and required extensive cleaning. This process was supported by the Body of European Regulators for Electronic Communications (BEREC). Members of the regulatory authority were simultaneously working with Tarifica's dataset and provided corrections as well as feedback on the dataset. Since we found flaws in the name and date variables on a regular basis, we do expect the more important variables (rental fees and out of bundle costs for example) to be imperfect as well. While a lot of effort was put into correcting typographical errors, it is not clear if, and to what extent the flaws resulted in alternative outcomes. Additionally, the frequency of observations was rather irregular: the first two years contained observations for all operators in each quarter, but the following years did not. Tariff plans were collected on a (illogical) semi-annual basis instead. For instance, tariff plans were sometimes collected in the second and third quarter for a specific operator while the tariff plans of the country's other operators were collected in the first and fourth quarter. This irregularity enables the possibility of biased estimates if the single-reported operators offers higher or lower prices compared to the other operators.

4. Empirical methodology

This study investigates whether Tele2's entry had a decreasing effect on mobile tariff plan prices in the Netherlands. Directly comparing tariff plan prices is not possible for two reasons. The first reason is that mobile tariff plans are very complex. They usually involve voice, text and data services with complicated non-linear pricing. Tariff plan components also differ significantly across countries. Some tariff plans offer high-speed internet connections while others throttle down if a data threshold is met. Secondly, the price of a single gigabyte of data or a one-minute voice call may depend on several factors. For example, the price may increase if the user is abroad or if the call is between different networks.

4.1 The OECD basket approach

The first empirical approach adopted in this study to account for these complexities is the basket approach used by Kemp & Stil (2016) and OECD (2012). The market is analysed from a demand-side approach, as it starts from a hypothetical consumer's perspective. In this method, three unique baskets (low, medium and high usage profiles) are defined for each country so that prices can be compared for different consumption patterns. Subsequently, for each basket, the price is constructed for each existing tariff plan at a certain point in time. Start-up fees such as handset and connection fees are spread out over the duration of the contract and out of bundle costs are used if tariff plans do not initially offer data. A representative price per country is then determined by taking the average price of the four cheapest tariff plans that are on offer at a specific moment. These representative prices are used as outcome variable in the identification strategy described below and are constructed for every quarter between 2012 and the first half of 2016, making 18 quarters in total.

The basket approach is somewhat controversial due to the possibilities in constructing the baskets. The method provides the researcher with great freedom regarding the basket specifications. One can choose to construct an identical basket for all countries in order to make a direct comparison between countries. Although this may seem logical at first, this would produce biased results as there is great heterogeneity between countries in terms of average usage of mobile services. Different segments of the market would be compared with identical baskets since a tariff plan with 500MB of data would be in the high-end market of countries like the Czech Republic and Belgium, while the same tariff plan would be in the low-end of Scandinavian mobile markets. Equally, a weighted average basket would not reflect all countries' mobile services. Following this intuition, a proper comparison between mobile markets should include country-specific baskets. Another dimension in which the researcher may vary the basket construction is through time. As average data usage has increased by more than tenfold in some European countries over the measurement period (Tefficient, 2017), dynamic baskets over time could be preferred over static baskets. Static baskets will result in biased estimates in the same way as constant baskets across countries. While a tariff plan with 500MB could be high-end in 2012, it may well be positioned in the lower end of the market a few years later. This study assumes that data demand develops identically between countries over time. Using the average growth rate of data demand in European countries, we calculate unique baskets for each country and year. Basket-specifications can be found in appendix C.

Following similar policy evaluation literature, the empirical strategy involves a difference-in-differences analysis. With this approach, the effect of a market entry can be identified by comparing the actual market outcome after entry with the hypothetical market outcome that would have occurred had market entry not have taken place. The hypothetical outcome without entry will have to be estimated because only the actual market outcome with Tele2's entry is observed in the Netherlands. In the difference-in-differences framework, other European mobile market outcomes are used as the counterfactual. In other words: the model compares the price development in the Dutch mobile market before and after Tele2's entry with the (average) price development in other countries where no entry or merger occurred.

The difference-in-differences approach can be utilized when the unobserved factors are time-invariant. Therefore, the common trend assumption is the main identifying assumption of this model. The assumption states that in the absence of the intervention, the change in outcome variable would be equal between the treatment group and the control group. However, there might be initial differences between countries, as long as the difference remains constant over time. For this reason, the study assumes that the baskets for each country have identical data growth rates. Furthermore, applying this assumption to the mobile market setting means that without the entry of Tele2, Dutch mobile market prices should have developed in equal way relative to other European mobile market prices. With parallel trends, the difference-in-differences estimator can estimate an unbiased treatment effect by comparing the change in outcome variable of the treatment group with the change in outcome variable of the control group. While the common trend assumption cannot be formally tested, it is customary practice to compare pre-treatment trends graphically. This is done in appendix D. Similar trends pre-entry may indicate that countries equally affected by unobservable variables**.** Under this assumption, the effect of Tele2's entry can be measured by:

$$Log\ (Price_{bit}) = \beta_0 + \beta_1 T_t + \beta_2 C_i + \beta_3 E_{it>t^e} + \beta_4 GDP_{it} + \beta_5 \log(MTR_{it}) + \varepsilon_{bit} \qquad (1)$$

Where $Log\ (Price_{bit})$ are the log real prices in euros of bundle *b* in country *i* at time *t*. These prices account for differences in value added tax rates and service and connection fees. The fees are spread out over the duration of the contract. $\beta_1 T_t$ and $\beta_2 C_i$ are series of time and country fixed effects respectively. Country fixed effects account for the possibility of different unobservable factors between national mobile markets. Time fixed effects account for price trends. The effect of Tele2's entry is measured by the variable of interest, $\beta_3 E_{it>t^e}$. This dummy will only have value 1 for the Netherlands, in time periods after the moment of entry t^e. Furthermore, two control variables have been included. The model controls for demand shocks by including the real GDP growth rate, $\beta_4 GDP$. Cost developments are captured in the log of Mobile Termination Rates, $\beta_5 \log(MTR)$. The error term, ε_{bit}, is assumed to be independent and identically distributed.

4.2 Hedonic pricing model

An additional approach to estimate the effect of Tele2's entry is offered by Grzybowski et al (2017). The authors assess the impact of competition and regulation on prices of mobile services in France between 2011 and 2014 by analysing more than 1000 unique tariff plans. They adopt a supply-side approach in their analysis because they

start with evaluating actual tariff plans that are offered by operators, instead of considering a hypothetical consumer's demand as defined in baskets (demand-side approach). The study acknowledges the complexity of mobile telecommunications pricing and deals with this problem by employing a hedonic pricing model. Hedonic pricing models can be used to estimate implicit prices of objective product characteristics that can be derived from observed prices of differentiated products and the specific amounts of objective characteristics associated with them (Rosen, 1974). This approach is often used to determine implicit prices within bundled offers, e.g. house prices. By regressing house prices on objective characteristics like the number of bedrooms and m^2, one can measure the implicit price of having a third bedroom for instance. Following Grzybowksi and his co-authors, the impact of tariff plan characteristics on mobile prices can be estimated by the following hedonic price regressions:

$$Price_{it} = \beta_0 + \beta_1 x_{it} + \beta_2 Text_{it} + \beta_3 Min_{it} + \varepsilon_{it} \quad (2)$$

$$\log(Price_{it}) = \beta_0 + \beta_1 x_{it} + \beta_2 \log(Text_{it}) + \beta_3 \log(Min_{it}) + \varepsilon_{it} \quad (3)$$

where $Price_{it}$ represents the price of mobile tariff plan i in quarter t. As with the basket approach, these prices exclude value added taxes and include service and connection fees. The mobile tariff characteristics x_{it} include: (i) dummy variables for data bundles of 250MB, 500MB, 1000MB, 2000MB, 5000MB and 10000MB; (ii) a dummy with value 1 for tariff plans with unlimited voice allowance; (iii) a dummy variable for tariff plans that include a mobile device; (iv) dummy variables for tariff plan contracts with a commitment period of one or two years. The hedonic price regression also includes the amount of text messages, $\beta_2 Text_{it}$, in the tariff plan as well as the number of minutes, $\beta_3 Min_{it}$.

As the standard hedonic pricing model estimates implicit prices for all tariff plans simultaneously, it is susceptible to biases resulting from periodic changes in the market offers. The representativeness of the implicit prices could be affected if the marketed goods change significantly over time. Consumption and tariff structures change over time in dynamic markets like the mobile telecommunications market. Consequently, specific bundles appear or disappear due to changing consumer preferences or technological improvements. The supply of data bundles in particular seems to have evolved between 2012 and 2016. Only 3.9%[3] of all tariff plans in the dataset offered a data bundle exceeding the 2000MB mark in 2012. This market segment amounted to 11.8%[4] three years later. Tariffs plans that offered small data bundles (up to 100MB) were almost completely replaced by larger bundles during these years.

Pakes (2003) shows that to account for the change in offered tariff plans, one can calculate a price index based on a series of hedonic price regressions. To estimate price developments in the market for desktop computers, Pakes runs hedonic price regressions for each available period. If we define $h^t(x)$ as the hedonic function in period t (in the form of equation 3), we can calculate the change in the base period's income that would allow the consumer to buy the good in following periods by:

[3] 461 out of 11865 tariff plans offered a data bundle with at least 2000 megabytes.
[4] 707 out of 6012 tariff plans offered a data bundle with at least 2000 megabytes.

$$h^{t+1}(x_1) - h^t(x_1) \quad (5)$$

This corresponds to the hedonic adjustment to the second period's income of a consumer who purchased x_1 in the first period. This process can be illustrated by a numerical example. Suppose the hedonic pricing model of the last quarter of 2012 calculates a sum of implicit prices of €10 for a mobile tariff plan with 100 minutes/text messages (€5) and 500MB (€5). New bundles with more favourable terms may be introduced in 2013, so that the predicted sum of implicit prices for the same tariff plan is 100 minutes/text messages (€5) and 500MB (€4), €9 in total. The hedonic adjustment between these periods would then be €1 because a consumer could acquire the same mobile tariff with €9. In other words: price effects are measured by considering how the total price of a tariff plan at time t (using the implicit prices of at time t) would differ at time $t+1$ given the newly calculated implicit prices at time $t+1$.

By estimating the hedonic adjustments for all available periods and tariff plans, one can construct a price index by averaging the price change of all tariff plans and relating them to a base period. These price indices are constructed for the Netherlands and control countries, enabling a difference-in-differences model.

$$Price\ index_{it} = \beta_0 + \beta_1 E_{it>t^e} + \beta_2 GDP_{it} + \beta_3 \log(MTR_{it}) + \varepsilon_{bit} \quad (6)$$

Where $Price\ index_{it}$ is the price index in country i and period t, relatively to the price in the base period of that country. The first quarter of 2012 is the base period for all countries. $\beta_1 E_{it>t^e}$ is considered the treatment dummy, taking the value of 1 for the Netherlands in periods after the entry of Tele2. The demand and cost control variables remain unchanged from the OECD basket approach.

5. Results

5.1 The OECD basket approach with all countries

After constructing three baskets for all countries, a variety of regressions were specified to estimate the effect of Tele2's entry. The first estimates compare Dutch mobile telecommunications prices with prices of all countries in the database that did not experience a change in market structure. There were 12 countries where no consolidation or market entry occurred.[5] The second quarter of 2016, being a significant outlier, was excluded from all regression models.

Table 2

VARIABLES	(1) low	(2) medium	(3) high
Mobile termination rate	-0.0503	-0.00967	-0.00206
	(0.0660)	(0.0727)	(0.0811)
Real GDP growth rate	0.0190	-0.0193	-0.00229
	(0.0311)	(0.0326)	(0.0394)
2013	-0.216***	-0.243***	-0.224***
	(0.0679)	(0.0748)	(0.0846)
2014	-0.291***	-0.399***	-0.399***
	(0.0799)	(0.0882)	(0.0992)
2015	-0.432***	-0.527***	-0.550***
	(0.0845)	(0.0931)	(0.105)
2016	-0.512***	-0.608***	-0.557***
	(0.0940)	(0.104)	(0.116)
Treatment effect 2013	0.00863	-0.0546	-0.191
	(0.128)	(0.141)	(0.156)
Constant	3.212***	3.570***	3.723***
	(0.0761)	(0.0842)	(0.0939)
Observations	195	195	190
R-squared	0.373	0.512	0.465
Number of countries	13	13	13
Country FE	YES	YES	YES
Year FE	YES	YES	YES

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 2 shows the results of the first difference-in-differences models. All models included country fixed effects to account for time-invariant heterogeneity between countries and time fixed effects in the form of yearly dummies. Mobile termination rates (as a proxy for cost developments) and real GDP growth rates (as a proxy for demand developments) were also controlled for in each model. Both control variables are insignificant. All year dummies have a significant negative effect on mobile prices. They should be interpreted as follows: for all low-usage baskets, prices in 2013 were on average 21,6% lower than in the base year 2012. Mobile prices were on average 51,2% cheaper for the same category in 2016 relative to the base year. Since the coefficients of the year dummies become more negative over time, they suggest a negative time trend. Mobile prices naturally decrease over time without changes in the mobile market structure. This trend is strongest for the medium-usage basket. Consequently,

[5] These countries are Belgium, Czech Republic, Denmark, Spain, France, Great Britain, Greece, Italy, Norway, Poland, Portugal and Sweden.

the variable of interest becomes insignificant for all usage categories. In this setting, Tele2's entry did not have a significant effect on mobile prices in the Netherlands.

5.2 The OECD basket approach with selected control countries

The next step in the analysis is to select control countries based on a common trend before the treatment. The common trend assumption is tested by assessing plots of basket prices. Based on the similarity of pre-treatment trends from appendix D, four control countries were selected for the low and high usage baskets while 3 control countries were selected for the medium basket. The categories are assessed independently to allow for varying control countries between the low, medium and high-end mobile markets.

Table 3

VARIABLES	(1) low	(2) medium	(3) high
Mobile termination rate	-0.0250	-0.152	0.174*
	(0.119)	(0.140)	(0.0954)
Real GDP growth rate	-0.0601	-0.0543	0.0105
	(0.0648)	(0.0635)	(0.0510)
2013	-0.223*	-0.395***	0.0620
	(0.129)	(0.137)	(0.0954)
2014	-0.332**	-0.670***	-0.0953
	(0.157)	(0.160)	(0.125)
2015	-0.526***	-0.684***	-0.247*
	(0.172)	(0.164)	(0.131)
2016	-0.575**	-0.693***	-0.507**
	(0.242)	(0.196)	(0.208)
Treatment effect 2013	0.107	0.102	-0.447***
	(0.169)	(0.162)	(0.125)
Constant	3.246***	3.749***	3.322***
	(0.150)	(0.137)	(0.108)
Observations	66	57	70
R-squared	0.501	0.658	0.675
Number of countries	5	4	5
Country FE	YES	YES	YES
Year FE	YES	YES	YES

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

The regression results with selected control countries from table 3 are somewhat similar to the results with all countries included. For the low and medium usage baskets, there is no significant effect of Tele2's entry on mobile telecommunications prices in the Netherlands if time fixed effects are included. However, the high usage basket specification stands out. Mobile termination rates are found to have a small positive effect on mobile prices. Two out of the four year dummies are insignificant for the high baskets, indicating that the high-end segment of European mobile markets do not seem to experience the same cost developments as the low and medium-end segments. This could be the result of increasing data bundles as well as the introduction of 4G-bundles. The model estimates a treatment effect that is significant on the 1% level. For the high usage basket, mobile prices dropped by 44,7% in the Netherlands compared to Denmark, Spain, Poland and Sweden. This is a large effect that could be explained by the fact that Tele2 especially targets the high-end part of the market. (Tele2, 2015). Short after

Tele2's large data bundles, T-Mobile responded with its own unlimited tariff plan, offering similar services for €35. The newly introduced tariff plans were significantly cheaper than their predecessors.

While Tele2 obtained frequency licences at the end of 2012, the company did not launch its own 4G-network until 2015. It is therefore conceivable that Tele2 could not effectively compete with Vodafone, KPN and T-Mobile before 2015. To test this hypothesis, the treatment dummy is altered to only take the value of one in the Netherlands from 2015 and onwards.

Table 4

VARIABLES	(1) low	(2) medium	(3) high
Mobile termination rate	0.0646	-0.0341	0.00680
	(0.0936)	(0.0993)	(0.0986)
Real GDP growth rate	-0.0806	-0.0495	0.00389
	(0.0574)	(0.0555)	(0.0608)
2013	-0.122	-0.289***	-0.130
	(0.0970)	(0.0910)	(0.0932)
2014	-0.209*	-0.548***	-0.343***
	(0.118)	(0.106)	(0.122)
2015	-0.325**	-0.497***	-0.464***
	(0.143)	(0.119)	(0.140)
2016	-0.258	-0.482***	-0.400**
	(0.162)	(0.130)	(0.158)
Treatment effect 2015	-0.316**	-0.286**	-0.172
	(0.139)	(0.116)	(0.133)
Constant	3.129***	3.639***	3.495***
	(0.124)	(0.101)	(0.115)
Observations	71	61	75
R-squared	0.544	0.701	0.540
Number of countries	5	4	5
Country FE	YES	YES	YES
Year FE	YES	YES	YES

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 4 suggests that if 2015 is considered the year of entry, most basket prices decreased over time. Out of the three baskets, both the low and medium usage baskets have a significant treatment effect of -31,5% and -28,6% respectively. While both control variables are insignificant, it is important to note that all year dummies are significant at the 5%-level in column 2. Moreover, the explanatory power (measured by R-squared) of the medium basket model trumps the other models, making it the preferred specification of the basket approach.

The OECD basket approach suggests that if the moment of treatment is considered to be in 2015, the low and medium usage baskets experience a price decrease when compared to other European countries. Contrarily, the model only estimates a price decrease for the high usage basket if the treatment effect is assumed from 2013 and onwards. It is important to air some reservations regarding the basket approach despite these findings. The size of the effects are relatively large when compared to other studies. Moreover, the assumption that data demand develops identically across countries may turn out to be invalid. For instance, countries that had low initial demand for mobile data, could have had stronger demand growth than countries with initial demand. This study resorted

to the hedonic pricing model to offset these reservations.

5.3 Hedonic pricing model

The first step of the hedonic pricing methodology is to relate the mobile bundles' characteristics to their prices. This is commonly done by regressing mobile bundle prices to a set of dummies. As was explained in the methodology section, dummies for varied sizes of internet bundles are the most important determinants of mobile prices. The relevance of data bundle sizes can be observed in Table 5. For the Netherlands, adding a 500-megabyte data bundle increases the mobile tariff plan price by 50,3% on average. The same 500-megabyte data bundle increases Italian tariff plan prices with 100,6% on average, further illustrating differences between European mobile markets. Looking at the first column, the hedonic pricing model suggests that contract length is not an important determinant of mobile prices as the dummies for both the one and two-year contracts are insignificant for the Netherlands. Whether the tariff plan includes a device does make a difference: tariff plans with a device are on average 21,9% more expensive than tariff plans without one. The number of minutes and text messages also have a significant positive effect on mobile prices.

Table 5

	(1)	(2)	(3)	(4)
VARIABLES	NLD	GBR	GRC	ITA
250 MB	0.370***	0.125***	0.315***	0.842***
	(0.0168)	(0.0194)	(0.0344)	(0.198)
500 MB	0.503***	0.146***	0.528***	1.006***
	(0.0158)	(0.0206)	(0.0414)	(0.148)
1000 MB	0.611***	0.257***	0.708***	1.218***
	(0.0157)	(0.0192)	(0.0453)	(0.131)
2000 MB	0.774***	0.201***	1.090***	1.335***
	(0.0160)	(0.0242)	(0.0397)	(0.129)
5000 MB	0.871***	0.251***	1.209***	1.378***
	(0.0239)	(0.0277)	(0.0563)	(0.149)
10000 MB	1.156***	0.284***	0.116	1.347***
	(0.0283)	(0.0221)	(0.160)	(0.131)
Minutes	0.117***	0.187***	0.0824***	0.242***
	(0.00371)	(0.00436)	(0.0133)	(0.0347)
Text messages	0.0348***	0.0631***	0.0261**	-0.0124
	(0.00288)	(0.00596)	(0.0115)	(0.0301)
Device included	0.219***	0.157***	0.0504	-0.0684
	(0.0285)	(0.0148)	(0.0378)	(0.164)
1 Year contract	0.0267	0.0504***	0.253***	0.121*
	(0.0233)	(0.0151)	(0.0309)	(0.0656)
2 Year contract	-0.00549	0.285***	0.218***	0.349***
	(0.0233)	(0.0132)	(0.0267)	(0.105)
Constant	1.819***	0.762***	2.316***	-0.519**
	(0.0678)	(0.0550)	(0.115)	(0.216)
Observations	3,935	4,931	1,222	505
R-squared	0.703	0.585	0.791	0.604

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

5.4 Periodic hedonic regressions with all countries

As mobile tariff characteristics may change over time due to market developments (i.e. adjustments in the mobile tariff offers), the previous hedonic pricing model is susceptible for biases if the marketed goods change significantly over time. This problem is bypassed by running hedonic price regression for each individual country and each available period. Following these regressions, the prices of individual tariff plans are predicted for the following period using the implicit prices estimated by the hedonic pricing model for that period and country. The next available quarter is used if the subsequent quarter is missing. Price changes are calculated by considering the difference between the predicted price in the current period and the predicted price of a tariff plan in the following period like the numerical example in section 4.2. Finally, the predicted price changes of all tariff plans are averaged to create a price index. Figure 4 shows the price indices for the Netherlands and all control countries. As discussed in the data section, the dataset does not provide tariff plan information for all quarters of countries. This results in several jumps in price indices. The decrease in mobile prices for the Netherlands in 2015 stands out in particular. Mobile prices decreased by about 25% relatively to 2012 while most other countries had stable price developments, suggesting a negative treatment effect of Tele2's market entry on mobile prices.

Figure 4 indicates that mobile prices have generally decreased in Europe between 2012 and 2016. Furthermore, there is a clear indication that price developments are different between countries even without Tele2's entry. For example, in 2012, mobile prices have decreased in Portugal and Sweden while they remained constant in the Netherlands. Based on the plots in appendix E, four to six countries are selected as control countries for the difference-in-differences analysis. Note that due to notable jumps in prices between the first and second quarter of 2012, the price indices are constructed from the second quarter and onwards. Table 6 contains the results of the price index difference-in-differences analysis with all control countries included.

Figure 4

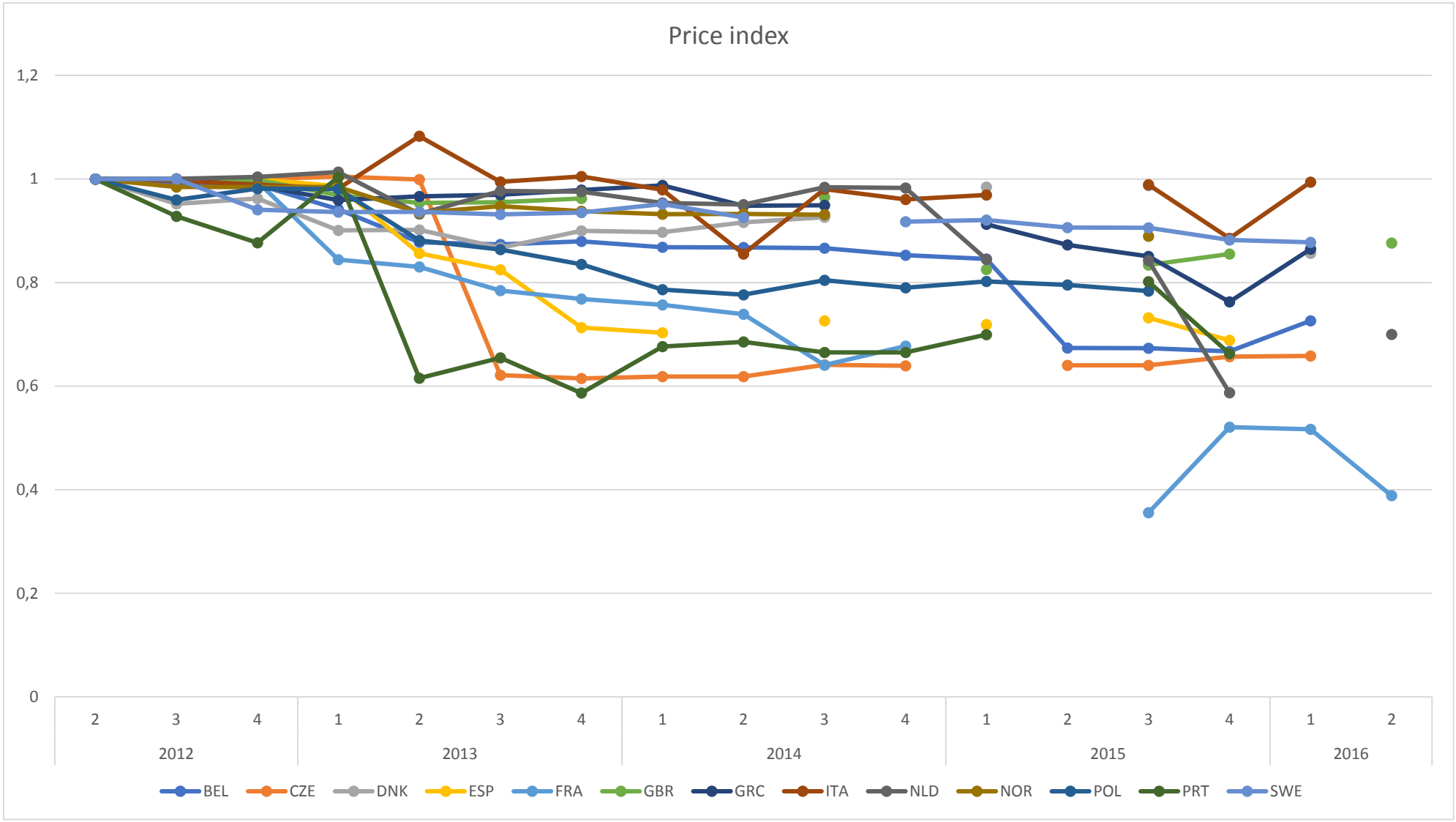

Price index
1,2
1
0,8
0,6
0,4
0,2
0
2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2
2012 2013 2014 2015 2016
BEL CZE DNK ESP FRA GBR GRC ITA NLD NOR POL PRT SWE

Table 6

VARIABLES	(1) 2013	(2) 2015
Mobile termination rate	0.0172	0.0311
	(0.0308)	(0.0287)
Real GDP growth rate	-0.0179	-0.0175
	(0.0131)	(0.0128)
2013	-0.0698**	-0.0570**
	(0.0302)	(0.0275)
2014	-0.117***	-0.102***
	(0.0357)	(0.0325)
2015	-0.172***	-0.146***
	(0.0379)	(0.0353)
2016	-0.216***	-0.188***
	(0.0427)	(0.0404)
Treatment effect 2013	0.0361	
	(0.0599)	
Treatment effect 2015		-0.126**
		(0.0508)
Constant	0.962***	0.947***
	(0.0344)	(0.0325)
Observations	182	182
R-squared	0.480	0.498
Number of countries	13	13
Country FE	YES	YES
Time FE	YES	YES

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 6 confirms the negative trend over time that was found in the basket analysis. Compared to the base year 2012, mobile prices decreased by approximately 6,5% in 2013. The price decrease was around 20% in 2016. The treatment variable is only significant if we consider 2015 as the year in which Tele2 starts to compete effectively. Column 2 suggests that due to the launch of Tele2's 4G-network in 2015, mobile prices dropped by 12,6% on average relatively to other European countries in the period from 1 January 2015 to 1 July 2016. The control variables are insignificant in both specifications, indicating that mobile termination rates and demand developments are no important indicators for mobile prices.

5.5 Periodic hedonic regressions with selected countries

Table 7 contains the regression results if mobile prices from the Netherlands are compared with those of the selected control countries. The control countries are different between the regression models and are selected on the plots found in Appendix E. For the specification in which 2013 is considered the treatment year, the model estimates no significant effect of Tele2's entry relative to the four control countries. The mobile termination rate control variable suggests that an increase in termination rates would result in slightly higher mobile prices. Additionally, the time fixed effects are insignificant in the first model. This is different in the model in which 2015 is considered the year of treatment. While the control variables are not affecting mobile prices, all year dummies are significant on the 5% confidence level. The treatment effect of Tele2's entry is estimated at -14,3% in this model. Being significant at the 1% confidence level, we find the size of the effect plausible considering other

empirical analyses that evaluated 4-to-3 mergers. More importantly, the hedonic model is not dependent on the assumption that data demand develops identically across European countries, because the model estimates price changes based on periodical implicit prices of data bundles.

Table 7

VARIABLES	(1) 2013	(2) 2015
Mobile termination rate	0.157***	-0.00140
	(0.0520)	(0.0222)
Real GDP growth rate	-0.0210	0.00332
	(0.0256)	(0.00799)
2013	0.0613	-0.0378**
	(0.0537)	(0.0186)
2014	0.0312	-0.0481**
	(0.0658)	(0.0228)
2015	-0.00596	-0.123***
	(0.0721)	(0.0267)
2016	-0.0293	-0.132***
	(0.0815)	(0.0294)
Treatment effect 2013	-0.0714	
	(0.0733)	
Treatment effect 2015		-0.143***
		(0.0264)
Constant	0.795***	0.996***
	(0.0648)	(0.0254)
Observations	68	68
R-squared	0.553	0.763
Number of countries	5	5
Country FE	YES	YES
Time FE	YES	YES

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

6. Conclusion

This study has assessed the effect of Tele2's entry on mobile telecommunications prices in the Netherlands. From a consumer's perspective, a fourth mobile network operator would be very desirable as economic theory implies that a market's competitiveness is enhanced by the number of players. Lower prices in addition to the introduction of new services will improve the market's efficiency and promote consumer welfare. The European Commission supports this view: mobile mergers often require remedies or are disapproved due to antitrust concerns.

Contrarily, there is a collection of studies that recommends more concentrated mobile market structures. While market characteristics certainly prevent mobile telecommunications markets to be perfectly competitive, the authors advocate 5-to-4 and 4-to-3 consolidations. They argue that new communication techniques are the driving factor for higher quality products and lower consumer prices. Furthermore, these studies put forward the argument that mobile telecommunications providers are better able to invest in innovative technologies if they operate in more concentrated markets. If they compete fiercely with each other, innovative technologies would be introduced at a slower rate, harming dynamic efficiency.

To evaluate these opposing views, this study exploited the decision of the Dutch government to reserve frequency licences for a fourth mobile operator. By comparing the development of mobile market prices before and after Tele2's entry in the Netherlands with other European countries, we were able to evaluate the effect of Tele2's entry. The size of the effect was estimated by two difference-in-differences models. The preferred specification involved a hedonic pricing model and found that mobile prices decreased by 14,3% compared to the control countries. The OECD basket analyses suggest that the price decrease was not uniform across the low, medium and high usage segments of the market. The high usage segment had a relatively strong treatment effect starting in 2013. Given that Tele2 was the first operator to introduce attractive 4G-tariff plans with large data bundles, this result appears reasonable. Reserving frequency licences for a fourth MNO thus seems a good decision by the Dutch government. Countries comparable to the Netherlands with three MNO's may want to consider implementing a similar policy to encourage entry.

While we do find that the entry of Tele2 has decreased mobile market prices, it is important to mention the circumstances in which the estimates were obtained. As set out in the data section, there were some flaws in the dataset. Data collection was inconsistent, resulting in some quarters with no or few observations. A recommendation for future research would therefore be to construct a more suitable dataset that contains information on all MNO (and possibly MVNO) tariff plans in each quarter as this will improve the reliability of both the basket and hedonic pricing approach. Including quality aspects of mobile tariff plans could also offer an additional perspective. Controlling for any biases caused by diverging levels of mobile service qualities is something we were not able to do with our dataset. Nonetheless, it may prove difficult to control for the quality of a provider's network and services. Another aspect that this study slightly overlooked was the effect of market entry on long term dynamics. As argued by mobile operators, investments and dynamic efficiency could decrease mobile prices on the long term. Extending the timespan and considering investment levels could thus add a useful insight for further analyses.

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Appendix A: Distribution of observations (operators)

	2012				2013				2014			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
BEL	132 (3)	92 (3)	96 (3)	98 (3)	82 (3)	84 (3)	84 (3)	99 (3)	91 (4)	39 (4)	44 (3)	71 (3)
CZE	51 (3)	70 (3)	72 (3)	66 (3)	66 (3)	76 (3)	75 (3)	83 (3)	176 (3)	175 (3)	31 (2)	
DNK	54 (4)	62 (4)	55 (4)	56 (4)	54 (4)	48 (4)	61 (4)	45 (4)	53 (4)	103 (4)		84 (4)
ESP	78 (4)	86 (4)	87 (4)	92 (4)	67 (4)	58 (4)	71 (4)	37 (4)		42 (4)		217 (4)
FRA	412 (3)	430 (3)	444 (3)	346 (3)	208 (3)	187 (3)	179 (3)	167 (3)	159 (3)	154 (3)	61 (1)	
GBR	405 (5)	594 (5)	515 (5)	507 (5)	450 (5)	511 (5)	539 (5)	415 (5)		216 (3)		251 (4)
GRC	108 (3)	129 (3)	95 (3)	97 (3)	112 (3)	128 (3)	89 (3)	98 (3)	54 (3)	110 (3)		224 (3)
ITA	62 (4)	70 (4)	70 (4)	59 (4)	55 (4)	50 (4)	46 (4)	51 (4)	51 (4)	19 (1)	13 (1)	45 (2)
NLD	62 (4)	420 (3)	304 (3)	252 (3)	245 (3)	268 (3)	445 (3)	681 (3)	1066 (4)	855 (3)	635 (4)	366 (4)
NOR	13 (1)	14 (1)	14 (1)	14 (1)	14 (1)	12 (1)	12 (1)	11 (1)	38 (1)	48 (2)	45 (2)	
POL	247 (3)	254 (3)	316 (3)	185 (3)	254 (3)	240 (4)	447 (4)	221 (3)	140 (3)	99 (3)	126 (3)	104 (2)
PRT	62 (3)	62 (3)	82 (3)	82 (3)	76 (3)	56 (3)	62 (3)	72 (3)	64 (3)	77 (3)	79 (3)	79 (3)
SWE	95 (4)	81 (4)	114 (4)	115 (4)	96 (4)	82 (4)	120 (4)	109 (4)	99 (4)		216 (3)	101 (3)

	2015				2016		
	Q1	Q2	Q3	Q4	Q1	Q2	Total
BEL	67 (3)	10 (2)	14 (2)	33 (2)	43 (3)		1179
CZE	67 (3)	36 (2)	36 (2)	60 (2)		74 (3)	1214
DNK		142 (4)		142 (4)		42 (4)	1001
ESP		211 (4)	158 (4)			46 (4)	1272
FRA		132 (3)	18 (2)	43 (2)	33 (2)	19 (2)	2992
GBR		401 (4)	297 (4)		309 (2)	394 (4)	5804
GRC	90 (1)	234 (3)	235 (3)	44 (1)		305 (3)	2152
ITA		97 (4)	17 (1)	14 (1)		98 (3)	817
NLD		739 (4)	680 (4)		45 (2)	123 (3)	7412
NOR		39 (2)	18 (2)		27 (1)	18 (1)	337
POL	81 (2)	108 (4)	108 (4)		40 (1)	110 (3)	3080
PRT		64 (3)	106 (3)		128 (3)		1151
SWE	152 (4)	146 (3)	202 (4)	98 (3)		87 (4)	1913

Appendix B: Description of variables

Name of the variable	Data type	Explanation/Example
id	Integer	A unique identifier for each tariff/date combination in the data base.
operator_name	String	The name of the operator under which this tariff is offered (e.g. Proximus).
operator_type	String	"MNO" or "MVNO"
MVNO_network_provider	String	The name of the network provider which the MVNO uses to offer this tariff.
brand_name	String	The name of the (sub-)brand, under which the tariff is offered (e.g. Smart+).
plan_name	String	The name of the tariff in question (e.g. Smart+ 15).
tariff_id	Integer	A unique identifier for each tariff plan by name of the tariff (plan_name); i.e.: per date, there can be only one tariff with the same tariff_id, but across dates, there can be more than one tariff with the same tariff_id (e.g. Smart+ 15 has the ID 1 for Q2 and Q3/2012; Smart+ 30 has the ID 2 for Q2 and Q3/2012).
country	String	The country name for each tariff according to the uniform spelling or country codes used by the EU5 (e.g. BE, UK,…).
operator_identifier	String	A unique identifier of the brand-country combination (e.g. proximus_belgium).
date_qq_yyyy	Date (qqyyyy)	The date, at which this tariff was offered in the market (e.g. Q12013).
currency	String	The currency of all the tariff elements (e. g. Euro).
VAT	Decimal* or percentage	Percentage of VAT in the country (e.g. 0.21 or 21%).
VAT_included	Boolean	If 1, the VAT has been added to all the prices in that tariff scheme (e.g. a net price of 10€ would be 12.1€ if the VAT is 21%).
prepaid	Boolean	If 1, this tariff is offered as prepaid tariff.
rental	Decimal*	Monthly rental for this tariff. If the monthly rental for a tariff varies over time, the monthly rental has to be calculated as the monthly mean over a two year period.
service_fee	Decimal*	All fees that are paid regularly on a yearly basis.
connection_fee	Decimal*	All one-time fees that are typically paid at the beginning of a contract; not discounted.
incl_min	Integer	Number of minutes included in this tariff that can be used for calls in any national network (i.e. calls on-net, off-net and to fixed networks).**
incl_min_onnet	Integer	Number of minutes included in this tariff that can be used only for national mobile on-net calls.**
incl_min_offnet	Integer	Number of minutes included in this tariff that can be used only for national mobile off-net calls.**
incl_min_fixed	Integer	Number of minutes included in this tariff that can be used only for national calls to fixed networks.**
incl_sms	Integer	Number of SMS included in this tariff that can be used for both, on-net and off-net usage.**
incl_sms_onnet	Integer	Number of SMS included in this tariff that can be only used for on-net usage.**
incl_data	Integer in MByte	Data allowance included in this tariff including data allowance with throttled speed (i.e. 2 GByte at full speed and unlimited GByte at throttled speed -> this value is 10,000).**

incl_data_throttling	Integer in MByte	Maximum full speed data allowance, after which some kind of throttling comes in. This value is zero, if there is no throttling or no data allowance is included in this tariff (e.g. 2 GByte at full speed and unlimited GByte at throttled speed -> this value is 2,048).
data_fee	Decimal*	The fee a consumer has to pay for the consumption of an extra 1 Mbyte of data not included in the data package.
allowance	Decimal*	Monetary allowance that is included in this tariff and can be used by the consumer for minutes/SMS and data per Mbyte (e.g. a tariff with 10€ rental and 10€ allowance means that the consumer pays 10€ per month and does not pay extra money for the first 10€ they consume with minutes/SMS/data).
incl_units	Integer	Allowance of units that can be used for different categories of usage as defined by the three Decimal values below. (E.g. a package with 1000 minutes OR SMS)
incl_units_min	Decimal*	If 0, the included units (specified under incl_units) cannot be used for calls. If > 0, the given amount provides how many units are subtracted from the allowance for one call minute.
incl_units_sms	Decimal*	If 0, the included units (specified under incl_units) cannot be used for SMS. If > 0, the given amount provides how many units are subtracted from the allowance for one SMS.
incl_units_data	Decimal*	If 0, the included units (specified under incl_units) cannot be used for data. If > 0, the given amount provides how many units are subtracted from the allowance for one MByte.
minimum_revenue	Decimal*	If this is greater than zero, then a consumer has to spend at least that amount per month (even if they do not make any calls/send any SMS/consume any data) in the given month.
call_fee_onnet	Decimal*	The fee a consumer has to pay per minute for a national mobile on-net call.
call_fee_offnet	Decimal*	The fee a consumer has to pay per minute for a national mobile off-net call.
call_fee_fixed	Decimal*	The fee a consumer has to pay per minute for a national call to a fixed network.
call_connection_fee	Decimal*	Fee that has to be paid once for each call initiation.
special_tariff	String (Enumerator)	This tariff is only offered for a special group; can be either “youth”, “elderly”, “physically_challenged” (for instance deaf) or “other”.
sms_fee_onnet	Decimal*	The fee a consumer has to pay for one SMS on the same national network.
sms_fee_offnet	Decimal*	The fee a consumer has to pay for one SMS to another national network.
incl_device	Boolean	If 1, in this plan, the purchase of a handheld is included. If 0, this tariff is a sim-only tariff.

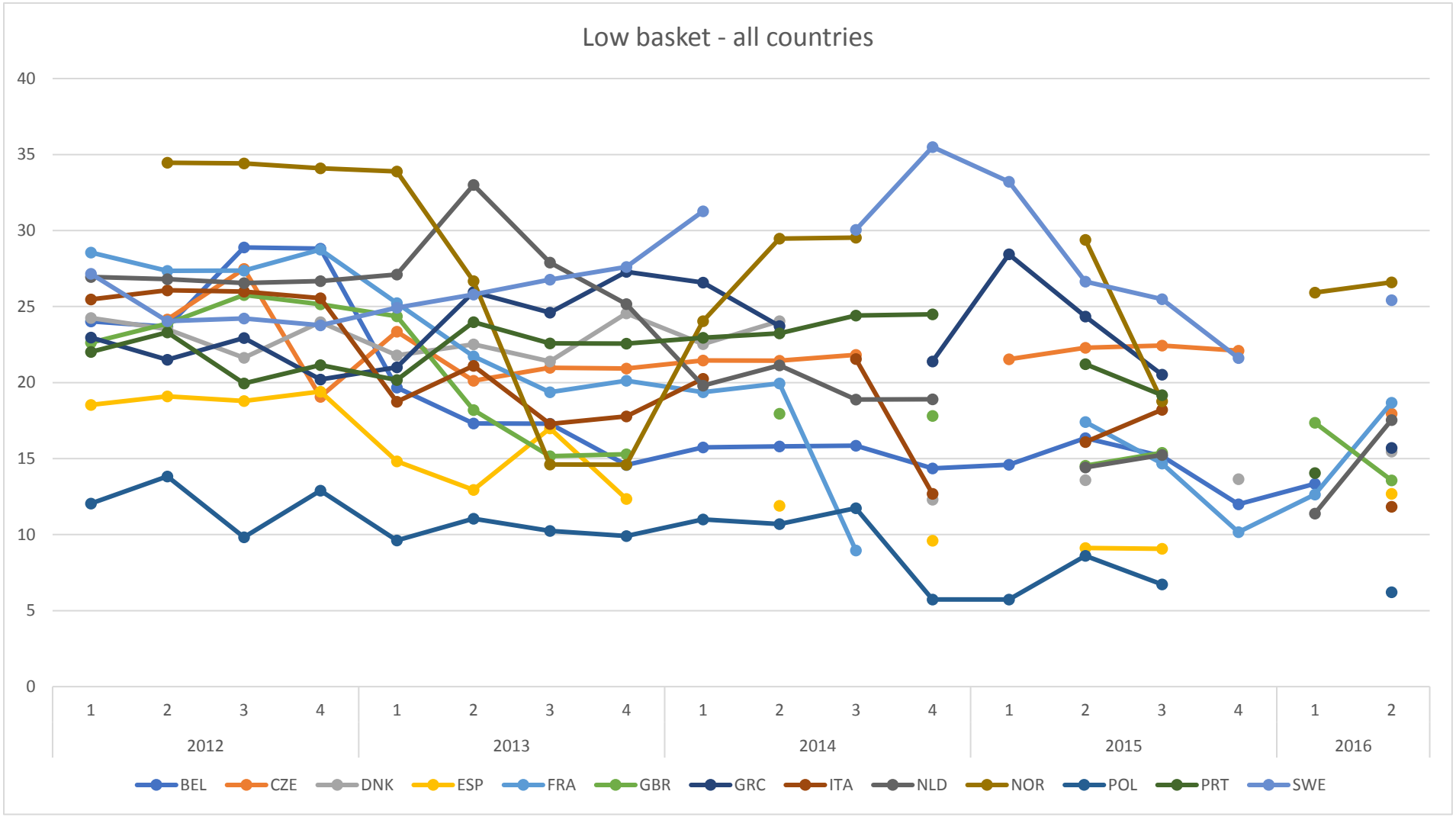
Appendix C: Basket specifications

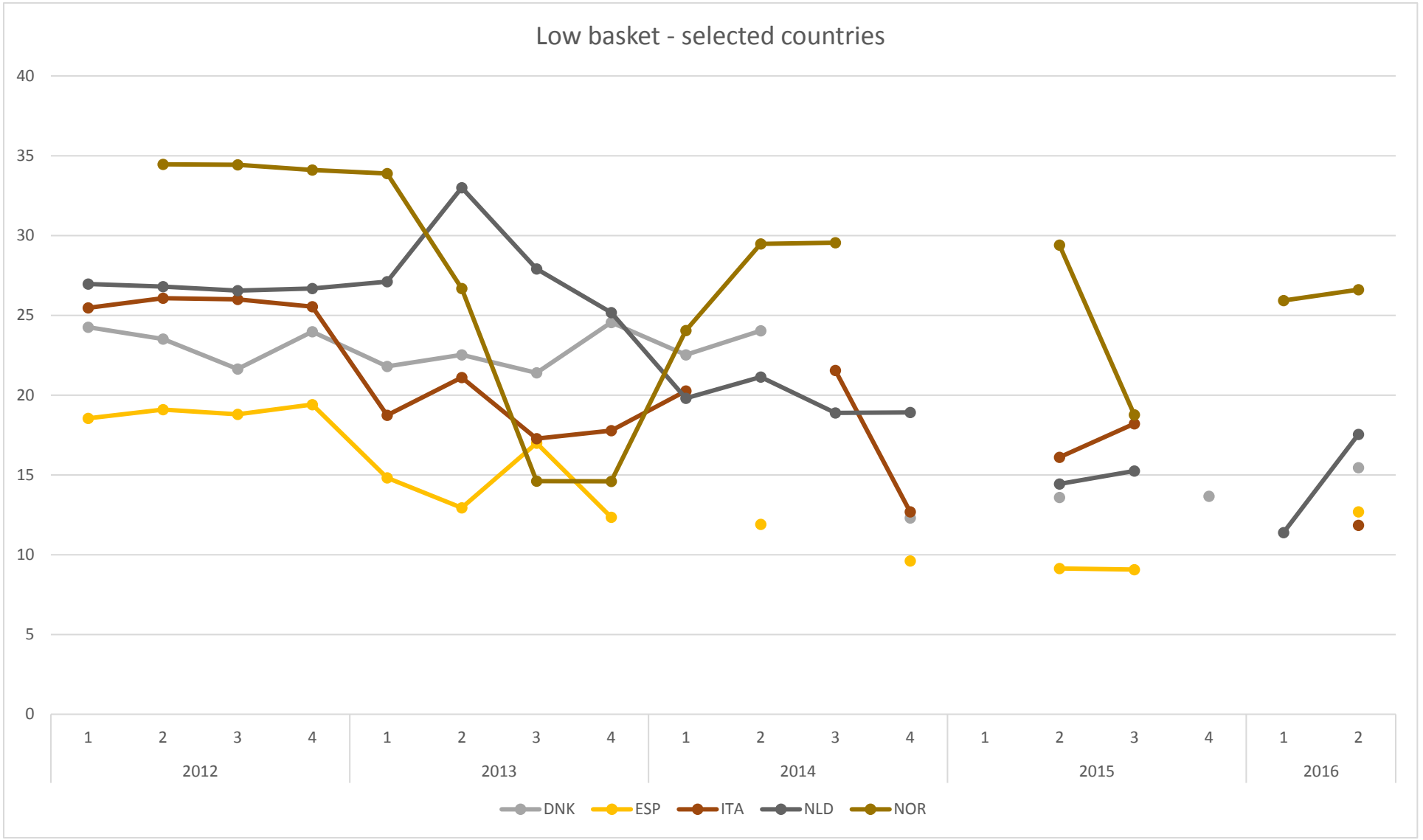
Country	Year	Low SMS	Low minutes	Low data	Medium SMS	Medium minutes	Medium data	High SMS	High minutes	High data
BEL	2012	88	51	40,9969325	176	102	81,993865	264	153	122,990798
BEL	2013	88	51	67,5	176	102	135	264	153	202,5
BEL	2014	83	52,5	80	166	105	160	249	157,5	240
BEL	2015	83	52,5	131,717172	166	105	263,434343	249	157,5	395,151515
BEL	2016	83	52,5	216,867667	166	105	433,735333	249	157,5	650,603
CZE	2012	27	55,5	41,6042945	54	111	83,208589	81	166,5	124,812883
CZE	2013	27	55,5	68,5	54	111	137	81	166,5	205,5
CZE	2014	27	65,5	90,5	54	131	181	81	196,5	271,5
CZE	2015	27	65,5	149,005051	54	131	298,010101	81	196,5	447,015152
CZE	2016	27	65,5	245,331548	54	131	490,663096	81	196,5	735,994643
DNK	2012	49	63	221,990798	98	126	443,981595	147	189	665,972393
DNK	2013	49	63	365,5	98	126	731	147	189	1096,5
DNK	2014	44	66	616	88	132	1232	132	198	1848
DNK	2015	44	66	1014,22222	88	132	2028,44444	132	198	3042,66667
DNK	2016	44	66	1669,88103	88	132	3339,76207	132	198	5009,6431
ESP	2012	3	55,5	68,9355828	6	111	137,871166	9	166,5	206,806748
ESP	2013	3	55,5	113,5	6	111	227	9	166,5	340,5
ESP	2014	2	63,5	167,5	4	127	335	6	190,5	502,5
ESP	2015	2	63,5	275,782828	4	127	551,565657	6	190,5	827,348485
ESP	2016	2	63,5	454,066677	4	127	908,133354	6	190,5	1362,20003
FRA	2012	114,5	81,5	58,6104294	229	163	117,220859	343,5	244,5	175,831288
FRA	2013	114,5	81,5	96,5	229	163	193	343,5	244,5	289,5
FRA	2014	121,5	90,5	196,5	243	181	393	364,5	271,5	589,5
FRA	2015	121,5	90,5	323,530303	243	181	647,060606	364,5	271,5	970,590909
FRA	2016	121,5	90,5	532,681206	243	181	1065,36241	364,5	271,5	1598,04362

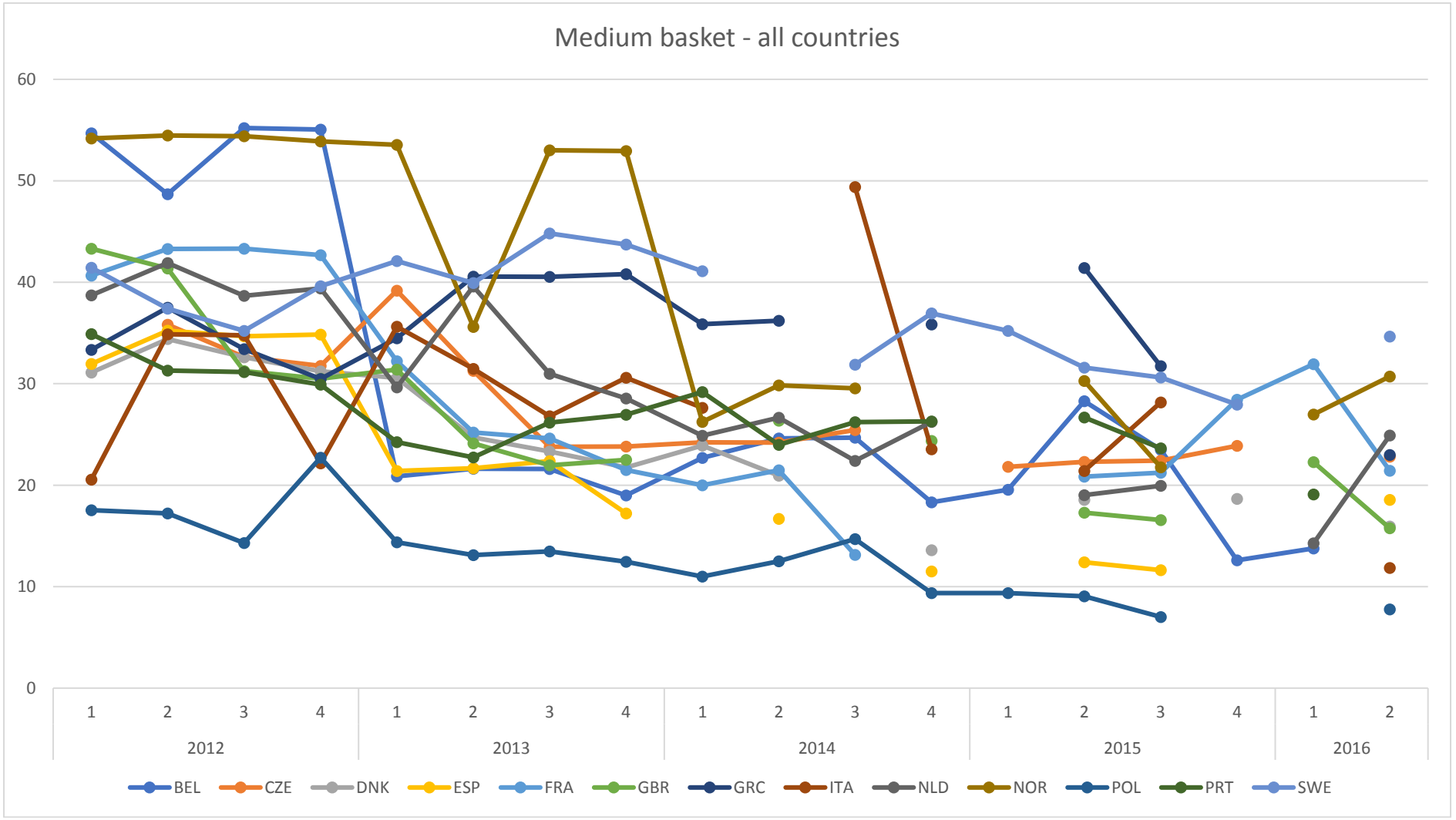
GBR	2012	65	67,5	91,4079755	130	135	182,815951	195	202,5	274,223926
GBR	2013	65	67,5	150,5	130	135	301	195	202,5	451,5
GBR	2014	55	69	240,8	110	138	481,6	165	207	722,4
GBR	2015	55	69	396,468687	110	138	792,937374	165	207	1189,40606
GBR	2016	55	69	652,771676	110	138	1305,54335	165	207	1958,31503
GRC	2012	17	79	19,1319018	34	158	38,2638037	51	237	57,3957055
GRC	2013	17	79	31,5	34	158	63	51	237	94,5
GRC	2014	15	90	69	30	180	138	45	270	207
GRC	2015	15	90	113,606061	30	180	227,212121	45	270	340,818182
GRC	2016	15	90	187,048362	30	180	374,096725	45	270	561,145087
ITA	2012	32,5	67,5	91,7116564	65	135	183,423313	97,5	202,5	275,134969
ITA	2013	32,5	67,5	151	65	135	302	97,5	202,5	453
ITA	2014	20,5	72,5	223,5	41	145	447	61,5	217,5	670,5
ITA	2015	20,5	72,5	367,984848	41	145	735,969697	61,5	217,5	1103,95455
ITA	2016	20,5	72,5	605,874043	41	145	1211,74809	61,5	217,5	1817,62213
NOR	2012	37,5	81,5	143,337423	75	163	286,674847	112,5	244,5	430,01227
NOR	2013	37,5	81,5	236	75	163	472	112,5	244,5	708
NOR	2014	39,5	86,5	422	79	173	844	118,5	259,5	1266
NOR	2015	39,5	86,5	694,808081	79	173	1389,61616	118,5	259,5	2084,42424
NOR	2016	39,5	86,5	1143,97694	79	173	2287,95388	118,5	259,5	3431,93082
NLD	2012	8,5	53	47,7710678	17	106	95,5421356	25,5	159	143,313203
NLD	2013	8,5	53	78,6533742	17	106	157,306748	25,5	159	235,960123
NLD	2014	8,5	53	129,5	17	106	259	25,5	159	388,5
NLD	2015	8,5	53	213,217172	17	106	426,434343	25,5	159	639,651515
NLD	2016	8,5	53	351,054535	17	106	702,109071	25,5	159	1053,16361
POL	2012	35,5	51,5	53,1441718	71	103	106,288344	106,5	154,5	159,432515
POL	2013	35,5	51,5	87,5	71	103	175	106,5	154,5	262,5
POL	2014	38	61	190,5	76	122	381	114	183	571,5
POL	2015	38	61	313,651515	76	122	627,30303	114	183	940,954545

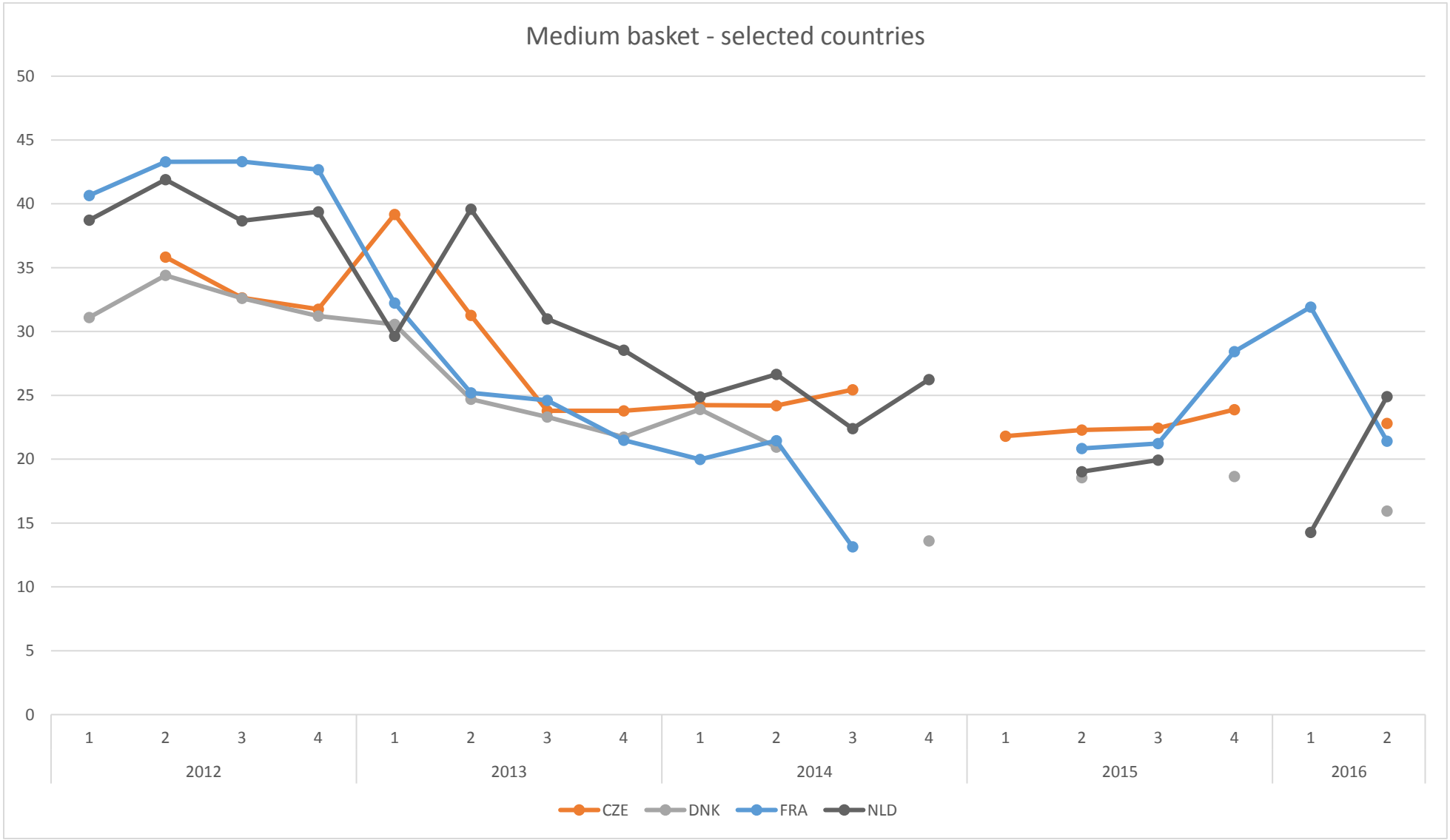
POL	2016	38	61	516,416131	76	122	1032,83226	114	183	1549,24839
PRT	2012	86	71	23,3834356	172	142	46,7668712	258	213	70,1503067
PRT	2013	86	71	38,5	172	142	77	258	213	115,5
PRT	2014	61,5	62,5	151,5	123	125	303	184,5	187,5	454,5
PRT	2015	61,5	62,5	249,439394	123	125	498,878788	184,5	187,5	748,318182
PRT	2016	61,5	62,5	410,693144	123	125	821,386287	184,5	187,5	1232,07943
SWE	2012	42	74,5	505,021472	84	149	1010,04294	126	223,5	1515,06442
SWE	2013	42	74,5	831,5	84	149	1663	126	223,5	2494,5
SWE	2014	38,5	79	1106	77	158	2212	115,5	237	3318
SWE	2015	38,5	79	1820,9899	77	158	3641,9798	115,5	237	5462,9697
SWE	2016	38,5	79	2998,19549	77	158	5996,39098	115,5	237	8994,58647

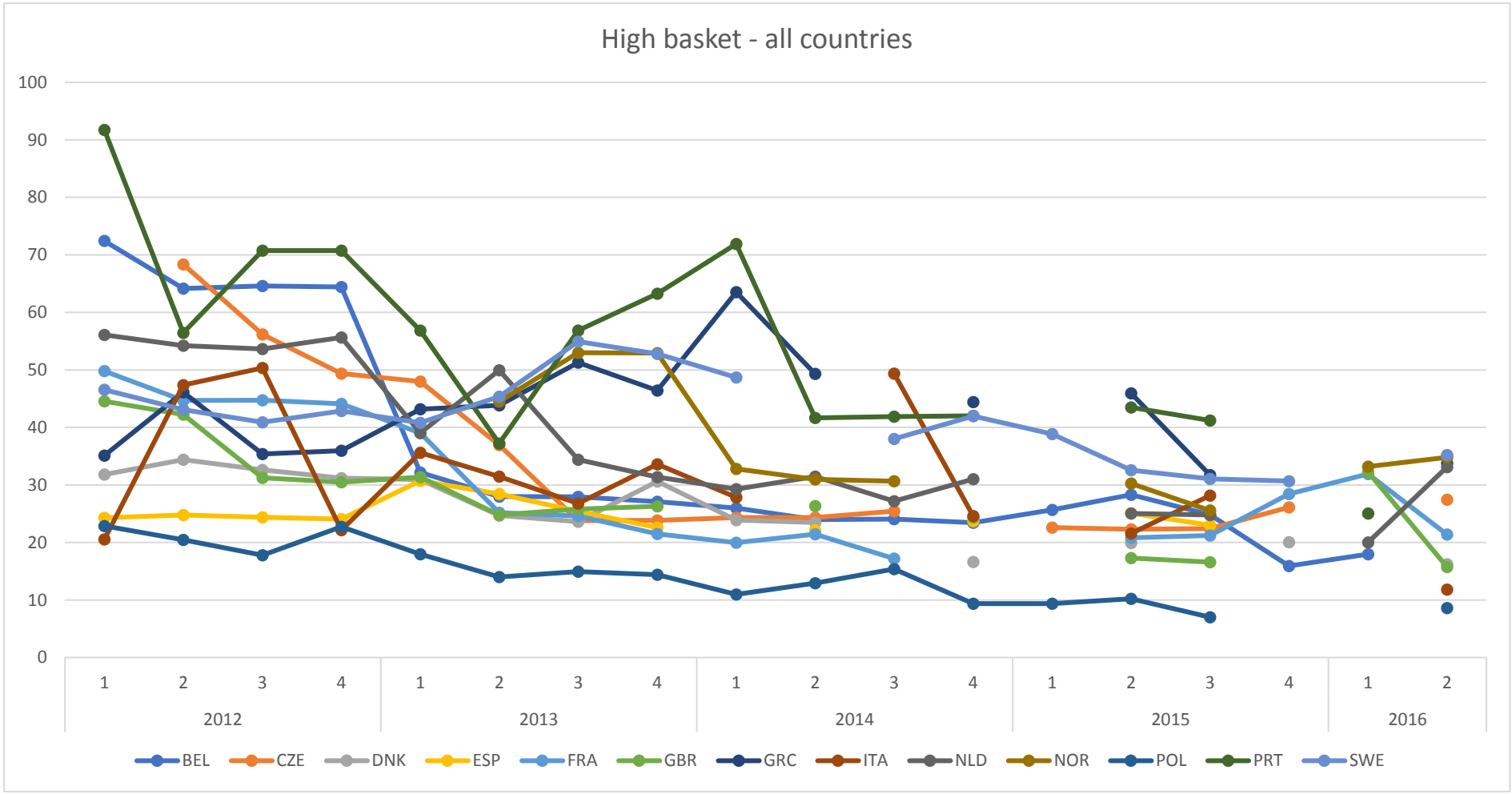
Appendix D: Basket plots

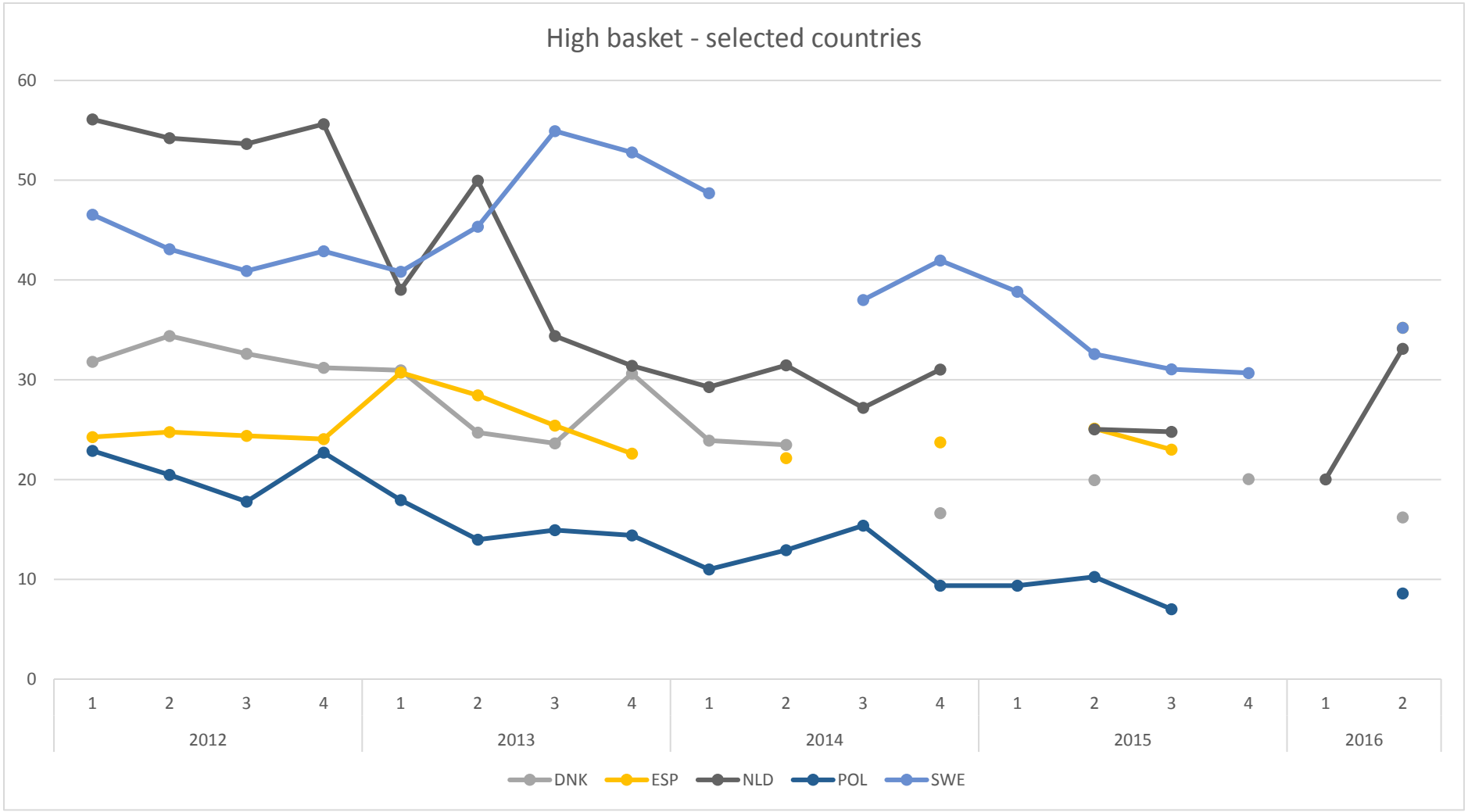



Low basket - selected countries
40
35
30
25
20
15
10
5
0
1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2
2012
2013
2014
2015
2016
DNK
ESP
ITA
NLD
NOR

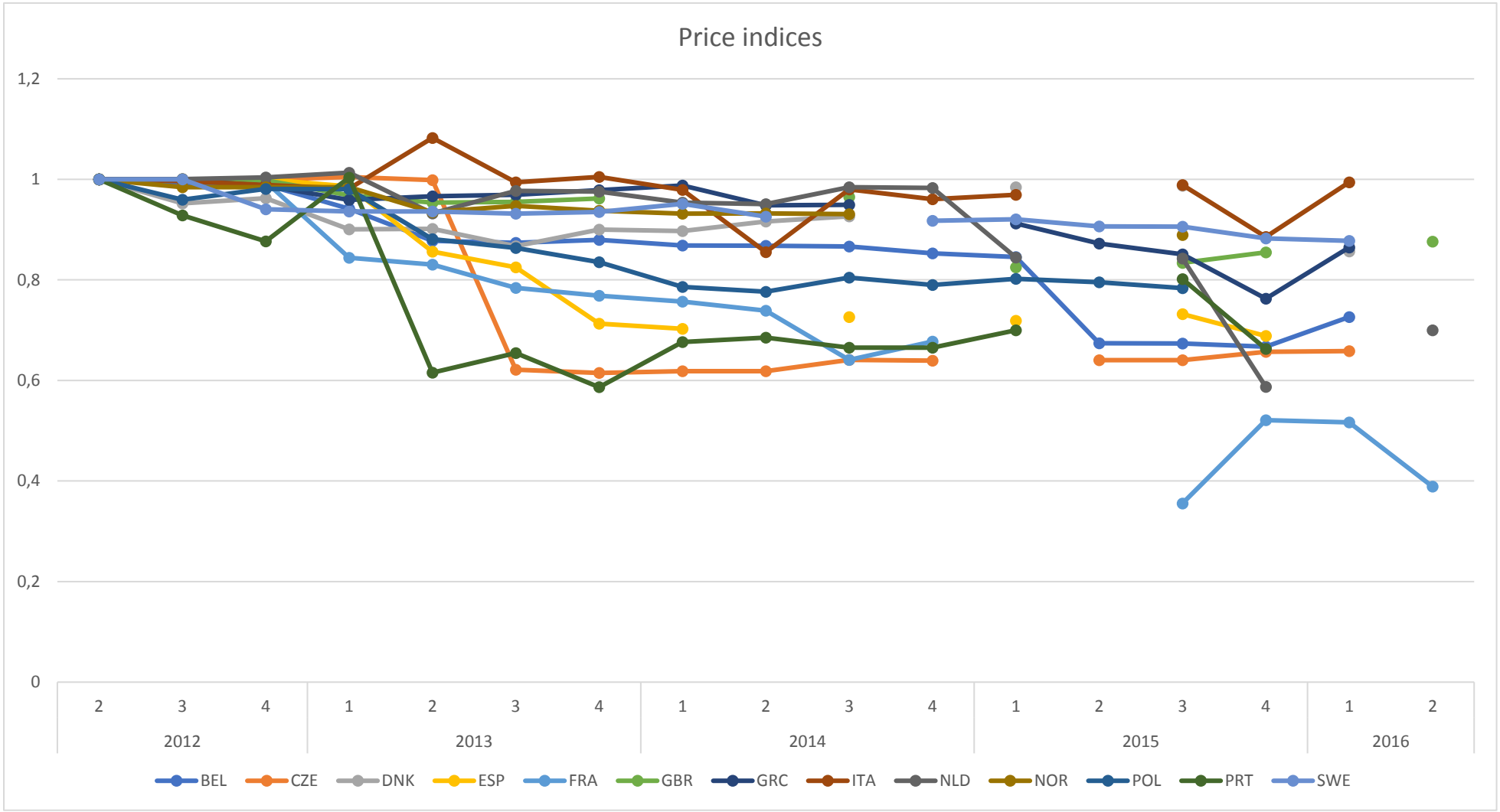

Medium basket - all countries
60
50
40
30
20
10
0
1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2
2012
2013
2014
2015
2016
BEL
CZE
DNK
ESP
FRA
GBR
GRC
ITA
NLD
NOR
POL
PRT
SWE

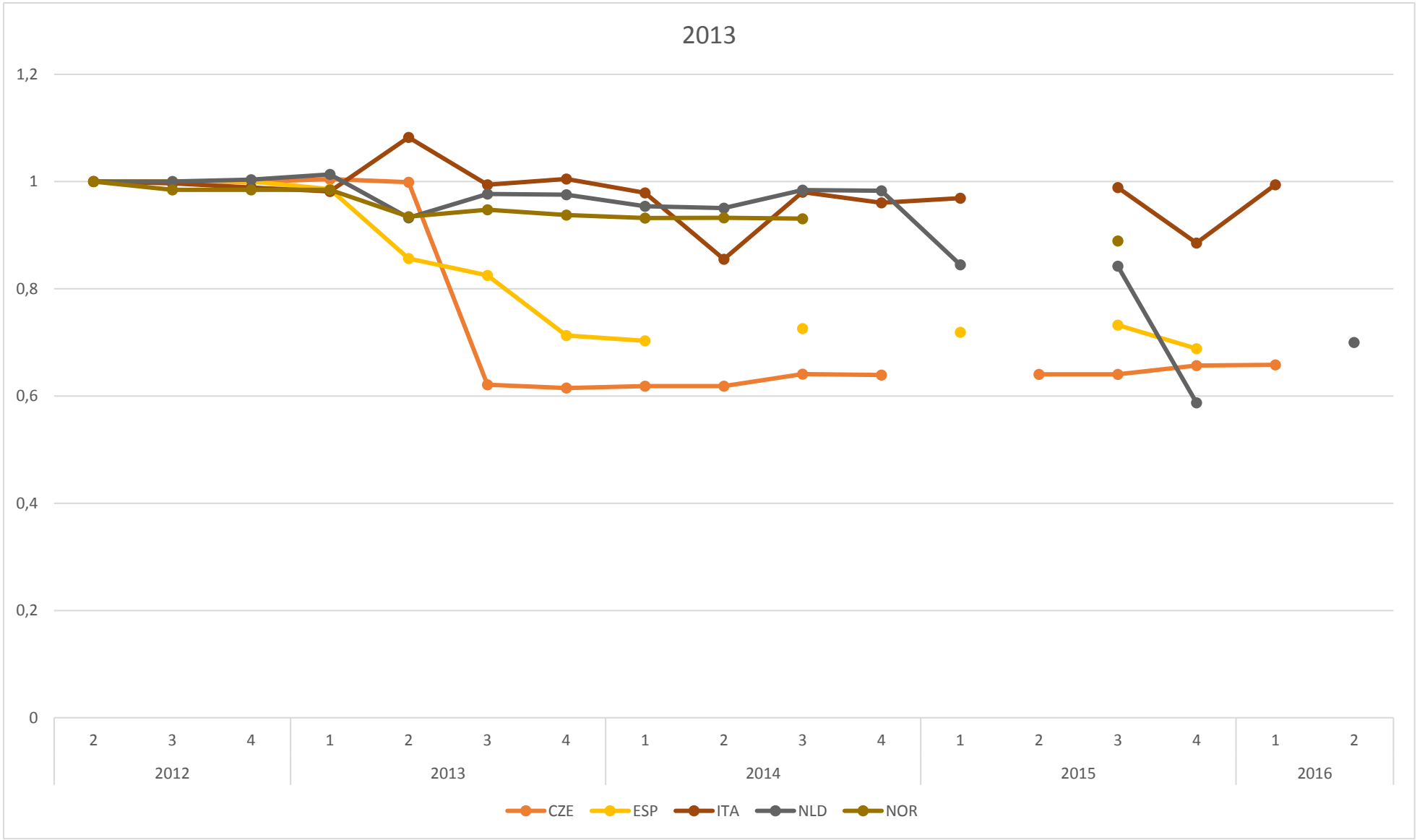

Medium basket - selected countries
50
45
40
35
30
25
20
15
10
5
0
1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2
2012
2013
2014
2015
2016
CZE
DNK
FRA
NLD

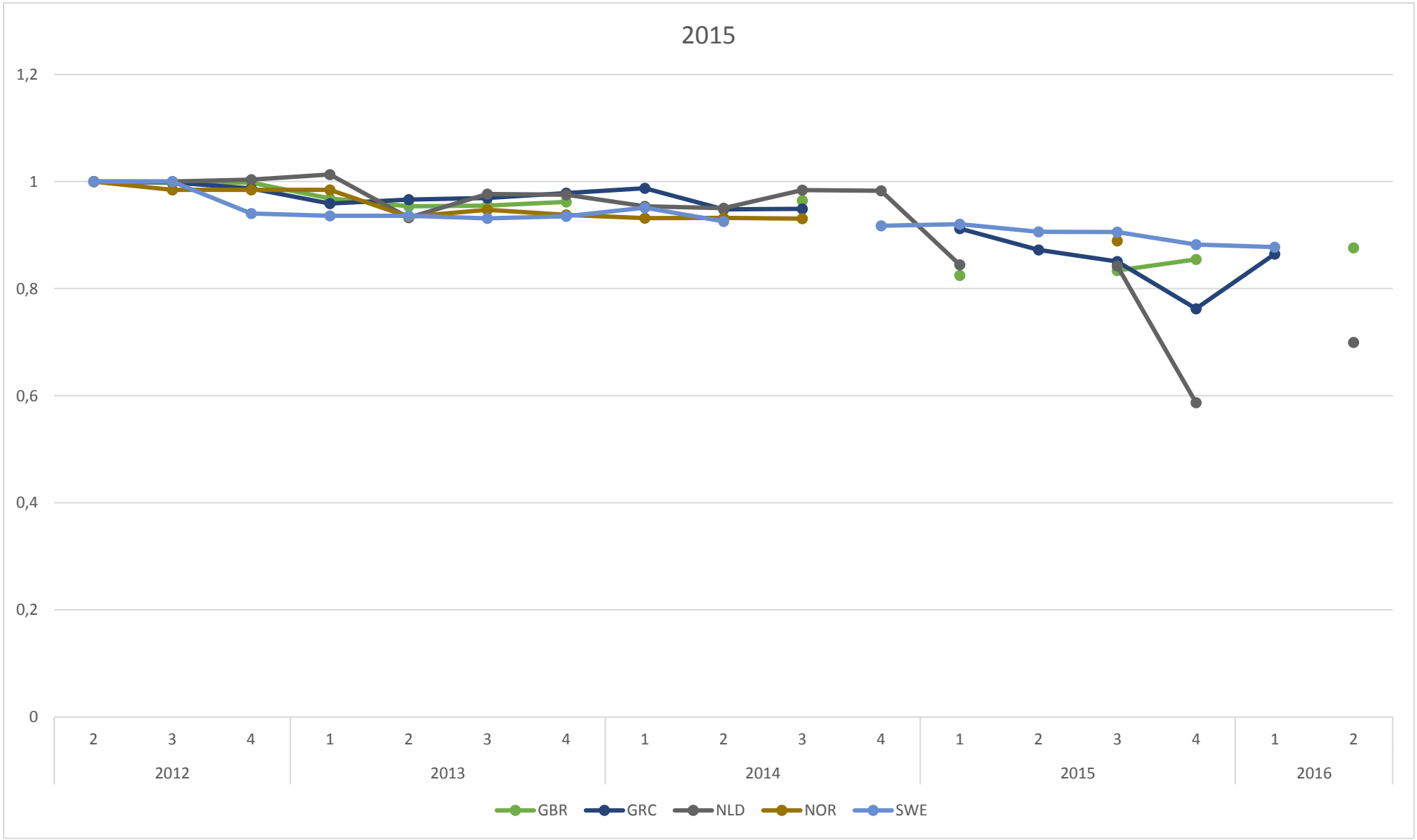

High basket - all countries
100
90
80
70
60
50
40
30
20
10
0
1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2
2012 2013 2014 2015 2016
BEL CZE DNK ESP FRA GBR GRC ITA NLD NOR POL PRT SWE


High basket - selected countries
60
50
40
30
20
10
0
1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2
2012
2013
2014
2015
2016
DNK
ESP
NLD
POL
SWE

Appendix E: Price indices




2013
1,2
1
0,8
0,6
0,4
0,2
0
2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2
2012
2013
2014
2015
2016
CZE
ESP
ITA
NLD
NOR


2015
1,2
1
0,8
0,6
0,4
0,2
0
2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2
2012
2013
2014
2015
2016
GBR
GRC
NLD
NOR
SWE