Annex 5

Data Analysis

Introduction

1. This Annex examines empirical data, notably from the Merrill Lynch Global Wireless Matrix database (ML data) that several recent studies have used to compare alternative mobile termination regimes. In particular, it examines data that have been extensively used to compare so-called B&K countries to countries that have adopted a Calling Party Network Pays (CPNP) regime.
2. The Annex is structured as follow:
    - We first introduce and present cross-country data on mobile usage, prices and take-up that have often been used in the debate over the effects and implications of the choice of mobile wholesale termination regime. These data have been used both for simple cross-country comparisons and for more complex econometric analysis as shown in Annex 6 and Annex 7;
    - We then discuss a number of concerns with these data and attempts to address them[1]; and
    - The final section summarises the key messages from our empirical analysis.
3. As a general, but critically important, observation, simple cross-country data comparisons and any inferences drawn from them (even with unbiased data) should be interpreted cautiously, as there are many factors alongside the termination regime (or the level of termination rates) that could explain differences in outcomes across countries. This is addressed in the econometric studies discussed in Annex 6 and in Annex 7.

The "Merrill Lynch" Data

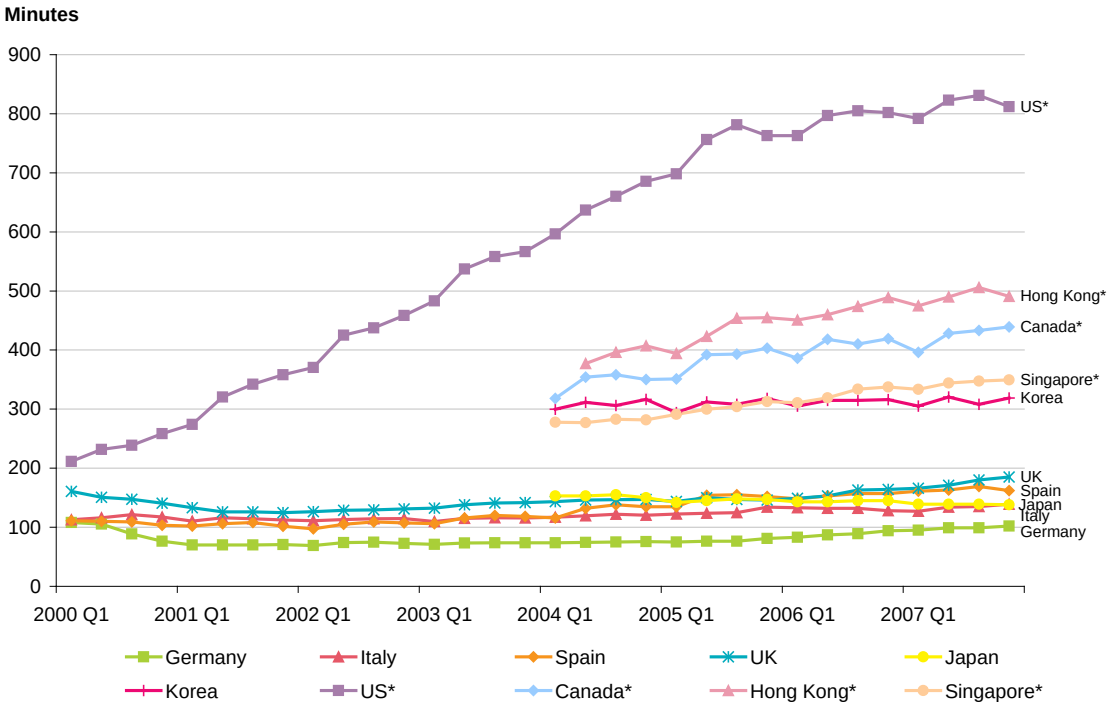
4. Several studies have relied on data from the Merrill Lynch Global Wireless Matrix database (ML) to examine the relative merits of the so-called B&K and CPNP regimes. In particular, they have focused on indicators such as average Minutes of Use (MoU) per subscriber, average Revenue per Minute (RpM) per subscriber and subscription penetration. It has often been argued on the basis of simple benchmarking exercises based on these data that output is higher and prices are lower in B&K countries relative to CPNP countries.[2]

[1] See for example Vodafone's response (and in particular Annex H) to the European Commission consultation on the Draft Recommendation on the Regulatory Treatment of Fixed and Mobile Termination Rates in the EU, available at http://ec.europa.eu/information_society/policy/ecomm/doc/library/public_consult/termination_rates/vodafone.pdf ("Vodafone Submission") and Frontier Economics: "Assessing the Impact of lowering mobile termination rates. A report prepared for Deutsche Telekom, Orange, Telecom Italia, Telefonica, and Vodafone". July 2008 ("Frontier Study") available at http://www.frontier-economics.com/_library/publications/Frontier%20publication_MTRimpact.pdf.

[2] For example, see the study by WIK-Consult for the European Commission, "The Future of IP Interconnection: Technical, Economic and Public Policy Aspects", 29 January 2008; and Littlechild, S. (2006), "Mobile Termination Charges: Calling Party Pays versus Receiving Party Pays", *Telecommunications Policy*, 30(5-6), 242-277.

5. We first compare average MoU and RpM per subscriber across a number of countries based on the original ML data. The so called B&K countries include the US, Canada, Hong Kong and Singapore. We have selected countries in this analysis with a similar level of economic development and similar institutional frameworks. This should reduce, but not eliminate, differences in the variables that can be explained by other factors (e.g. income differences).
6. Figure 1 shows that average (monthly) MoU per subscriber is significantly higher in B&K countries, relative to CPNP countries. Figure 2 shows that average RpM per subscriber is significantly lower in B&K countries, relative to CPNP countries. Note that Korea is labelled as a CPNP country but its mobile termination rates are close to zero. Therefore, it is not surprising perhaps that it is "closer" to the so-called B&K countries in terms of average MoU and RpM per subscriber. This suggests that the level of mobile termination rates, rather than the regime adopted, may be more important in explaining the differences in the data.

Figure 1: Average monthly minutes of use (MoU) per subscriber

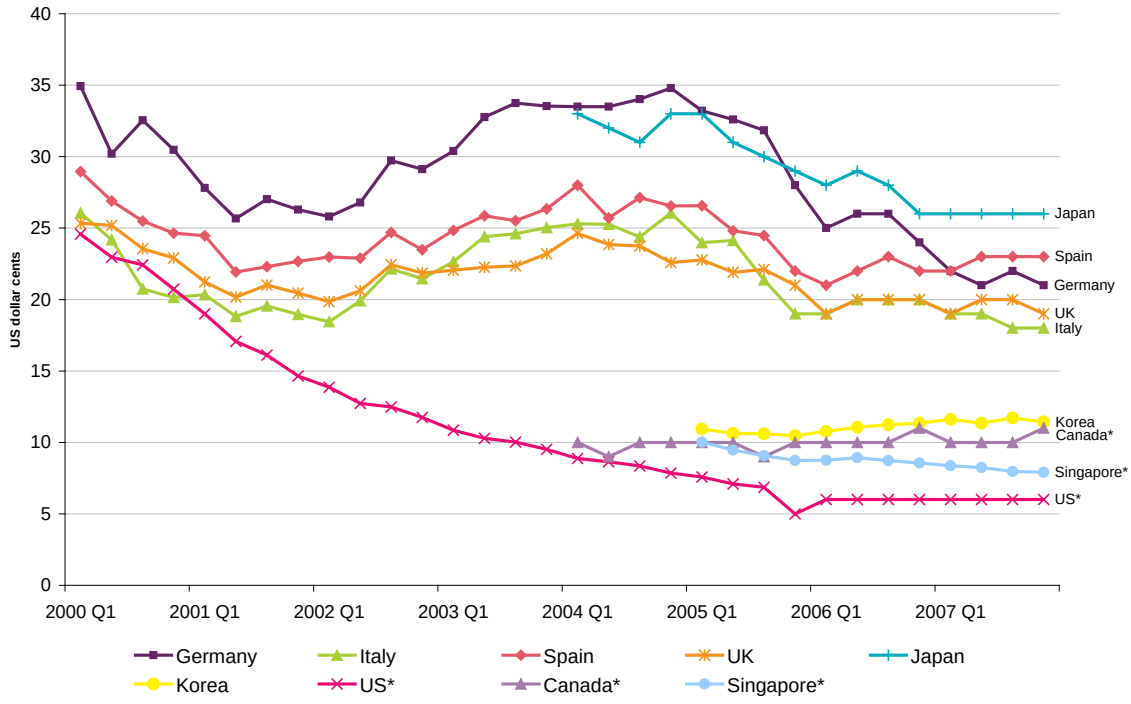


Notes: *ML measures average minutes of use by dividing total outgoing and incoming minutes by the number of subscriptions.*

Merrill Lynch dataset covers period up to 2007 Q4.

** denotes a B&K country.*

Figure 2: Average monthly revenue per minute (RpM) per subscriber



Notes: *RpM has been calculated on a monthly basis (i.e. dividing monthly ARpU by monthly MoU). RpM data is unavailable for Hong Kong.*

RpM is converted into dollar cents using average exchange rates calculated in each quarter.

** denotes a B&K country.*

Concerns with ML data

7. There are a number of concerns regarding the ML data. ML acknowledges that MoU figures are biased upwards and Average Revenues per User (ARpU) figures are biased downwards in B&K countries, relative to CPNP countries. Further biases might also affect the results, especially when comparing the US and Europe.

Average MoU per subscriber

8. The ML data set systematically overestimates MoU in B&K countries (by around 20% according to ML) as there is some double counting of mobile-to-mobile[3] minutes.
9. It has also been noted that, with particular reference to the US - Europe comparison, the ML MoU figures may also overstate US usage because of differences in billing methodologies.[4]

[3] In the data source, ML refers to the double counted minutes as "on-net" mobile minutes. However ML appears to be referring to all mobile minutes that are billed to both the caller and receiver. In this case the bias arises because minutes of use is defined as MoU=F2M+M2F+2*M2M in RPP countries (B&K countries are usually also RPP countries) rather than MoU=F2M+M2F+M2M in CPP countries. The Vodafone Submission claims that the double-counting is larger because they assume 50% of mobile originated calls to be on-net. Vodafone claims that this assumption is conservative because evidence from Europe shows that on-net calls may be more than 50%. We note, however, that one of the reasons why on-net traffic may be "intense" in Europe (but not in the US) is due to the fact that historically on-net call charges have been lower than off-net. The Frontier Study used Spanish data to adjust the US MoU by 29%.

10. We have not attempted to adjust the data further than for the bias explicitly recognised by ML because we do not have sufficient information to do so. We note that even if all these adjustments were implemented average MoU per subscriber would remain substantially higher in the US. This is consistent with the conclusions of similar recent studies[5]. We also note that Hong Kong and Singapore have significantly higher average MoU per subscriber than CPNP countries (except Korea).

Average RpM per subscriber

11. Average RpM per subscriber is a proxy for mobile prices often used to compare consumer outcomes (Figure 2). It is calculated by dividing voice-only ARpU by MoU.
12. The revenue figure used by ML to estimate ARpU overstates revenues in CPNP countries, because it includes wholesale termination revenues (biasing revenues upwards by about 20% in these countries[6]).
13. Furthermore, it is not clear that non-service revenues (such as equipment sales) are treated consistently across countries. ML states that "*some operators also include non-service revenues…in their ARpU calculation*". This possible inconsistency does not necessarily imply a bias between CPNP and B&K countries, however it reinforces the need to interpret the data carefully. In addition, the data is expressed by ML in US$ using the relevant quarterly average exchange rate and, hence, it is subject to exchange rate variations.
14. As ARpU figures are biased upwards in CPNP countries and MoU figures are biased upwards in B&K countries, the total effect is that the RpM of B&K countries relative to CPNP countries is biased downwards. However, because of the data concerns highlighted above, RpM data has to be treated significantly more cautiously than MoU data.

Subscription vs. Ownership Penetration

15. Mobile penetration is often, including in the ML data, measured as the number of SIM cards or subscriptions in the population. This measure tends to overestimate take-up or ownership of mobile telephony in general, as some consumers may have more than one subscription. We believe that ownership rather than subscription is the appropriate measure for mobile take-up. The former measures the proportion of population that makes use of a mobile phone.
16. The presence of non-zero termination rates in CPNP countries means that there are likely to be more consumers with multiple subscriptions in CPNP countries than in B&K countries. With high termination rates operators find it more profitable to retain subscribers that make no or few calls but receive some. Furthermore, it is in most cases costless for consumers to have multiple subscriptions (i.e. consumers on pre-

[4] For example Frontier Economics argues that there is a wide range of billing systems in Europe (by second, by minute, with a minimum charge of 30 or 60 seconds, etc.), while the billing system in the US is by minute as it rounds conversation time to the *next* full minute. This implies that US MoU may be overstated. The same point is made in the Vodafone Submission.

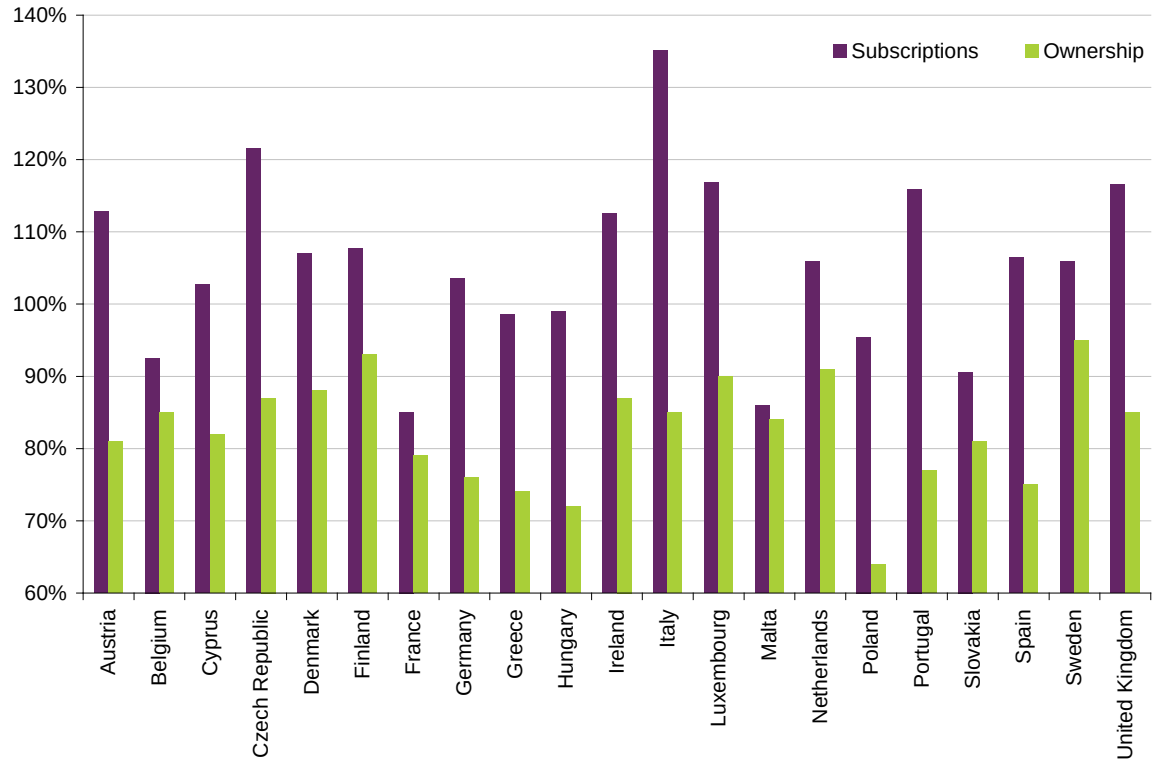
[5] See for instance the Vodafone study.

[6] The ML report from 2006Q1 estimates that termination payments account for roughly 20% of operators' revenues in CPNP countries. Frontier Economics uses estimates of wholesale termination revenues from a range of EU countries to adjust downwards RpM in CPNP countries. The adjustment used for European countries range from 10% for Belgium to 20% for Poland.

pay do not incur any expenditure unless they make calls). This explains why in many CPNP countries current subscription penetration rates often exceed 100 per cent.

17. The difference between the number of subscriptions and mobile ownership can be significant in CPNP countries, as shown, for example, in Figure 3 for European countries where the CPNP system applies. Unfortunately, we could not gather consistent and comparable data for the so-called B&K countries. However, there is some evidence suggesting that multiple subscriptions are less common in the US[7]. This means that penetration, as measured by the number of subscriptions, tends to be overestimated in CPNP countries to a much greater degree than in B&K countries.[8]

Figure 3: Subscriptions and ownership (2006)



Source: Subscriptions – Merrill Lynch dataset; Ownership – Eurobarometer, European Commission, 2006

Dealing with the ML data biases

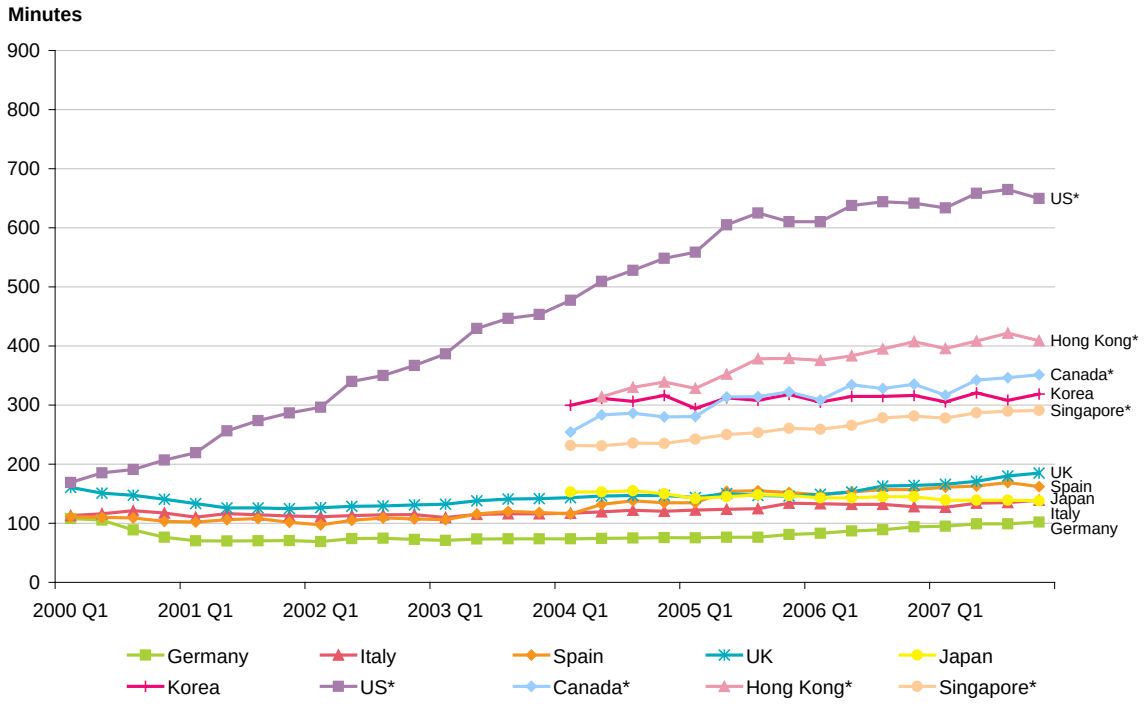
18. We have attempted to adjust the ML data to account for biases, but the adjusted data should be interpreted carefully, as the size of each bias is uncertain. Therefore, the adjusted figures have to be considered as illustrative only. As argued above this is particularly the case for the RpM figures.

[7] Vodafone argues that the percentage of adults using a mobile phone in the US is lower than the number of subscriptions per capita, though the difference is significantly less than for the European countries.

[8] Frontier Economics attempts to correct for this bias by considering only penetration data in the EU for which they have found information on active subscribers (defined as subscribers who have made or received a call/SMS in the previous three months). However, even after such adjustments, they find the penetration rates to be broadly consistent with those reported from other sources.

19. We adjusted both the average MoU[9] and RpM[10] per user data using the information in the ML database. Figures 4 and 5 show the impact of these adjustments.

Figure 4: Average monthly minutes of use (MoU) per subscriber (de-biased)



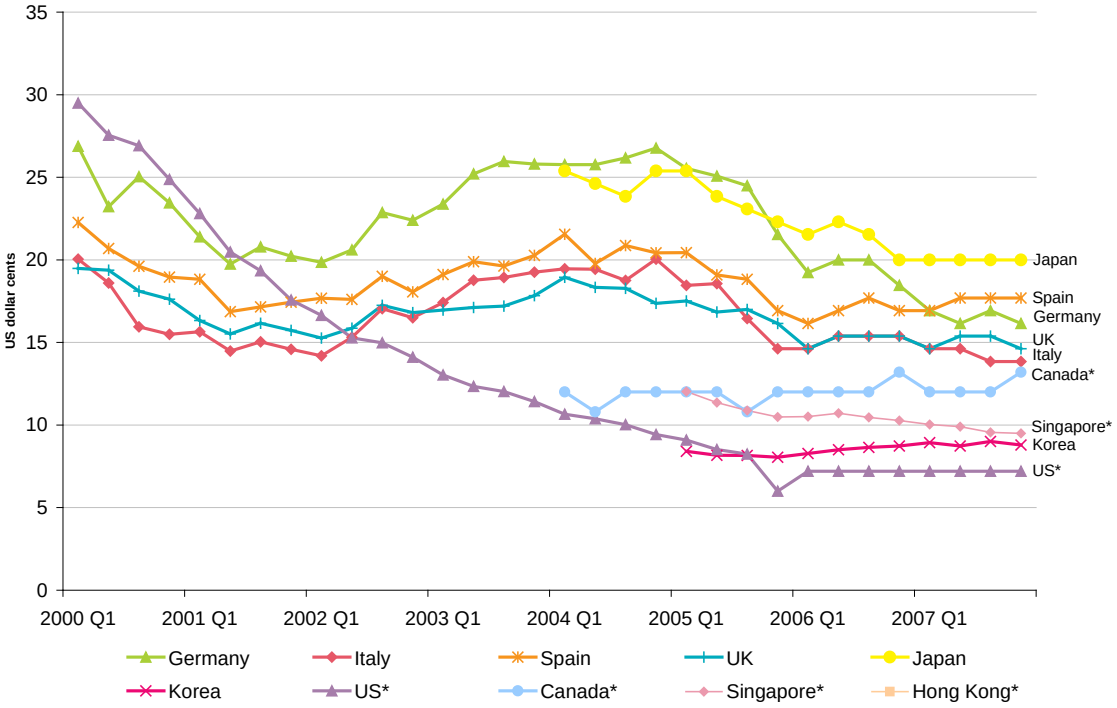
Notes: *US, Canada, Hong Kong and Singapore data have been de-biased.*

** denotes a B&K country.*

[9] ML estimated that MoU figures may be biased upwards by roughly 20% in B&K countries as there is double counting of minutes which are billed to both receiver and caller. Therefore, MoU figures in B&K countries were adjusted downwards to reflect this.

[10] MoU figures are potentially overstated by 20% in B&K countries and according to an internal flow of funds analysis ARpU figures may be overstated by 30% in CPNP countries.

Figure 5: Average revenue per minute (RpM) per subscriber (de-biased)



Notes: *US, Canada and Singapore data have been de-biased.*

** denotes a B&K country.*

20. Comparing Figures 4 and 5 with Figures 1 and 2, we note that these adjustments materially reduce the gap between CPNP and B&K countries, but B&K countries still show higher MoU and lower prices than CPNP countries.

An Alternative Price Measure

21. Given the above concerns as to the reliability of the ML RpM data we have also explored alternative price data.

22. Figures 6 to 9 show mobile price indices for a number of countries over the period 2002 to 2007, provided by Teligen.[11] The Teligen price indices measure the price of a representative basket of mobile services over time.[12]

23. Teligen provides three different baskets of mobile services which represent users with low, medium and high usage post-pay profiles. They also provide an additional basket covering a low usage profile independently of whether they are pre-pay or post-pay tariffs. These usage profiles were chosen by Teligen to be broadly representative of consumption profiles of mobile services across the OECD. The baskets specify a given number of outbound call minutes to on-net mobiles, off-net

[11] Teligen is a commercial organisation that collects and compares all available tariffs of the two largest mobile operators for thirty OECD countries over time (See http://www.teligen.com/).

[12] The 2002 basket definitions are specified as "Old definitions" in OECD Basket Definitions p.7 http://teligen.com/publications/oecd.pdf. The volume of calls (per year) in each of the low, medium and high baskets is 300, 900 and 1800 minutes respectively. The volume of messages is 360, 420 and 504.

mobiles and fixed lines as well as some SMS services and construct a yearly price index.

24. For each usage profile, Teligen calculates a price index by selecting the cheapest tariff for that usage profile from the available tariffs of the two largest operators[13]. This price is reported in local currency units. For comparison purposes, we have converted all prices to US$ using the OECD (GDP Purchasing Power Parity - PPP - in US$) exchange rates. The data appendix to Annex 7 discusses this dataset in more detail.

25. The Teligen dataset may have some advantages over prices expressed as RpM per user. First, RpM is an average price per user and consumers generally do not react to average prices. Second, the Teligen data have been converted using PPP which reduces the risks of price variations being solely due to exchange rate fluctuations. However, it is well known that price indices do not work very well when usage varies significantly over time and across countries. For example, the ML data indicate that current MoU per user in the US is above 600 *per month*, while the "high" user Teligen basket records 1,800 MoU per user per year (i.e. about one fourth of the current average MoU per user for the US).[14] [15] [16]

26. One pattern that seems to emerge from the Teligen data is that the prices for the US and Canada are higher in relative terms for the low usage profile and lower for the high usage profile. This might suggest that low termination rates lead to tariffs that "favour" high usage consumers.[17] However, one needs to be cautious in reaching this conclusion as this may be partly a consequence of distortions in the price indices, as discussed above. Furthermore, Korea which is a CPNP country but has very low mobile termination rates shows very low prices for both low and medium usage profiles.

[13] This is defined in terms of market share by subscribers when the two largest operators' market shares sum to at least 50%. Otherwise the tariffs of the third largest operator are also included. Where tariff data is only available for one operator the price index finds the lowest price for a given usage profile from that operator's tariffs.

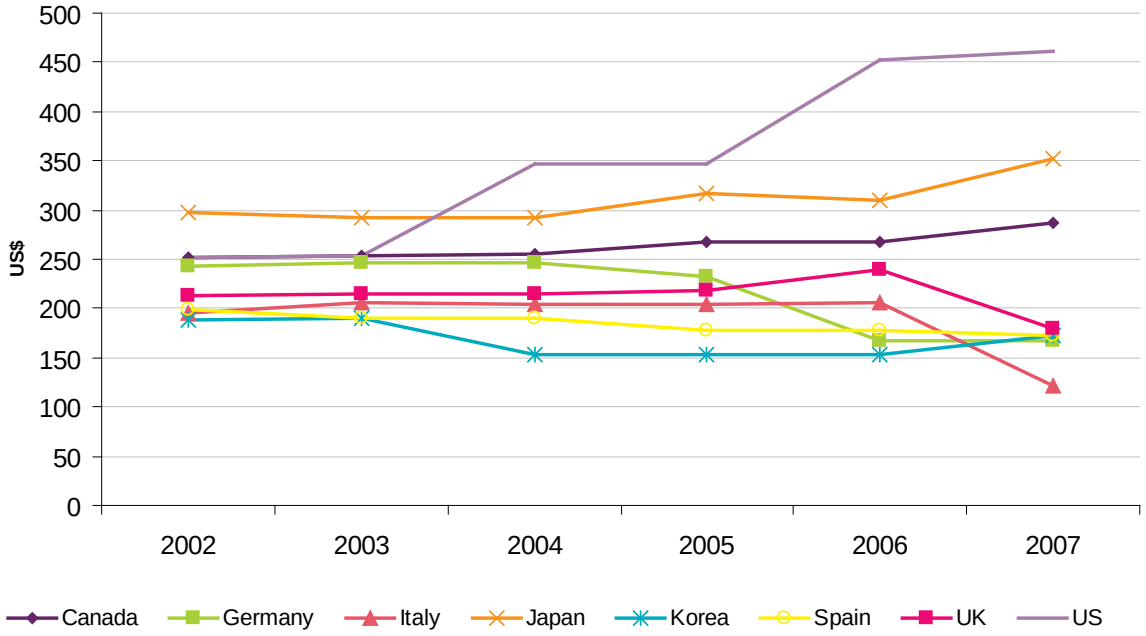
[14] Because there are no OECD GDP PPP conversion rates for Hong Kong and Singapore these countries are not reported in the Figures below.

[15] We have also tried the World Bank GDP PPP. Results were very similar and their use allows including results for Hong Kong and Singapore. However, the values for these countries vary significantly year on year raising concerns about data reliability.

[16] Another potential concern relates to the fact that the basket remains constant over time while usage may not. In particular, as mobile termination rates have declined over the period covered by the data, the retail price structure is likely to have changed accordingly with increasingly large bundles of minutes and higher subscription fees and lower usage charges. This means that if in the early period the basket may have included both a subscription and a call charges component, in more recent years the basket may include only a subscription fee. Critically it may be the case that the bundle of inclusive minutes may become larger than the minutes included in the basket. This means, for example, that the cheapest tariffs available may include more minutes than those in the basket. This may result in overestimating the price index for countries that have low or zero termination charges.

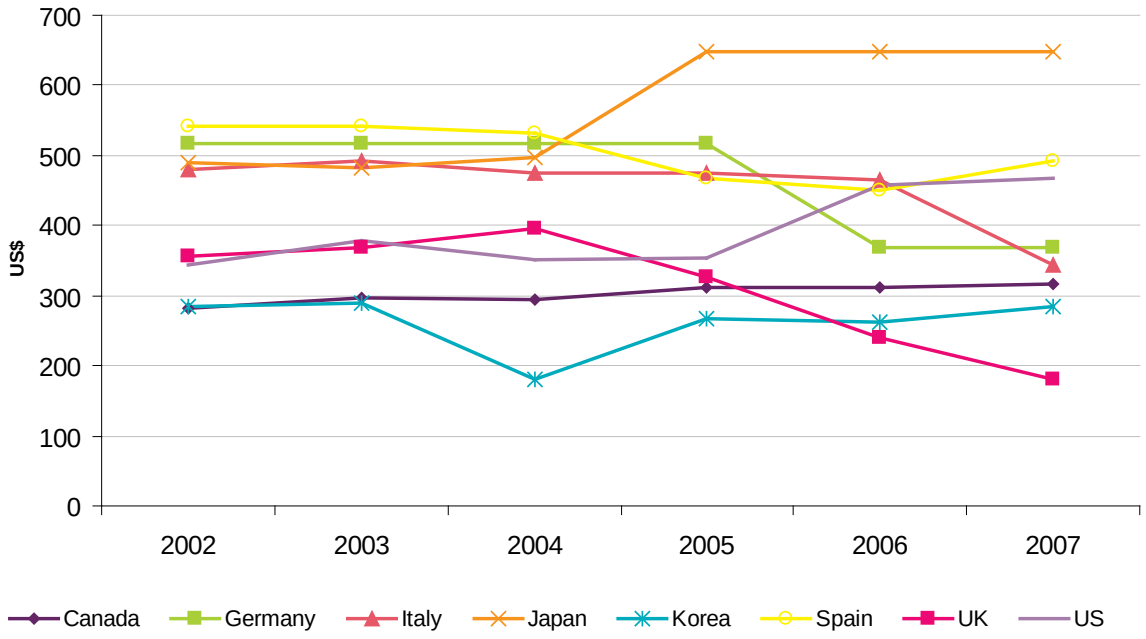
[17] This appears to be consistent with Frontier Economics' interpretation that US pricing plans offer a good deal for high consumers of mobile minutes / services compared to European plans but "score worse" as the usage intensity decreases. Their interpretation is based on OECD consumption basket data, possibly the same as the data we use.

Figure 6: Low usage price index (post-paid)



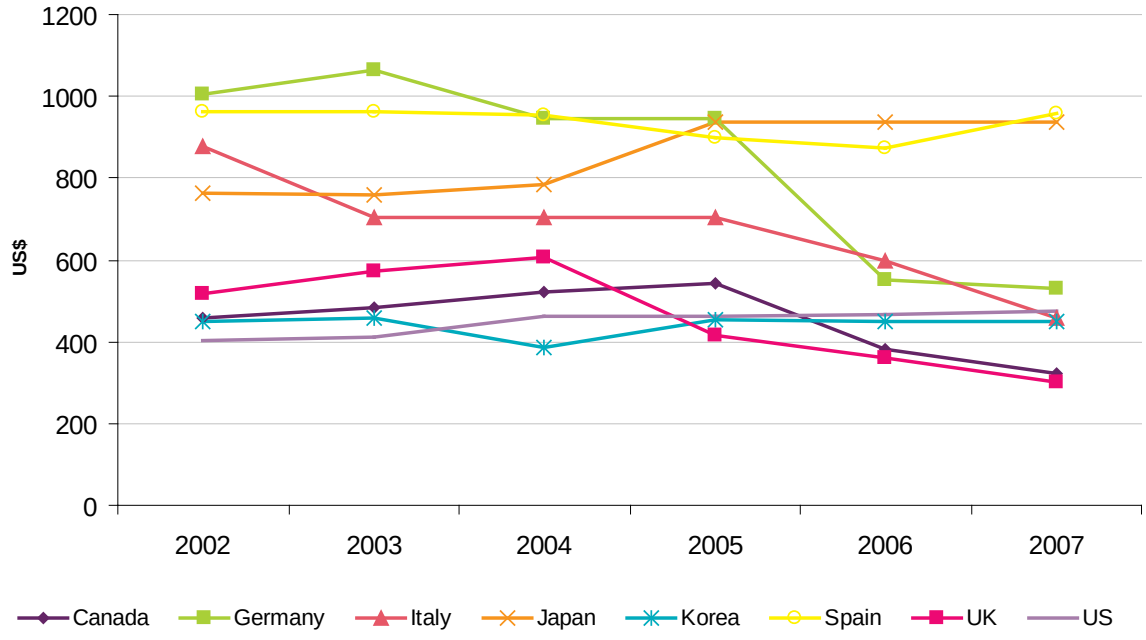
Source: Teligen

Figure 7: Medium usage price index (post-paid)



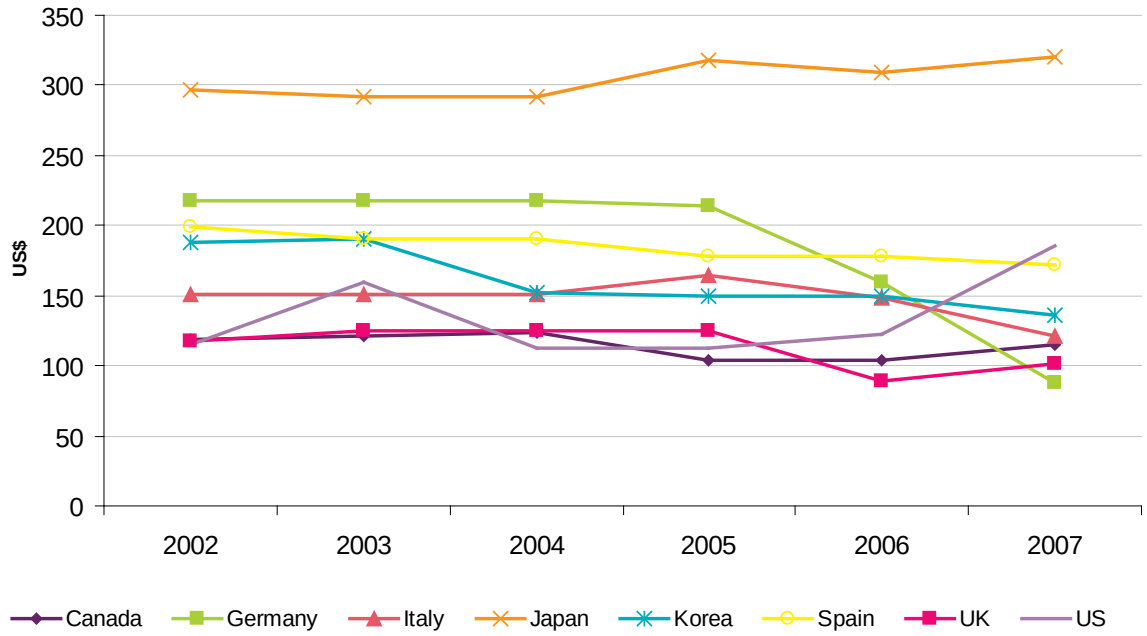
Source: Teligen

Figure 8: High usage price index (post-paid)



Source: Teligen

Figure 9: Low usage price index (pre-paid and post-paid)



Source: Teligen

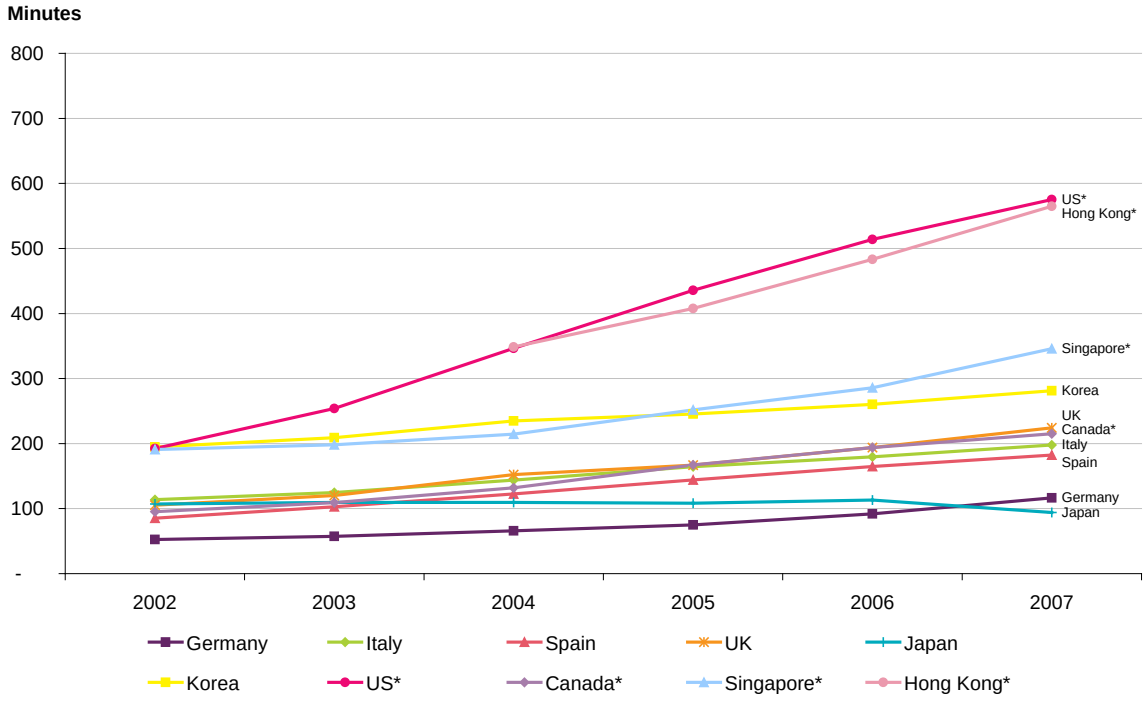
Dealing with a Possible Penetration Bias

27. Both measures of MoU and RpM are expressed on a per subscription basis. As discussed above, this may add a further distortion to the data as subscription per capita figures tend to be higher in CPNP countries, while this may not be the case when ownership is considered instead.

28. An alternative to average MoU per user is to use average MoU per capita. This could be interpreted as a comprehensive measure of output which is comparable across countries (rather than having penetration and minutes as two separate measures).

29. The effect of this adjustment is shown in Figure 10. The MoU difference between B&K countries and CPNP countries is significantly reduced. However, MoU per capita remains substantially higher in the US, Hong Kong and also Singapore. In Korea, where termination rates are close to zero, despite being labelled as a CPNP country, MoU per capita is also higher than in other CPNP countries.

Figure 10: Average monthly minutes of use (MoU) per capita (de-biased)



Notes: *US, Canada, Singapore and Hong Kong data have been de-biased.*

** denotes a B&K country.*

Conclusions

30. While this empirical analysis should be interpreted cautiously, some key messages emerge.

31. First, our preferred output measure is average MoU per capita adjusted for the bias in ML data. This shows that average MoU per capita is significantly higher for the US and Hong Kong. Singapore also shows a high MoU per capita and so does Korea which has very low termination rates despite being a CPNP country. Therefore, average MoU per capita is higher in so called B&K and/or low termination countries. This probably reflects the fact that low termination rates are likely to lead to lower retail call charges providing an incentive for longer and more frequent calls. Other studies that reviewed and adjusted for these biases focusing on the US and the EU have reached similar conclusions, even if there are differences in the proposed adjustments.

32. Second, it is difficult to reach any reliable conclusions in terms of prices using either the ML RpM figures and the Teligen price indices data.

33. Third, there is some evidence that in CPNP countries multiple subscriptions are more widespread than in B&K countries. This may explain in part why CPNP countries have significantly higher subscription penetration than the US or Canada (but not Hong Kong and Singapore). However, the difference is significantly lower when using the share of unique mobile users in the population.

34. Last, it is also worth noting that the large difference in MoU between the US and Hong Kong on one side and other countries on the other appears to be a relatively recent development. The gap in MoU significantly increased over the period,

suggesting that it may not perhaps be solely driven by differences in termination rates levels. A possible reason for the divergence could be the introduction of flat rate tariffs in the US in the early part of this decade.