Post- och telestyrelsen

COST OF CAPITAL FOR SWEDISH MOBILE TELECOM NETWORKS

18 MARCH 2008

INFORMED DECISIONS

COPENHAGEN ECONOMICS

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PREFACE

Copenhagen Economics has been commissioned by Post- och telestyrelsen to undertake a study on the weighted average cost of capital for the mobile telecommunications network in Sweden. The cost of capital will be used as an essential input to determine cost-based pricing.

The report from Copenhagen Economics has been prepared by a team consisting of project manager Ph.D. Henrik Ballebye Olesen, Ph.D. Karl Lundvall, M.Sc. Jonatan Tops, M.Sc. Marcin Winiarczyk, and M.Sc. Petter Berg.

Copenhagen, 18 March, 2008

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Chapter 1 | MAIN FINDINGS

The Swedish National Post and Telecom Agency (PTS) has identified mobile operators with significant market power in the Swedish market for mobile voice call termination. PTS has therefore imposed *ex ante* regulation based on cost-based pricing. An essential ingredient in the regulation is an adequate estimate of the cost of capital. The current regulation in force is from January 2004.

PTS has commissioned Copenhagen Economics to review and update the weighted average cost of capital (WACC) for the mobile telecommunications net.

The parameters in the WACC are estimated using various sources and the results of the estimations are presented in Table 1.1. The table illustrates the WACC with a high and a low gearing scenario. Copenhagen Economics recommends the midpoint of these two scenarios, 13.1%, to be used in the regulation of mobile telecommunications net in Sweden.

Our estimate is slightly higher than the previous WACC and close to the average used by regulators in other countries in Europe.

Table 1.1: WACC for mobile telecom networks in Sweden

	Low gearing	High gearing
Risk free rate	4.20%	4.20%
Debt risk premium	1.00%	2.00%
Cost of debt	5.20%	6.20%
Equity risk premium	4.75%	4.75%
Unlevered beta	1.2	1.2
Levered beta	1.49	1.67
Cost of equity	11.27%	12.11%
Gearing	25%	35%
Tax rate	28%	28%
Post-tax WACC	9.39%	9.43%
Pre-tax WACC	13.04%	13.10%
Midpoint, pre-tax WACC	**13.1%**	

Source: Copenhagen Economics

Chapter 2 ESTIMATION METHODOLOGY

The regulator PTS uses a long-run incremental cost model (LRIC) in its regulation of the mobile telecommunications net. The underlying principle is that firms subject to regulation should be able to retrieve costs caused by the activity in the regulated market. These costs should represent those of an efficient operator. Firm specific inefficiencies should not be compensated for. An essential element in the LRIC is the cost of capital which represents the return that an investor would require on the investment.

2.1. THE WACC FORMULA

The WACC is a weighted average of the cost of borrowing capital and the costs of raising capital through equity. The two estimates are then weighted together in order to provide the lowest possible cost of capital for the investor.

The parameters of these calculations are given by the WACC-formula which is derived from the capital asset pricing model (CAPM). The post-tax WACC is defined as:

$$WACC = g \times \underbrace{(1-T) \times (R_f + DRP)}_{Cost\ of\ Debt} + (1-g) \times \underbrace{(R_f + \beta_j ERP)}_{Cost\ of\ Equity}$$

where

$$g = \frac{Sum\ of\ Debt}{Sum\ of\ Debt + Sum\ of\ Equity} = \frac{D}{D+E}$$

The parameters are defined as follows: T is the company tax rate; DRP is the Debt Risk Premium, i.e. the difference between the risk free rate of return and the interest of company debt; R_f is the risk free interest rate; ERP is the Equity Risk Premium (i.e. the required interest on a relevant market portfolio above the risk free rate), and; $ß_j$ is the asset beta, i.e. the sensitivity of the return on asset j relative to a market portfolio.

2.2. ESTIMATION

The estimation of the parameters follows the principles and methodologies outlined by the AMI report and the previous WACC-estimation for the fixed-net.[1]

The WACC consists of six parameters. Three of these are independent of the product market under assessment (the risk-free rate, taxes and equity risk premium) and are estimated using available statistics and studies according to well-defined and transparent criteria. The details are further explained below in connection with the presentations of the respective estimates. Furthermore, previous decisions by PTS and other regulators are taken into account before making final judgements on the appropriate values of the parameters. The motivation for weighing in previous decisions is the estimation uncertainty

[1] AMI (2003), Copenhagen Economics (2007) and PTS (2007a).

involved and the subsequent need for *regulatory reference* (not too large variation across countries in the EU) and *regulatory precaution* (moderate changes over time).

The remaining three parameters (debt-risk premium, financial gearing and beta) are determined by the market to be regulated. These are estimated using a group of companies that serve as reasonable proxies for an efficient operator in the Swedish market for mobile voice call termination. The companies are also denoted "pure play", although it in practise can be difficult to find really 'pure' companies, i.e. companies solely focussed on mobile telecommunication. These are referred to as the "peer group" of mobile operators. The estimates are also reviewed with the principles of regulatory precaution and regulatory benchmarking.

The mobile peer group has seven members which are all large and quoted in Western Europe. We only included companies where mobile voice operations represents 70% or more of total earnings (measured as EBITDA). Further details are provided in Appendix A. In addition to the peer group, we also use a larger reference group of nineteen European telecommunications companies when we estimate the beta parameter. The reference group consists of the mobile peers as well as of the major integrated telecom operators in Europe and are further described in Appendix B.

Chapter 3 COST OF DEBT

In this chapter, we present our estimates of the parameters underlying the cost of debt. The parameters are: Financial gearing (*g*), tax rate (*T*), risk free rate (R_f) and debt risk premium (*DRP*).

3.1. FINANCIAL GEARING

Financial gearing expresses the balance of debt and equity in the funding a company's activities. The estimation does in practise involve a valuation of these two components of the firm.

Regarding equity, market value is the preferred estimate rather than book value, which normally tend to be underestimated.[2] We therefore base the valuation of equity on market values calculated as the number of outstanding shares times the unit share price.

The estimation of company debt usually require separate valuations of every debt instrument. This may be straightforward for company bonds, but can be highly complex for many other types of interest bearing instruments. We therefore base the valuation of debt on book values of debt as a proxy for the market value following international practise.[3]

There are two main approaches to measure gearing levels: *actual* versus *target* gearing. *Actual* gearing is used in Norway, Spain and the UK and is defined as the existing gearing of the companies to be regulated. The disadvantage associated with this measure is that it may deviate from the company's long-run optimal capital structure and therefore not be in accordance with the LRIC principles. In addition, the LRIC-methodology is based on the costs of an efficient operator whereas the regulated company's gearing may be inefficient.

Target gearing involves the assessment of an efficient level of gearing by using a peer group. The approach implicitly assumes that the peer group jointly represents an efficient investor.

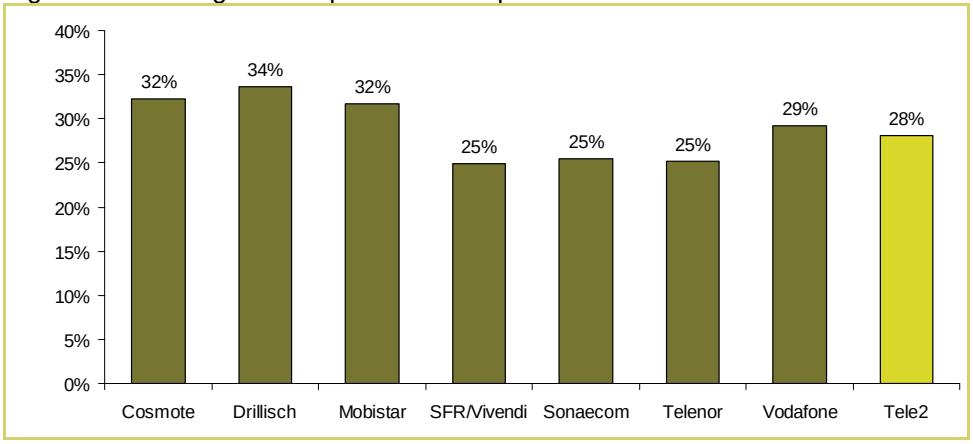
We use target gearing since we believe that the peer group is closer to an efficient operator than actual telecom companies in Sweden.[4] Furthermore, reliable data on the actual gearing for all mobile operators in Sweden is not readily available.

[2] Present value of growth opportunities is, for example, not included in the book value. In addition, accounting principles can also decrease the usefulness of book values.
[3] This approach was used in the recent decision by PTS on the fixed-net (PTS 2007a). It is also used by other regulatory authorities and is recommended by AMI (2003).
[4] Target gearing is recommended by AMI (2003) and IRG (2007).

Peer group

The gearing levels of the peers are presented in Figure 3.1 below. As evident in the figure, the estimates do not deviate much from each other. All belong to the 25%-34% interval. Tele2, which is not in the peer group but is included for reference[5], is well within this interval at 28%. Both the median and the average gearing is 29% and remain unchanged whether Tele2 is included or not.

Figure 3.1 Gearing for European mobile operators

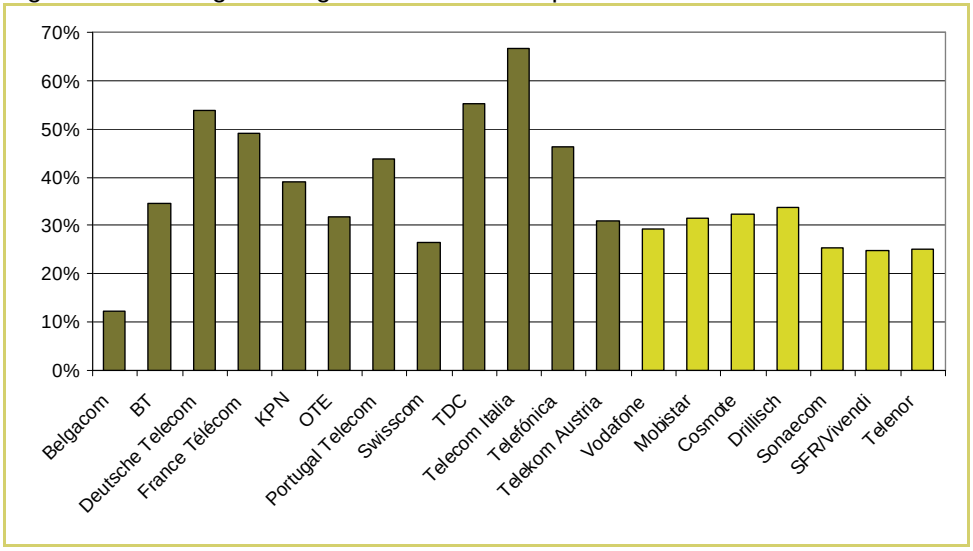


Note: Total equity refers to August 2007 and total debt to 2006
Source: Annual reports 2006 and Data Stream

It is illustrative to compare mobile with integrated operators. As evident in Figure 3.2, integrated operators have significantly more diverse gearing rates than mobile operators. This suggests that an appropriate gearing range for an efficient mobile operators probably is narrower than for integrated operators.

[5] The motivation for including Tele2 is that this company is falling short only by a tiny margin of being a member of the mobile peer group. See further details in Appendix A.

Figure 3.2 Gearing for integrated and mobile operators

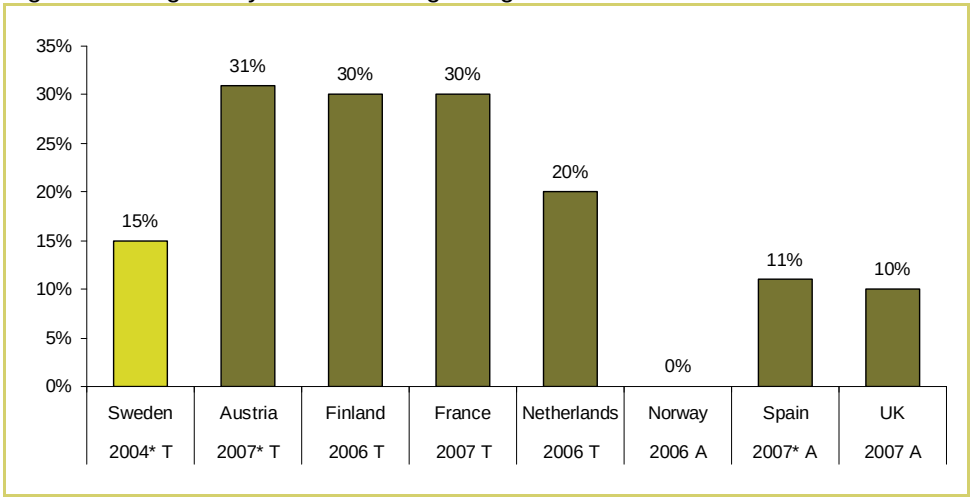


Note: Total equity from August 2007 and total debt from 2006. Dark columns = integrated operators, bright columns = mobile operators
Source: Annual reports 2006

Regulatory reference

The gearing rates used by seven other regulators in EU15 are presented in Figure 3.3 below. The average as well as the median amounts to 18%. Some countries, notably Norway, Spain and the UK, use actual gearing for existing operators which appear fairly low. The other four regulators in Figure 3.3 above use target gearing and report considerably higher estimates - the average is 28% and the median is 30%. The 2004 decision by PTS uses a gearing range of 10%-20% (midpoint 15%).

Figure 3.3 Regulatory reference on gearing



*Note: *) indicates that a gearing range is used and that the midpoint is reported*
T=Target gearing, A=Actual gearing
Source: See Annex C

Estimate

Based on the evidence above we conclude that the previous gearing range defined by the 2004 PTS decision of 10%-20% appears too low and does not fairly represent an efficient operator. The mobile peers all fall within the 25%-34% range. Also Tele2 has a gearing level that fall in this interval. The average as well as the median of four regulators which use optimal gearing also fall within this range. We therefore recommend an interval for gearing of 25%-35%.[6]

3.2. TAX RATE

Most of the market information is based on post-tax figures. We therefore find it convenient to calculate the post-tax WACC and then convert it to pre-tax WACC. We follow the standard methodology and use the marginal tax rate in our calculations.[7] The Swedish corporate tax rate is currently 28% which we use in the calculation of pre-tax WACC.

3.3. RISK FREE RATE

The risk free rate is the expected return on an asset which has no risk. In practice, it is not possible to find an asset that is free of risk. However, freely traded investment-grade government bonds are generally regarded as having a default risk close to zero and zero

[6] Given the uncertainties associated with the estimate, however, we will conduct sensitivity analysis in the WACC-calculation in Chapter 5 with respect to this variable using two alternative intervals. These alternatives include the 10%-20% range used in PTS (2004) and an interval of 10%-35% which combines the lower bound of the former decision and the upper bound in our recommendation.
[7] See for example AMI (2003), Ofcom (2005).

liquidity risk. The bond should be measured in the same currency as cash flows of the operators to be regulated, i.e. Swedish Kronor.

Since bonds have different durations, there are a number of alternative estimates of the risk free rate. A bond with a shorter maturity is normally more volatile than a bond with longer maturity. On the other hand, the yield on bonds with long duration may be subject to expectations of future inflation risk which should not be included in a nominal WACC.

The LRIC-model is based on a forward looking principle. Hence, an *ex ante* WACC requires that all variable estimates should be forward looking, reflecting the current expectations for the relevant future period. Furthermore, the timing of the risk free rate should be consistent with the timing of the equity risk premium and the debt risk premium.

The estimate can be based on an historical average or the last observation. The last observation represents in principle the most accurate expectation of the future risk free rate, but may be volatile therefore not suitable for regulatory purposes. We propose that an average is used to smooth out these temporal fluctuations. This is in line with the practice advocated by the Independent Regulatory Group (IRG).[8]

Since the risk free rate varies considerably over the business cycle and that the parameter has a strong influence on the cost of capital,[9] we recommend that PTS updates the estimate in case of major changes. The other WACC-parameters are more stable and in less need for frequent updates.

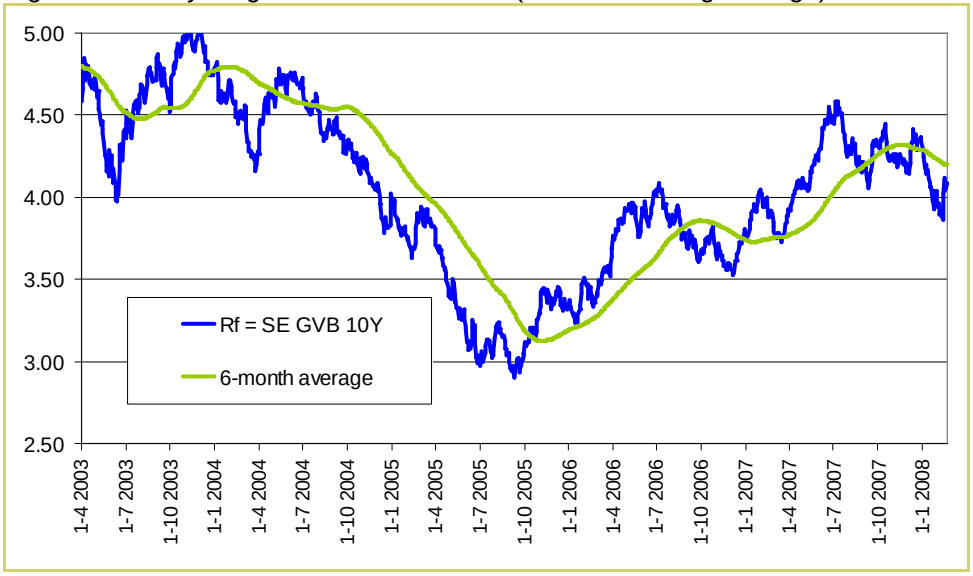
Estimate

The estimate is based on a 6-month moving average of nominal 10-year government bonds.[10] The rationale for restricting the average to six instead of twelve months is that the risk free rate is based on expectations of future returns, as opposed to historical returns. The methodology is in accordance with IRG practice mentioned above and the 2007 PTS decision on fixed-net WACC.

The development of the yield from the chosen bond for daily as well as moving 6-month average is displayed in Figure 3.4 below. During the last five years the yield has been in the 3%-5% range. The last observation is 20 February 2008. The corresponding 6-month moving average is 4.20%, which we propose be used.

[8] IRG (2007), p.15.
[9] The risk free rate is part of both cost of debt and cost of equity. A one per cent increase in the risk free rate, given a tax rate of 28%, would result in an increase by 0.86% of the WACC.
[10] A 10-year government bond is also used by other national regulatory authorities, for instance in Denmark, Finland and France. It is also used in the analysis of the fixed-net WACC.

Figure 3.4 Ten-year government bond rate (6-month moving average)



Note: The last observation is 20 February, 2008
Source: Sveriges Riksbank

3.4. DEBT RISK PREMIUM - DRP

Owners of company debt, such as corporate bonds, normally demand a premium above the risk free rate to compensate for the risk of bankruptcy. This is the DRP.[11] A higher financial gearing is often associated with a higher risk of default and consequently entails a larger DRP.

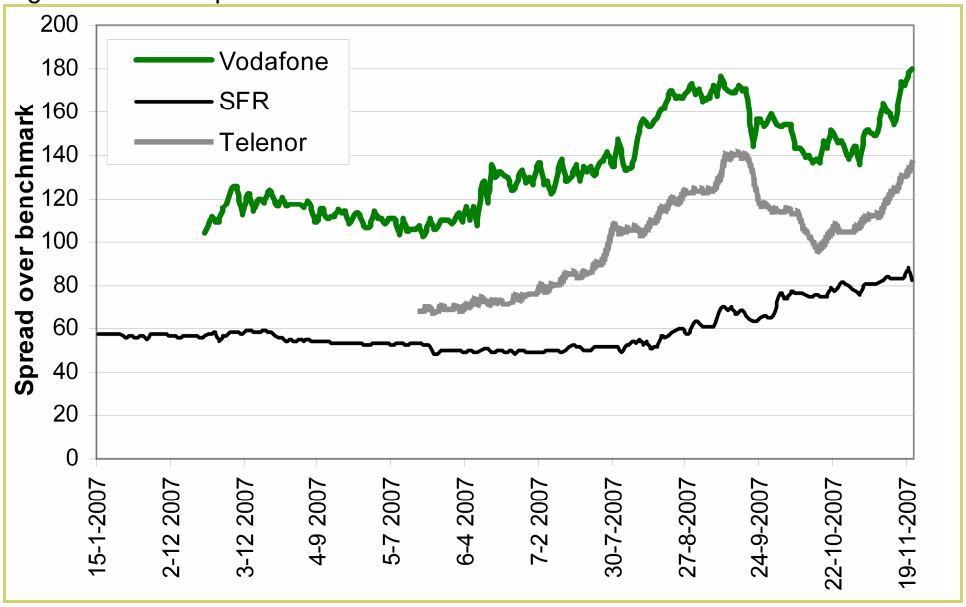
The estimation usually involves the corporate bond spread (the positive difference) over the risk free rate for a group of peers.[12] The spread is a direct measure of the DRP demanded by the market and represents the compensation over the risk free rate an investor requires. An important determinant of the spread is the period remaining before redemption. At redemption, the spread is by definition zero. The choice of maturity of the reference bonds used to determine the DRP is therefore important. Ideally, the maturity of these corporate bonds should be similar to the government bonds used to estimate the risk-free rate. Since we use a 10-year government bond to estimate risk free rate, we should also seek to use corporate bonds with similar length. In addition, credit ratings within the peer group should not divert too much from the ratings typically observed in the telecommunications market.

[11] Sometimes referred to as Debt Default Premium (DDP)
[12] This is also the most common methodology among regulators (AMI 2003).

Peer group

Only three of the peers issue corporate bonds. We use the 10-year bonds for Vodafone and Telenor and seven year bonds for SFR since no 10-year bonds are issued. The Figure 3.5 below display the spread over the risk free rate (spread over benchmark) for these three financial instruments. Vodafone has a spread in the 100-180 point range whereas Telenor is in the 70-135 point interval.[13] SFR displays the lowest spread hovering between 50 and 80 interest rate points. For the last observation, the DRP for these three companies is in the 80-180 range which is somewhat higher than in the beginning of the measurement period.

Figure 3.5 Bond spread over national risk free rate



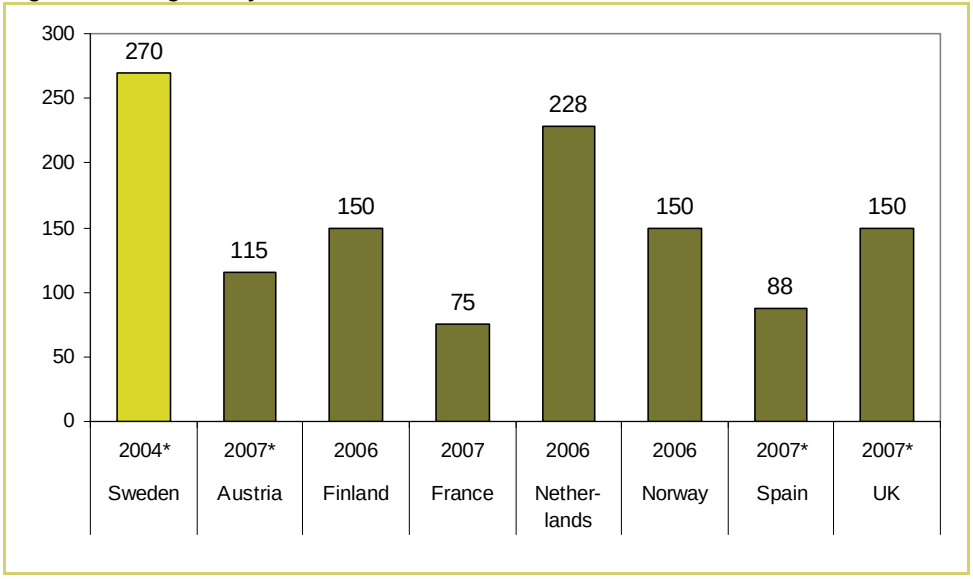
Note: All are fixed-coupon corporate bonds. The company, issuing year, coupon rate, redemption date, S&P credit rating and the currency denominations are as follows
VODAFONE GROUP 2007 5 5/8% 27/02/17 S, (S&P: A-), USD
SFR 2005 3 3/8% 18/07/12, (S&P: NA), €
TELENOR AS 2007 4 7/8% 29/05/17, (S&P: BBB+), €.
Source: DataStream.

Regulatory reference and precaution

The DRPs used by European regulators varies considerably, c.f. Figure 3.6. France adopts a DRP of 75 points compared to the Netherlands with a DRP of 228. The average DRP among the European regulators is 137 and the median is 150 interest rate points. The current 2004 decision by PTS identifies an interval of DRP of 250 to 290 points which appears as relatively high in an international perspective. The UK, Finland and Norway all have a DRP-range of 100-200.

[13] Interest rate spreads are measured in points: 1 % = 100 points, 70 – 135 points = 0,7 – 1,35%.

Figure 3.6 Regulatory benchmark on DRP



*Note: Some national regulators adopt a point estimate, whereas others employ ranges (denoted with * in the figure). The midpoint of a DRP range is shown*
Source: See Annex C

Estimate

The analysis of the peer group is in itself subject to some uncertainty since only three out of seven companies issue corporate bonds. In addition, the implied DRP rates from these bonds vary both over time and between companies. Hence it is appropriate to define a relevant range for the DRP parameter. With reference to the peer group, which suggests a DRP in the 80-180 interval, and other regulators, which indicate DRP in the 75-230 interval, we conclude that the present level of 250 to 290 points in the 2004 decision by PTS is too high.

Weighing these inputs together while simultaneously respecting regulatory precaution, we propose a DRP range of 100 to 200 points. This is identical to the DRP decided in 2007 by Ofcom and also shares the midpoint of 150 with Finland and Norway.

Chapter 4 COST OF EQUITY

In this chapter, we present our estimates of the parameters that are used to determine the cost of equity. These are the beta (β_j) and equity risk premium (*ERP*) parameters.

4.1. BETA

The beta parameter in the WACC-formula represents the systematic risk associated with mobile voice call termination. It is a measure of the correlation between the rate of return of a stock and overall market return and captures the risk that cannot be eliminated by portfolio diversification. However, a stock may also exhibit non-systematic risk that is not correlated with the market. Such risk is sometimes referred to as idiosyncratic risk and is specific to the individual asset. Most importantly, idiosyncratic risk can be eliminated by the investor through portfolio diversification and is therefore not accounted for in the WACC.

We base our beta estimate on three different sources of evidence. The first is the average beta of the peer group. This implicitly assumes that the mean is a plausible representation of the systematic risk for mobile voice call termination.

The second source is an analysis of betas of a broader group of telecommunication companies including the peers. We conduct a "divisionalised approach" in which betas for fixed-net as well as mobile telecommunications services across firms are estimated. The approach involves further estimation and may provide more reliable estimates due to a richer sample of comparator firms. The approach is described in further details below.

The third source is regulatory reference and precaution. Because of the estimation uncertainties involved, we acknowledge the importance of considering the decisions taken by regulators in other countries as well as the current regulation in force in Sweden.

The standard procedure to estimate beta is using ordinary least-squares regression analysis. There are, however, a number of specification issues to be dealt with in order to arrive at reliable estimates. We have adopted the following estimation strategy.

The MSCI world index is used as the market benchmark in the beta estimation, since we adopt an international investor's perspective. We use five years of data to cover an entire business cycle which smoothes out atypical events and other disturbances which may bias the estimates. After evaluating different alternatives, we find that weekly data on the second trading day of the week (normally Tuesdays) provide the most stable and robust beta parameter estimates. Monthly observations were found to produce less stable parameters estimates and daily observations introduced other technical problems without improving efficiency.[14]

[14] For further detail, see Copenhagen Economics (2007), p 19f.

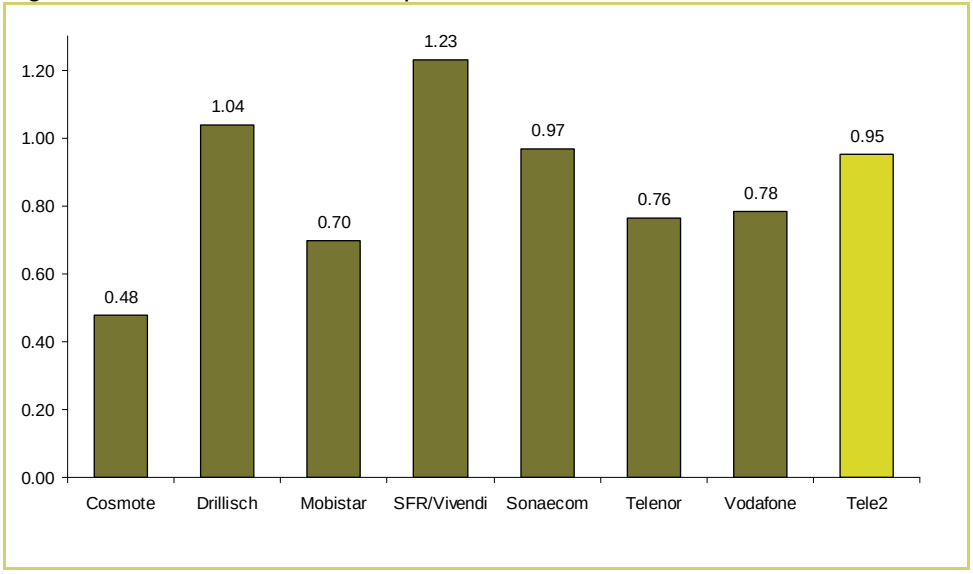
The estimated betas for the peers were robust for alternative specifications. Reducing the number of years of the estimation window from five to three years and changing the trading day from number two to three (typically Wednesdays instead of Tuesdays) did not change the results significantly.

Before comparing individual company betas, they need to be unlevered to account for the variation in gearing and tax levels. This is done using the Modigliani-Miller formula[15].

Peer group

The betas for the peers are displayed in Figure 4.1. The estimates exhibit a large variation, with Cosmote at 0.48 and SFR/Vivendi at 1.23 being at the bottom and top end, respectively. The average and the median is about 0.8. For reference, Tele2 is included[16] and is found to be well in the range of the peers with a beta estimate somewhat higher than the peer average.[17]

Figure 4.1 Unlevered beta for the peers



Note: The average is 0.85 and the median is 0.78
Source: Copenhagen Economics

[15] Unlevered Beta = Estimated Beta/(1 + (1 - *T*)*D/E). D/E is equivalent to *g*/(1-*g*).
[16] The full documentation of the beta estimations (except Tele2) is provided in the WACC-report for the fixed net (Copenhagen Economics 2007).
[17] The average and median of the peers is 0.85 and 0.78 respectively. If Tele2 were to be added, both the average and the median would be 0.86.

Divisional approach

The large variation in betas among the peers suggests national differences in systematic risk. In this respect, the peer group alone does not provide precise guidance on a reliable beta estimate reflecting the systematic risk for with mobile voice termination in Sweden.

To enrich the picture, we also refer to the divisionalised approach adopted in Copenhagen Economics (2007) regarding the estimation of a fixed-net WACC. The approach involves estimation of company betas of a group of companies engaged in fixed-net and mobile voice call termination services. After unlevering these estimated betas they are modelled in terms of relative income shares of the respective companies referring to fixed-net, mobile and other activities. Given the variation in income shares between firms, it is in principle possible to disentangle the betas that are associated with each field of operation within firms. In this way, the overall company beta is divisionalised between the different types of operations that are part of the same company.[18]

In the fixed-net WACC-estimation in Copenhagen Economics (2007) the divisional model was estimated on a sample of 20 European telecommunications companies. The sample, here referred to as the reference group, consists of the peer group of mobile operators together with 12 integrated telecommunications operators and is further described in Appendix B.

Given the heterogeneity of the companies in the reference group, it is appropriate to interpret the original results with some caution. For this reason, we have estimated four additional alternative models to check the robustness of the results. These alternative specifications involve adding Tele2, removing Drillisch and SFR, and using an alternative estimation of beta for the reference group companies. These estimation are further presented in Appendix D.

The overall conclusion from the alternative estimations is that the results reported in Copenhagen Economics (2007) are robust. In all five estimated models, estimated beta of mobile services is stable at around 0.8.

Another robust result is that all five models underestimate the betas of the two Swedish telecom operators that are included in the analysis, TeliaSonera and Tele2. The actual company beta of TeliaSonera is 59%-83% larger that the level predicted by the model. The corresponding figures for Tele2 is 36%-57%.

The additional systematic risk for the Swedish operators could possibly refer to risks inherent in the respective companies (e.g. rumours about changes in ownership or exposure to risk of mobile operations outside Europe). It could also represent a general and sys-

[18] A more formal statement of the approach is provided in Appendix D and in Copenhagen Economics (2007).

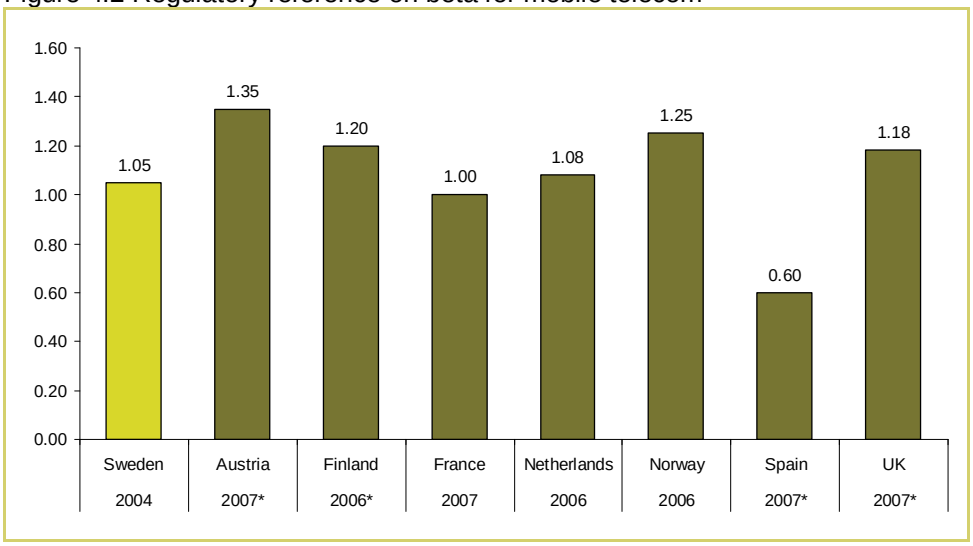
tematic positive risk premium for mobile termination in Sweden.[19] Alternatively, and perhaps most likely, it is a combination of both. In any case, the model itself is silent on the relative weight of these two effects.

If we assume that it is market specific differences, i.e. geographic conditions, that causes a higher beta in Sweden than in other European countries, the beta for Swedish mobile operators is higher than 0.8. If we, on the other hand, assume that all the residual risks are caused by specific events, then we should use the estimated beta of 0.8. We cannot estimate the size of these two effects and thus exactly divide the residual systematic risk between them.

Regulatory reference and precaution

Several regulators in Europe have taken decisions on mobile WACC-rates that involve levels on unlevered betas for mobile services. The most recent ones are reported in Figure 4.2 below. They range from a low of 0.60 for Spain to a high of 1.35 for Austria. The average is 1.1 and the median 1.2 for these seven regulators. Only one out the seven regulators has an unlevered beta below 1.0. The current 2004 decision by PTS in force is based on a beta of 1.05.

Figure 4.2 Regulatory reference on beta for mobile telecom



*Note:*The beta is defined as a range. The midpoint is reported*
Source: See Annex C

Estimate

The three sources that constitute our basis for estimating beta are summarised in Table 4.1 below. Together, the evidence delimit a wide interval, ranging from a low of 0.5 to a

[19] Interestingly, for TDC and Telenor, the model overpredicts the company beta. This could possibly be interpreted as a negative general risk premium for Denmark and Norway.

high of 1.35. It is undeniable that our estimate of beta is bound to be associated with some degree of uncertainty.

Table 4.1 Sources of evidence on beta

Source of evidence	Results
Peer group	Range: 0.5–1.2, average/median: 0.8
Divisional approach	Estimate: 0.8, 36%–83% positive risk residual for TeliaSonera and Tele2
Regulatory reference	Range: 0.6-1.35, average: 1.1, median: 1.2
Regulatory precaution	PTS 2004: 1.05

Sources: See Figures 4.1-3

Our interpretation of the evidence and reasoning behind our beta estimate is as follows.

First, both the peer group average and the divisional approach indicate a beta of 0.8. The consistency of these two sources provides support that this is a plausible level for overall systematic risk in mobile voice call termination in Europe.

Secondly, other regulators have consistently employed higher betas in their recent (2006 and 2007) decisions. Although the range is large, the typical regulator uses a beta of 1.1 or 1.2. We do not know the underlying causes for this divergence and, most importantly, whether it is due to perceived systematic risk in the individual country or a more general expression of regulatory precaution.

Thirdly, the beta estimate must reflect a stable regulatory regime. Dramatic shifts in the underlying parameters in the WACC-formula may increase uncertainty among investors and discourage investments. Changes in the most influential parameters of WACC-formula should be undertaken with stability considerations in mind. In addition, when important changes are implemented, it may be warranted to review the parameter estimates in shorter intervals than normal, such as 2-3 years instead of 4 years.

Fourthly, the two largest operators in this market in Sweden, TeliaSonera and Tele2, who together represent about three quarters of the market[20], have betas that are 36% to 83% higher than predicted by the divisionalised model. If these positive risk residuals were interpretable in full as a fair representation of systematic risk in Sweden, the appropriate WACC-beta implied by the model would range between 1.1 and 1.5.[21] As underlined above, however, the estimation methodology itself is incapable of determining what proportion of the positive risk residuals that can be considered as caused by market specific differences (e.g. geographical differences) and what proportion caused by specific events (for instance of rumours about changes in ownership structure or risks associated with mobile operations outside Europe).

[20] PTS (2007)
[21] Based on an beta estimate of 0.8, adding 36% to 83%, respectively.

Based on these grounds, we believe that the estimate in the previous 2004 decision by PTS of 1.05 and the range proposed by AMI (2003) of 1.0 to 1.1 is an underestimation of the current of systematic risk. We therefore propose beta to be increased.

We conclude that a plausible estimate for beta is in the 1.1 to 1.3 range. We propose the midpoint 1.2 to be used in calculation of WACC.[22] The estimate is relatively high compared to the results of the peer group analysis and the divisionalised approach but consistent the with the regulatory references and the estimated large positive risk residuals of TeliaSonera and Tele2.[23]

4.2. EQUITY RISK PREMIUM – ERP

The ERP is the excess return that an individual stock or the overall stock market provides over a risk-free rate. This corresponds, in equilibrium, to the additional return that a market investor requires in order to accept the systematic risk associated with investing in the market portfolio instead of a risk free asset.

The correct estimation of ERP is largely an unresolved issue in the literature. The principles previously adopted by PTS[24] have been employed in the WACC study of the fixed-net telecommunications net in Sweden[25], and we also use these principles here.

The overall principle is that ERP should be forward-looking since it is future behaviour that is subject to regulation. In terms of practical measurement, the estimate usually reflects an appropriate balance between historic and forward-looking ERP which represents the perspective of a, presumably efficient, international investor. The historical values of return should preferably be averaged using arithmetic rather than geometric means and possibly adjusted downwards to reflect the development of financial markets where international diversification is easier and cheaper than it used to be.

Evidence

The principle source for identifying an appropriate ERP is published evidence and regulatory reference and precaution. A selected list of influential recent studies on ERP is presented in Table 4.2 below.

[22] The beta estimate is later re-levered in the WACC-calculation according to the Miller-Modigliani formula.
[23] In the WACC-calculation in chapter 5, we conduct sensitivity analysis for alternative levels of beta. These alternatives include 1.05, which corresponds the 2004 PTS decision, and 1.35, which corresponds to the upper bound of the sample of regulators in Figure 4.2.
[24] PTS (2007a), largely based on AMI (2003).
[25] Copenhagen Economics (2007).

Table 4.2 Evidence on ERP

Study	Main results
Fernandez (2007), metastudy	Historical ERP: range=2.83%-6.35%, average 4.8% (10 studies, geometric)
	Required ERP: range=2.55%-7.3%, average 4.3% (12 studies)
DMS (2007)	Forward looking ERP: around 5% (arithmetic basis)
DMS (2006)	Forward looking ERP: 4.5%-5% (arithmetic basis)
Damodaran (2008)	Historic ERP: 6.42% (arithmetic, 1928 – 2007)
Merrill Lynch, GFMS (2007), survey	Mean ERP: 3.5%
PWC (2007), survey of investors	Mean ERP: 4.3%

Note: Averages in Fernandez (2007) table 9 and 13 computed by Copenhagen Economics (regarding historical ERP 7 out of 10 studies use geometric averages)
Source: Various, see table fields and references

Fernandez (2007) surveys the available published evidence to date on ERP distinguishing between historical and required ERP. On historical ERP, ten different studies presents estimates range from 2.83% to 6.35% using (mostly) geometric averages. A simple average across these studies yield 4.8%. On required or implied ERP, which is the forward-looking ERP referred to here, 12 studies provides estimates in the 2.55% to 7.3% range. A simple average across these studies equals 4.3%.

Perhaps the most commonly used reference for ERP in regulatory purposes is the Dimson, Marsch and Staunton's (DMS) annually updated study.[26] In a 2007 study the forward-looking ERP is estimated to be around 5% for the world's largest markets whereas in a 2006 study a historical ERP of 4.5%-5% was estimated. Both these measures are estimated on an arithmetic basis.

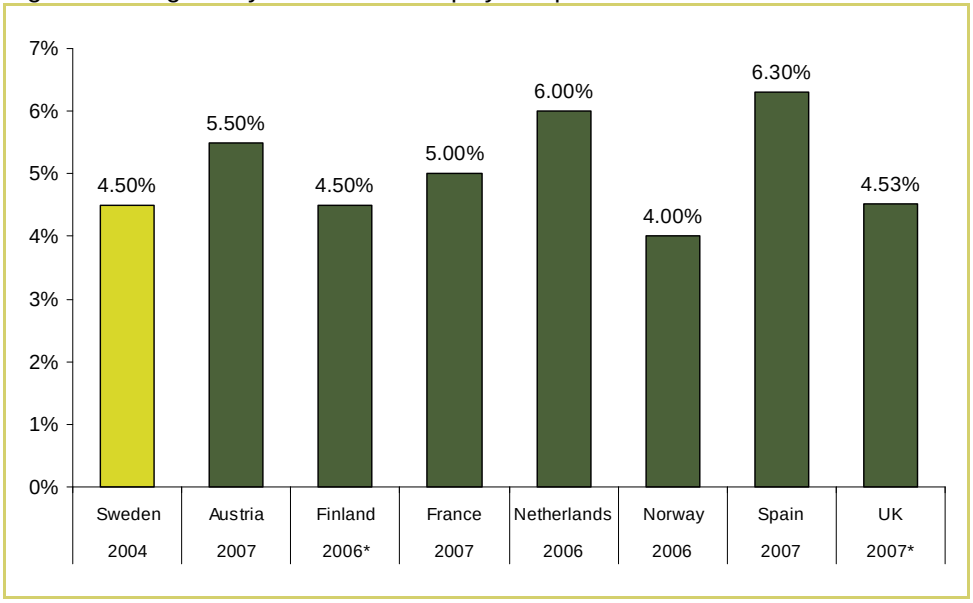
Another well-known source for estimates of ERP is Damodaran (2008). The arithmetic historical ERP in the US for the years 1928-2007 is 6.42%.

The academic studies yield higher equity risk premium than indicated in recent surveys of financial analysts' expectations: Merrill Lynch (2007) estimated ERP to 3.5% compared to PWC's (2007) 4.3%.

The ERP-rates adopted by regulators in Europe are shown in Figure 4.3 below. As among academics, there are different views on the correct level. The range begins with Norway at 4% and ends with Spain at 6.3%. The average ERP among these regulators is 5.1% which can be compared with the IRG (2007) 19-country average of 5.3%. The current 2004 PTS decision on WACC uses an ERP of 4.5%.

[26] DTe (2005), OFCOM (2005), COMP-COMM (2006), CRAI (2003), Johnsen (2006) and AFORST (2005) all use studies by DMS as their main source when estimating ERP.

Figure 4.3 Regulatory reference for equity risk premium



Note: Average 5,04% ;Median 4,76%
Source: Annex C

Estimate

Taken together, we conclude that the evidence presented above indicates that the current level of ERP at 4.5% is too low. At the same time, the variation in evidence is fairly large. In our judgement, we give a comparably large weight to the DMS studies cited above. Based on these grounds, we propose an ERP for use in the WACC formula of 4.75%, which is identical to the level used in the fixed-net WACC.

The current indications of a possible global recession has not been taken into account in the estimate since the ERP is based on long-term relationships.

Chapter 5 WACC

This chapter presents the resulting WACC-rate for mobile voice call termination based on the parameters identified and estimated in chapters 3 and 4. We also compare the proposed WACC with the current one in force in Sweden and with the corresponding ones in other countries.

We evaluate two separate cases: high and low gearing, which are also assumed to correspond to the high and the low level of DRP, respectively. The results are presented in Table 5.1 below. The midpoint of the two scenarios is our proposed WACC-rate for mobile voice call termination in Sweden. The estimate is 13.1%.[27]

Table 5.1 WACC for mobile telecom networks in Sweden

	Low gearing	High gearing
Risk free rate	4.20%	4.20%
Debt risk premium	1.00%	2.00%
Cost of debt	5.20%	6.20%
Equity risk premium	4.75%	4.75%
Unlevered beta	1.2	1.2
Levered beta	1.49	1.67
Cost of equity	11.27%	12.11%
Gearing	25%	35%
Tax rate	28%	28%
Post-tax WACC	9.39%	9.43%
Pre-tax WACC	13.04%	13.10%
Midpoint, pre-tax WACC	**13.1%**	

Source: Copenhagen Economics

5.1. COMPARISONS

The proposed WACC implies an increase from the current level of 12.9%. The details of the new set of parameters in comparison to the ones of the 2004 decision by PTS are presented in Table 5.2. From a European perspective, the proposed WACC is well in line with recent decisions as is shown in Figure 5.1. The WACC-rates range from 11.0% in Spain to 14.6% in the UK. The average of these estimates is 13.0%.

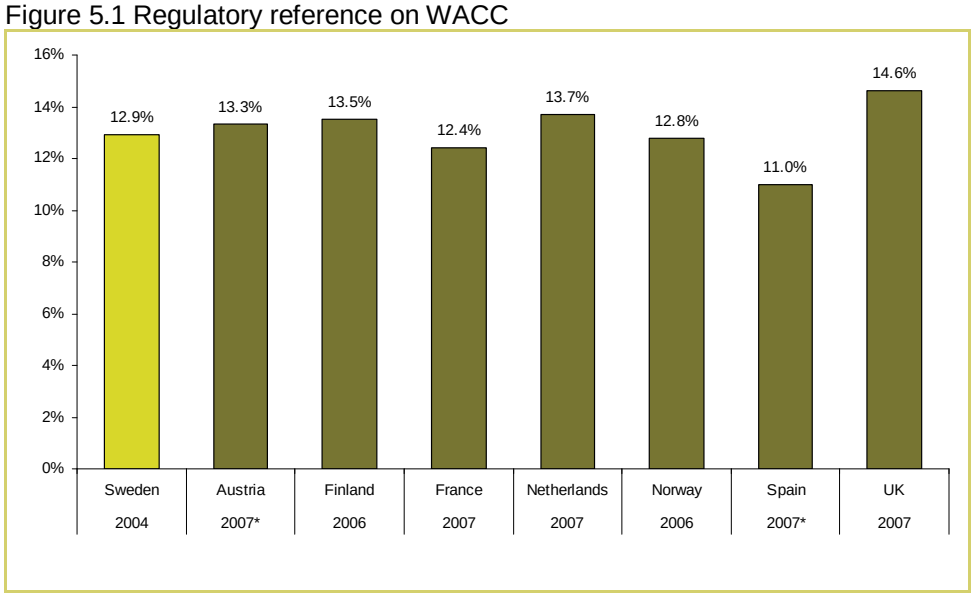
[27] Rounded to one decimal digit from 13.07%.

Table 5.2 Proposed versus present WACC in Sweden

Parameters	PROPOSED		PTS (2004)	
	Low gearing	*High gearing*	*Low gearing*	*High gearing*
Risk free rate	4.20%	4.20%	4.64%	4.64%
Debt Risk Premium	1.00%	2.00%	2.50%	2.90%
Cost of debt	5.20%	6.20%	7.14%	7.54%
Equity Risk Premium	4.75%	4.75%	4.50%	4.50%
Unlevered beta	1.20	1.20	1.05	1.05
Levered beta	1.49	1.67	1.14	1.24
Cost of Equity	11.27%	12.11%	9.80%	9.80%
Gearing	25%	35%	10%	20%
Tax rate	28%	28%	28%	28%
Post-tax WACC	9.39%	9.43%	9.30%	8.90%
Pre-tax WACC	13.04%	13.10%	12.92%	12.89%
Mid-point	**13.1%**		**12.91%**	

Source: Copenhagen Economics and PTS (2004)

Figure 5.1 Regulatory reference on WACC



Source: Appendix C

5.2. SENSITIVITY ANALYSIS

To illustrate the sensitivity of the results subject to changes in the gearing and beta parameters, we have calculated the corresponding WACC-rates for alternative values. We consider two alternative values for gearing, including the 10%-20% interval used in the 2004 PTS decision, and 10%-35%, which is a combination of the lower bound in the former decision and the upper bound in our current proposed interval. We also consider two alternatives for beta, including the level of the current decision of 1.05 and 1.35, which is

the upper bound of the beta parameter in the sample of regulators presented in Figure 4.2 above.

Together with our proposed estimates, the sensitivity analysis comprises nine different situations and are presented in Table 5.3 below.

Table 5.3 WACC sensitivity analysis of different gearing and beta values

Gearing	Beta=1.05	Beta=1.2	Beta=1.35
10%-20%	12.47	13.42	14.37
10%-35%	12.36	13.28	14.21
25%-35%	12.16	13.07	13.98

Note: Midpoint WACC-rates given in the cells
Source: Copenhagen Economics

As evident from the table, the WACC increases strongly with higher beta and decreases moderately with higher gearing. Interestingly, if the beta and gearing levels of the 2004 PTS decision would remain unchanged, the WACC would amount to 12.47%, considerably below the actual level of 12.91%. This is clearly a relevant benchmark to our proposed level of 13.1%.

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PTS (2007b), Svensk telemarknad 2006, PTS-ER-2007:15, 7 juni 2007

PWC (2007), Riskpremien på den svenska aktiemarknaden

APPENDIX A PEER GROUP

The mobile peers are identified to represent proxies for an efficient operator in the Swedish market for mobile voice call termination. Naturally, ideal peers seldom exist and one has to resort to the best available alternatives. The intuition behind the peer group is to find companies that operate under conditions similar to those of the companies to be regulated. The average of these would then constitute a reasonable estimator of efficiency. This is the simplest and most transparent approach to estimate industry-specific parameters. The problem of this approach is to identify sufficiently 'pure' candidates for being peers.

The principles adopted to select peers are as follows. We restricted the sample to companies mainly active[28] in Western Europe since these are expected to be reasonably comparable to a hypothesised efficient operator in Sweden. Further, we set the 'pureness' of mobile income at a threshold of 70% of total EBITDA (Earnings before interest, taxes, depreciation and amortization). Only publicly traded companies are included because these are the only companies for which we are able to observe the relevant financial statistics. The resulting peer group consists of the seven top companies in Table A.1.[29]

Table A.1 Defining the peer group for mobile operators

Company	Country	Mobile share of EBITDA
Mobistar	Belgium	100%
Drillisch	Germany	100%
Cosmote	Greece	99%
Vodafone	United Kingdom	98%
Sonaecom	Portugal	91%
Telenor	Norway	78%
SFR/Vivendi	France	70%
Tele 2 (not included)	Sweden	68%

Note: The mobile share of EBITDA is derived from the annual statements of the operators
Source: Annual reports for 2006

There are two observations to make. First, Tele2 falls very short of being included in the peer group with a mobile share of 68%. Secondly, the other companies do display considerable heterogeneity among themselves (not shown in the table). The companies not only differ in absolute size, but also in the share of operations that accrue to Europe and corporate structure. For instance, Drillisch is an operator without a domestic network on its own, a feature that it shares with a number of smaller companies not included in the peer group. SFR/Vivendi is a company that is heavily engaged in the media industry which distinguishes it from the other companies.

For these reasons, we will as a check of robustness analyse the marginal influence of these companies in the analyses.

[28] Since annual accounts typically do not report regional EBITDA, we base our conclusion of where the company is "mainly active" on qualitatively statements and other relevant information in the Annual reports. Such information typically contain descriptions of market activity, main events and the location of the head quarters.
[29] The same mobile peer group as in the fixed-net WACC estimation in Copenhagen Economics (2007).

APPENDIX B REFERENCE GROUP

The reference group consists of nineteen telecom companies engaged in mobile as well as fixed-net services. Seven of these are the same companies as in the mobile peer group presented above in table A1.

The remaining 12 are integrated operators and were selected according to the following three principles.

The first principle was geographic delimitation – only companies with the majority of their operations in the EU15-zone plus Norway and Switzerland were chosen. This is motivated by the need to identify a roughly uniform sample of companies with respect to regulatory environment, macroeconomic indicators and demand for telecommunications services.

A second principle was to omit small or atypical players.[30]

A third principle was that the company had to be publicly listed and beta estimable.

We consider the defined reference group as a representative sample of the population of telecom operators active in markets which are relevant as benchmarks for mobile telecom regulation in Sweden. Together, the reference group constitute a significant part of the market, although they may not constitute the complete population of relevant comparators.

The 12 integrated operators are listed in ascending order of fixed-net share in Table B.1.

Table B.1 Integrated operators included in the analysis

Company	Incumbent in	Share fixed	Share mobile
KPN	Netherlands	64%	36%
TDC	Denmark	58%	34%
Telecom Italia	Italy	56%	44%
Swisscom	Switzerland	48%	48%
Belgacom	Belgium	47%	52%
Telefónica	Spain	47%	52%
OTE	Greece	44%	34%
Portugal Telecom	Portugal	44%	48%
TeliaSonera	Sweden	42%	58%
Deutsche Telecom	Germany	42%	58%
France Télécom	France	38%	53%
Telekom Austria	Austria	38%	62%

Note: The fixed-net and mobile shares of EBITDA are derived from the annual statements of the operators BT is not included due to uncertainties regarding the EBITDA for the mobile share.
Source: Annual reports for 2006

[30] Luxemburg was omitted because of small size and Eircom in Ireland was omitted due to negative beta estimates and recent delisting.

APPENDIX C REGULATORY REFERENCES

The regulatory references include recent decisions by regulators on mobile voice call termination according to the following list, c.f. Table C.1.

Table C.1 Sources of regulatory references

Country	Source	Year
UK	Ofcom: Mobile call termination: A statement	2007
Netherlands	Final Report for OPTA: Conceptual design document	2006
Austria	Private correspondence	2007
Finland	Ficora´s principles for assessing mobile termination pricing	2006
France	Arcep: Décision n° 06-0206	2007
Spain	Decision: AEM 2007/699; AEM 2007/343; AEM 2007/648 (Comision Del Mercado De Las Telecomunicaciones)	2007
Norway	Kapitalkostnad for norske mobilselskaper; Professor Thore Johnsen	2005
Sweden	PTS: Antaganden för beräkning av priser 03-2332/23	2004

APPENDIX D DIVISIONALISED BETA ESTIMATE

The divisional approach was adopted in a previous study of WACC for fixed-net by Copenhagen Economics (2007). The approach is based on regression analysis where unlevered estimated company betas are modelled in terms of value shares for the different fields of activity of the company. The model is specified as

$$\beta_C = \beta_F w_F + \beta_M w_M + \beta_O w_O + \varepsilon$$

where β_C is company beta, β_A [*A=Fixed, Mobile, Other*] are parameters to be estimated representing betas relating to fixed-net, mobile and other operations, respectively. The variables w_A [*A=Fixed, Mobile, Other*] represents the corresponding weights of these operations. The weights for each respective business segment should, theoretically, be calculated as the economic value of each segment. However, that information is not available and we therefore use EBITDA as a proxy. The EBITDA is the operating cash flow and, as it represents the yearly contribution generated by a business segment. Hence, EBITDA is a reasonably accurate estimate of value. We use the EBITDA per segment for 2006 derived from the companies' latest annual reports.

The error term ε is iid and is assumed to fulfil the conventional distributional conditions.

The model is estimated using ordinary least-squares regression[31] on the reference group described in Appendix B above. Full documentation of the results according to the original model is provided in Copenhagen Economics (2007).

Given the importance of this model for our final judgement of beta, we have conducted robustness checks of the results. These checks involves the estimation of four additional models as follows.

- Model 1 is the reference model.
- Model 2 adds Tele2.
- Model 3 uses alternative beta estimates based on weekly data (Wednesdays) for the period 8 November 2002 – 7 November 2007, and adds Tele2.
- Model 4, same as Model 3 dropping Drillich and SFR/Vivendi.
- Model 5, same as Model 4 but also dropping Tele2.

The motivation for including Tele2 is that this company is falling short only by a tiny margin of being a member of the mobiles peer group. Since beta estimates can be sensitive to the estimation window, an alternative window was tried in models 3–5 in order to test parameter stability. The two companies which are reportedly somewhat odd, Drillisch, which is a virtual operator with no network of their own, and SFR/Vivendi, which is a large actor on media markets, were dropped for the same reason.

[31] Omitting the intercept term to ensure full rank.

A summary of the results are provided in Table C.1 below. The parameter of principal interest is β-mobile. As evident in the table, the parameter estimate is very stable across models, ranging from 0.71 to 0.81. In fact, the hypothesis that the parameter estimate is the same for all models cannot be rejected at any conventional level of probability.

The parameter estimate for fixed net fluctuates somewhat more in relative terms, in particular when Drillisch and SFR/Vivendi is dropped in models 4 and 5. These differences are, however, well within the 95% confidence interval. The beta estimate for the remainder "other" category drops considerably when these companies are dropped. These changes are not significant at the 95%-level, however, because of the high standard errors. Since the "other" category can be expected to be fairly heterogeneous, this is hardly surprising.

The overall fit as measured by R-square is satisfactory, and together with the stability of the relevant parameters, we can conclude that the systematic risk across countries in Western Europe is likely to result in a beta for mobile telecom services of around 0.8.

Table C.1 Divisionalised approach - alternative models

Model	β - fixed (s.e.)	β - mobile (s.e.)	β - other (s.e.)	R-square
1. Reference model, n=19	0.32 (0.15)	0.792 (0.094)	1.78 (0.44)	0.931
2. Reference model, including Tele2, n=20	0.33 (0.15)	0.810 (0.094)	1.79 (0.42)	0.931
3. New model, including Tele2, n=20	0.29 (0.15)	0.746 (0.082)	2.10 (0.75)	0.924
4. New model, drop Drillisch SFR, n=18	0.41 (0.14)	0.741 (0.095)	0.86 (0.53)	0.922
5. New model, drop Drillich/SFR/Tele2, n=17	0.42 (0.14)	0.712 (0.089)	0.77 (0.53)	0.922

Note: Robust standard errors in parentheses
Source: Copenhagen Economics

As identified in the study of fixed-net WACC referred to above, the Swedish incumbent has a significantly larger beta than implied by the model. In fact, the actual beta of TeliaSonera is 83% higher than the reference model 1 predicts. In the additional models estimated here, the actual beta of TeliaSonera is 59%-79% higher than predicted. For Tele2, the principal rival of TeliaSonera, actual betas are 36%-57% larger than predicted across the five estimated models. In contrast, Telenor and TDC in the neighbouring Norway and Denmark have betas that are lower than predicted.

Table C.2 Actual relative to predicted values for TeliaSonera and Tele2

Model	TeliaSonera	Tele2
1. Reference model, n=19	83%	39%
2. Reference model, including Tele2, n=20	79%	36%
3. New model	73%	43%
4. New model, drop Drillich SFR, n=18	59%	52%
5. New model, drop Drillich SFR, Tele2, n=17	62%	57%

Note: The percentages are defined as [Predicted beta/Actual beta – 1]x100. Predicted values are also calculated for companies in cases where these were dropped in the estimations

Source: Copenhagen Economics