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August 17, 2016

VIA ECFS

Marlene H. Dortch
Secretary
Federal Communications Commission
445 Twelfth Street, S.W.
Washington, DC 20554

Re: *Business Data Services in an Internet Protocol Environment et al., WC Docket Nos. 16-143, 15-247, and 05-25* and *RM-10593*

Dear Ms. Dortch:

On August 15 and 16, 2016, CenturyLink, Inc. engaged in several meetings with Commission personnel to discuss the above-referenced matters. Specifically:

- On August 15, 2016, Melissa Newman and Craig Brown of CenturyLink, Bryan Tramont and Russell Hanser of Wilkinson Barker Knauer, LLP, and Dr. Mark Schankerman of the London School of Economics met separately with Travis Litman of Commissioner Rosenworcel's office and Amy Bender of Commissioner O'Rielly's office.

- On August 16, 2016, Melissa Newman and Craig Brown of CenturyLink, Bryan Tramont and Russell Hanser of Wilkinson Barker Knauer, LLP, and Dr. Mark Schankerman of the London School of Economics met separately with Nick Degani of Commissioner Pai's office and Claude Aiken of Commissioner Clyburn's office.

- On August 16, 2016, Melissa Newman, Craig Brown, Jeff Lanning, and (by phone) Carolyn Hammack of CenturyLink, Bryan Tramont and Russell Hanser of Wilkinson Barker Knauer, LLP, and Dr. Mark Schankerman of the London School of Economics met with Stephanie Weiner of Chairman Wheeler's office; Matthew Del Nero, Eric Ralph, William Kehoe, Shane Taylor, and Christopher Koves of the Wireline Competition Bureau; Howard Symons and William Dever of the Office of General Counsel; and Chief Economist Katja Seim.

During these meetings, Dr. Schankerman discussed the study he conducted with Dr. Pierre Régibeau, entitled *Response to the FCC Further Notice: Regulation of DS1 and DS3 Services*.[1] The points he made are summarized on the attached presentations, which CenturyLink distributed to attendees of the meetings. In particular, Dr. Schankerman explained that (1) of the three data sets the Commission proposes to consider as potential bases for a one-time "catch-up" rate cut, only the United States Department of Labor's KLEMS data is appropriate; (2) use of that data shows that a properly computed adjustment would either leave TDM BDS rates virtually unchanged or result in a one-time rate increase of at least 4.4%; (3) accounting for U.S. KLEMS data would result in a going-forward X-factor of 1.06%; (4) the Commission should mitigate risk by committing to reevaluate the X-factor every five years; (5) there is no economic basis for applying an ad hoc "consumer dividend" (or, conversely, a "service provider dividend"); and (6) any rate reset should be geographically de-averaged to reflect variations in business density.

In applying these principles to a potential one-time reset, Dr. Schankerman recommended that the Commission go back at least to the year 2000, because the X-factors in the CALLS Plan were not based on productivity and, in fact, significantly exceeded actual productivity gains during those years. In other words, the CALLS-mandated 6.5% X-factors applied in 2001, 2002, and 2003 were no more "productivity-based"[2] than those that have been in place since 2005. It thus would be unreasonable for the Commission to include in its analysis some, but not all, of the years in which it imposed an X-factor not based on productivity evidence. And, as Drs. Schankerman and Régibeau further noted in their study, there is a strong case for extending the analysis back to 1997, because the X-factors applied thereafter were very high (6.5%) and ultimately were rejected by a reviewing court as empirically unsupported.[3]

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[1] *See* Mark Schankerman and Pierre Régibeau, *Response to the FCC Further Notice: Regulation of DS1 and DS3 Services*, attached to Letter from Russell P. Hanser, Counsel to CenturyLink, to Marlene H. Dortch, Secretary, FCC, WC Docket Nos. 16-143 *et al.* (filed Aug. 9, 2016).

[2] *Business Data Services in an Internet Protocol Environment*, Tariff Investigation Order and Further Notice of Proposed Rulemaking, 31 FCC Rcd 4723 at ¶ 360 (2016).

[3] *See United States Tel. Ass'n v. FCC*, 188 F.3d 521, 526 (D.C. Cir. 1999).

Please do not hesitate to contact the undersigned with any questions.

Sincerely,

WILKINSON BARKER KNAUER, LLP

Russell P. Hanser

Attachments

cc (via email): Stephanie Weiner
Amy Bender
Nick Degani
Howard Symons
Eric Ralph
William Kehoe
Shane Taylor
Travis Litman
Claude Aiken
Matthew Del Nero
Katja Seim
William Dever
Christopher Koves

Price Cap Design for Business Data Services

Mark Schankerman
London School of Economics

August 15 & 16, 2016

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Biography

Mark Schankerman is Professor in Economics at the London School of Economics, and Research Fellow at the Centre for Economic Policy Research (CEPR). He has a Ph.D. in Economics from Harvard University, formerly taught at New York University, and was Research Associate at the National Bureau of Economic Research (NBER) for ten years. He was Director of Policy Research and Advisor to the Chief Economist at the European Bank for Reconstruction and Development (EBRD) from 1995-2003, has worked at the World Bank on Africa, and has extensive consultancy experience in the private and public sectors. He is widely published in the areas of patents, innovation, university technology transfer, R&D and productivity, open source software, and emerging economies. His papers have appeared in many scientific journals, including the *American Economic Review*, *Econometrica*, *Journal of Political Economy, Quarterly Journal of Economics,* and the *RAND Journal of Economics.* He serves on the Advisory Board of the *Journal of Industrial Economics* and was an editor of several scientific journals. His book, *The Comingled Code: Open Source and Economic Development* (MIT Press, 2010, with Josh Lerner) was reviewed in *The Economist* (13 January 2011). In 2010-11 he served on the Panel of Experts for HMG Hargreaves Review of Intellectual Property and Growth.

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Summary

- **The Commission proposed three alternative data sources for establishing a one-time rate adjustment and going-forward X-factor.**
  - Only the first of these data sources (i.e., the U.S. Bureau of Labor Statistics' "KLEMS" data) is legitimate for this purpose.
  - Sappington/Zarakas' recommendation to use the European Union version of KLEMS data, which would double the X-factor, has critical pitfalls and therefore cannot reasonably be used by the FCC.
- **Getting the reset correct is critical, because an initial error will cause cumulative ongoing impacts, which can result in significant losses.**
  - Using the best publicly available productivity data and methodology, there is a strong empirical argument for *raising* DS1 and DS3 rates on a one-time basis *by a minimum of 4.4%,* depending on the data period used.
- **In setting the rate cap, the FCC should recognize that demand is declining, and the scope for technological improvements is limited, for these regulated, legacy services.**
  - Taking this into account, and using the best productivity evidence, *DSn rate caps going forward* should be permitted *to increase at the rate of inflation minus an X-factor of 1.06% per year*. This corresponds to a rise in *nominal rates* of 0.5% per year (but declines in inflation-adjusted rates)
- **Setting DSn rates too low will discourage the rapid adoption of superior technologies and undermine effective competition.**

There is no evidentiary basis for a negative rate reset, when proper methodology/productivity data are used.

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Basic Principles of Price Cap Design: “Similar but Different”

- The first principle of price cap regulation is that it should track the behavior of “competitive” prices that compensate for relevant economic costs including a normal return on capital investments. This should accurately reflect changes in the *cost conditions related to the regulated services.*

- This is done in two steps:

  - Setting the initial price at a competitive level in line with costs

  - Setting an annual adjustment rate to ensure that the regulated price remains at a competitive (cost compensatory) level. This is done by tying the evolution of prices to changes in determinants of costs, i.e., changes in input prices and total factor productivity.

- The second principle is that, in order to preserve the regulated firms’ incentives to invest in cost reduction, the measures of input prices and productivity used as the benchmark in the price cap should not be under the direct influence of the regulated firm.

  - Do not use performance of the regulated firm (even past performance creates a “ratchet effect”)

Potential Reset: Initializing price to reflect past productivity performance

- To set a potential reset, one should compare the past productivity performance for the benchmark (sector) with productivity adjustments actually used to cap prices under past regulation, and to choose the relevant period of comparison.

- Capped level of prices can be calculated using one of two established approaches: ”direct” or “indirect” methods.

Direct: % change in price cap = % change in sector input price index - % change in sector TFP

Indirect: % change in price cap = % change in GDPPI – X

where X = (% change in economy input price index - % change in sector input price index)
+ (% change in sector TFP - % change in economy TFP)

- Both ensure that the price cap tracks competitive (cost compensating) prices, provided the degree of market power (if any) in the economy and the sector is constant over the regulatory period.

- FCC uses what appears to be a different formulation, but it is equivalent to the direct approach (see discussion in the White Paper).

Either the direct or indirect price cap formulation can be used. Input price and TFP data must be internally consistent (mixing and matching sources vitiates the analysis).

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Potential Reset: Initializing price to reflect past productivity performance

- Using the same U.S. KLEMS data as the FCC and taking changes in capacity utilization over the business cycle for the period 2005-2014 into account, we find that current regulatory prices require almost no reset at all (a reduction of 0.1%). The regime in place since 2005 appears to have roughly matched what a properly designed X-factor would have achieved over this period.

- If we go further back and use the period 2000-2014, also taking changes for capacity utilization over the business cycle into account, we find that prices would need to be raised by 6.45%.

- DS1/DS3 are old legacy technologies. Potential sources/scope for productivity gains seem much more limited for these TDM services than in more dynamic parts of the telecommunications sector.

  -- Gains from economies of scale (which are reflected in sector-level TFP) are lower for ILECs since they focus more on DS1/DS3, whose demand is declining. The bias implies an additional upward adjustment of the price of as much as 0.81%, depending on the importance of DS1/DS3 services in the firm's overall offerings.

  -- Scope for technological improvement in these legacy services is likely to be more limited

- Thus any productivity estimate based on KLEMS data (and the X-factor that uses that estimate) will be an *overestimate of the true productivity growth* for DS1/DS3 services which are the target of regulation (in "non-competitive" markets).

Summary of Findings on Potential Reset: 2005-2014 Period

Table 10: Cumulative Reset of Regulated Price Implied by the X-Factor Approach, Allowing for Different Adjustments (2005 – 2014)

(1) FCC KLEMS 2005 – 2013	-0.63%
(2) KLEMS, Direct Method, 2005 – 2014	-0.4%
(3) KLEMS, Indirect Method, 2005 – 2014	+1.0%
(4) Adding Economies of Scale Effect Additional Reset	+0.36% to +0.81%
(5) KLEMS, Direct Method, Capacity Adjusted	-0.3% to +0.1%
(6) Allowing for 25% Lower TFP Growth for DS1/DS3. Additional Reset	+4%
(7) Possible Range = (2) to (3) + max(5) + (6)	-0.4% to +5.81%
(8) Baseline Estimate excluding economies of scale and lower TFP growth for DS1/DS3 = midpoint (5)	-0.1%
(9) Our "Best" Estimate including economies of scale and lower TFP growth for DS1/DS3 = midpoint (4) + midpoint (5)+ (6)	+4.4%

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Summary of Findings of Potential Reset: 2000-2014 Period

Table 11: Cumulative Reset of Regulated Price Implied by the X-Factor Approach, Allowing for Different Adjustments (2000 – 2014)

(1)	KLEMS, Direct Method, 2000 – 2014	+7%
(2)	KLEMS, Indirect Method, 2000 – 2014	+10.9%
(3)	Adding Economies of Scale Effect Additional Reset	+0.36% to +0.81%
(4)	KLEMS, Direct Method, Capacity Utilization Adjusted	+6.1% to 6.8%
(5)	Allowing for 25% Lower TFP Growth for DS1/DS3. Additional Reset	+ 10.5%
(6)	Possible Range = Lowest (3) to (2) + max(4) + (5)	+6.1% to +18.51%
(7)	Baseline Estimate excluding economies of scale and lower TFP growth for DS1/DS3 = midpoint (4)	+6.45%
(8)	Our "Best" Estimate including economies of scale and lower TFP growth for DS1/DS3 = midpoint (3) + midpoint (4)+ (5)	+17.5%

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Ongoing Price Cap Regulation

- The best productivity adjustment factor to be used going forward is the KLEMS-based “direct” or “indirect” approach which relates to a period recent enough to capture current productivity trends accurately.

- Using U.S. KLEMS data from 2011-2014, and taking changes in capacity utilization over this period, we find that, going forward, the price cap for DS1/DS3 service should be increased at an annual rate of 0.5%.

- In the FCC’s formulation – and starting from an average annual change in GDDPI equal to 1.56% from 2011 to 2014 -- this corresponds to an X-factor of 1.06%.

- Again, this productivity estimate based on KLEMS data (and the X-factor that uses that estimate) is likely to be an overestimate of the true TFP growth for DS1/DS3 services, given that these are legacy services based on old technologies.

- To mitigate the risk that the initial productivity factor may fail to track competitive prices accurately as circumstances change, the FCC may consider adopting in-depth reviews every 5 years and sporadic checks based on prices charged in markets deemed competitive.

- It would be economically unwarranted to address this two-sided risk by introducing a “consumer dividend” (or a dividend for service providers). Relying on a completely ad hoc consumer dividend is likely to encourage unproductive rent-seeking behavior on both sides.

Summary of Findings for Price Cap Going Forward

Table 12: Ongoing Regulation: Direct method Adjusted for Cyclical Changes in Capacity Utilization, 2011 to 2014.

Year	% change in input prices	% change in TFP	% change in capacity utilization	Direct Method Adjustment
2011	-1.04	-0.90	1.13	0.99
2012	0.76	-0.20	0.09	1.05
2013	3.28	3.30	0.17	0.15
2014	1.45	1.70	0.05	-0.20
Average Annual Rate	1.1%	0.96%	0.36%	0.50

Based on the best data and methodology, the price cap should allow *nominal prices* to increase at the rate of 0.5% per year (real prices decline since GDPPI exceeds this value). The corresponding X-factor in the FCC formulation of the price cap is 1.06%.

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The Sappington and Zarakas Study

- While there is broad agreement across economic experts in this proceeding as to the methods that should be used for potentially resetting the regulated price and designing the future regulatory regime, the Sappington and Zarakas testimony uses incorrect and seriously misleading data and should be rejected.

- First, the TFP data in the EU-KLEMS is based on value added, not gross output. To be translated into the correct gross output-based measure of TFP, the value-added TFP must be divided by the ratio between gross output and value added, which is around 1.8 for the telecommunications sector. Thus, their productivity adjustment is nearly double the correct measure.

- Second, the EU-KLEMS input index excludes prices for capital and labor, which make up most of value-added and more than half of total costs. Correct economic reasoning compels consistency between the TFP measure and the input price index used, and the EU-KLEMS data they use fails this requirement.

By failing to adjust their value-added TFP measure, Sappington and Zarakas overestimate the true (gross output) TFP gains in the sector by a factor of nearly two.

Conclusion

- For the period 2005-2014, and taking into account a capacity utilization adjustment, our best estimate, based on the hard productivity evidence (without appropriate adjustments noted below), is that a potential reset should involve a *0.1% reduction* in regulated prices.

- If we take into account other important factors (e.g. competitive erosion of market share in the context of economies of scale, and the fact that DS1/DS3 are legacy technologies with likely lower TFP growth than other parts of the telecommunications sector), our best estimate is that the *reset should involve a 4.4% increase in regulated prices.*

- However, we recommend using the period 2000-2014 for any potential reset. Our best estimate, based only on the hard productivity evidence, is that the reset should involve a *6.45% increase in regulated prices*. If we take into consideration competitive market erosion in the context of economies of scale, and the fact that DS1/DS3 are legacy technologies with lower TFP growth than other parts of the telecommunications sector, our best estimate is that the reset should involve a 17.5% increase in regulated prices.

- Economic studies confirm that business density is an important determinant of unit cost. Thus the reset should de-averaged to reflect variations in business density, if the price cap is to achieve the stated objective of tracking prices in competitive markets.

- After that, for ongoing price cap regulation, a *single X-factor* based on productivity evidence should be adopted.

Conclusion (continued)

- The rate of the productivity adjustment factor to be used in the ongoing price cap regime is best obtained by applying the KLEMS-based "direct" or "indirect" approaches to data that relate to a period recent enough to capture current productivity trends accurately.

- Based on the hard productivity evidence from the last few years and taking into account scale effects we recommend that, *going-forward regulated prices should be allowed to increase by 0.5% in nominal terms* (but they decline in real terms). This corresponds to an *X-factor in the FCC formulation of the price cap of about 1.06%.* This should be taken as the minimum upward adjustment in nominal prices (equivalently, the maximum X-factor) because it does not recognize the likelihood that DS1/DS3, which are legacy services, with less ongoing productivity gains than other services in the telecommunications sector.

- We agree with the Commission that there is a legitimate concern about the possibility that any productivity adjustment factor chosen initially might fail to track competitive prices accurately as circumstances change. We suggest adopting in-depth reviews every five years, possibly with sporadic checks based on prices charged in markets the FCC deems to be competitive.

- It is economically unwarranted to address this two-sided risk by introducing a one-sided "consumer dividend" (or a dividend for service providers, for that matter).

Appendices

Charts and Graphs

Table 1: Percent difference between regulated and competitive prices as a function of the reset rate (measured relative to the competitive price)

	$x_c = 1\%$	$x_c = 2\%$	$x_c = 3\%$	$x_c = 4\%$	$x_c = 5\%$
$x_r = 1\%$	0	12.50%	26.50%	42.10%	59.40%
$x_r = 2\%$	-11.20%	0	12.40%	26.20%	41.60%
$x_r = 3\%$	-21%	-11%	0	12.30%	26%
$x_r = 4\%$	-29.60%	-20.80%	-10.90%	0	12.20%
$x_r = 5\%$	-37.30%	-29.40%	-20.60%	-10.80%	0

Source: CRA

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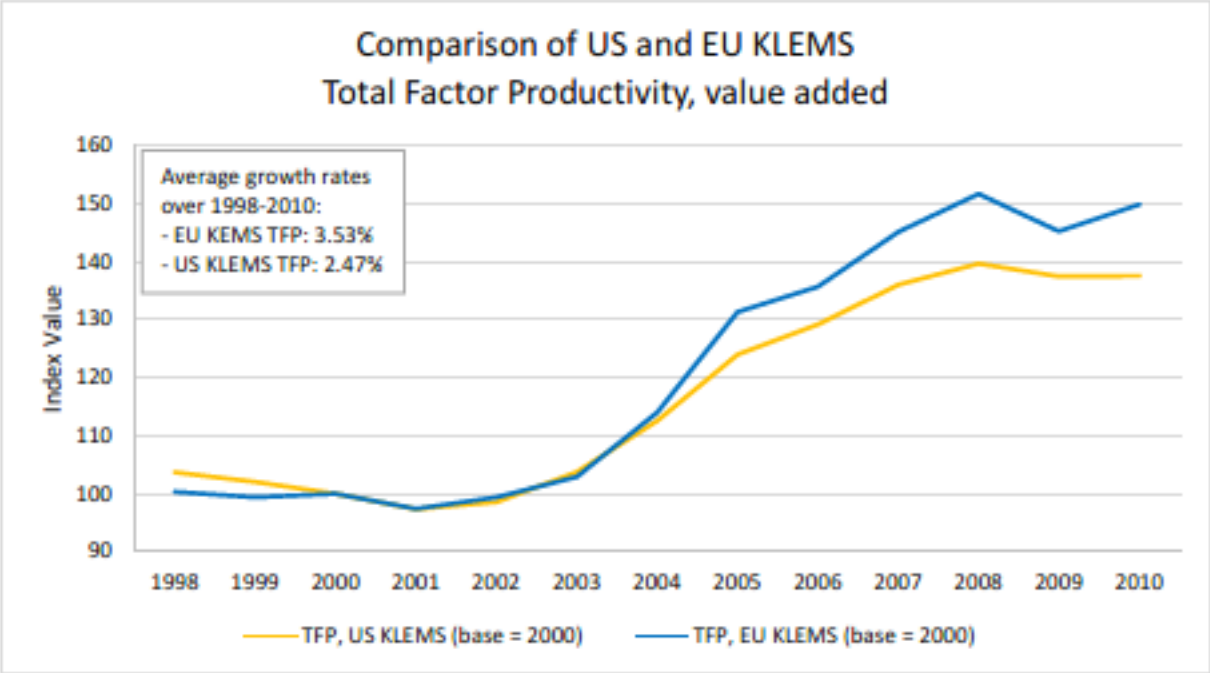
Figure 1: Comparison of US and EU KLEMS



Source: The TFP series from EU KLEMS refers to the variable "TFPva_I: TFP (value added based) growth, index" for "Telecommunications" in the EUKLEMS database, March 2013 release, accessed via http://euklems.net/, last accessed: 13/07/2016. The TFP series from KLEMS refers to the variable "Multifactor productivity" in Table 1.2, for "Broadcasting and telecommunications (NAICS 515, 517)" from the Bureau of Labor Statistics (BLS), accessed via http://www.bls.gov/mfp/mprdload.htm, last accessed: 30/06/2016.

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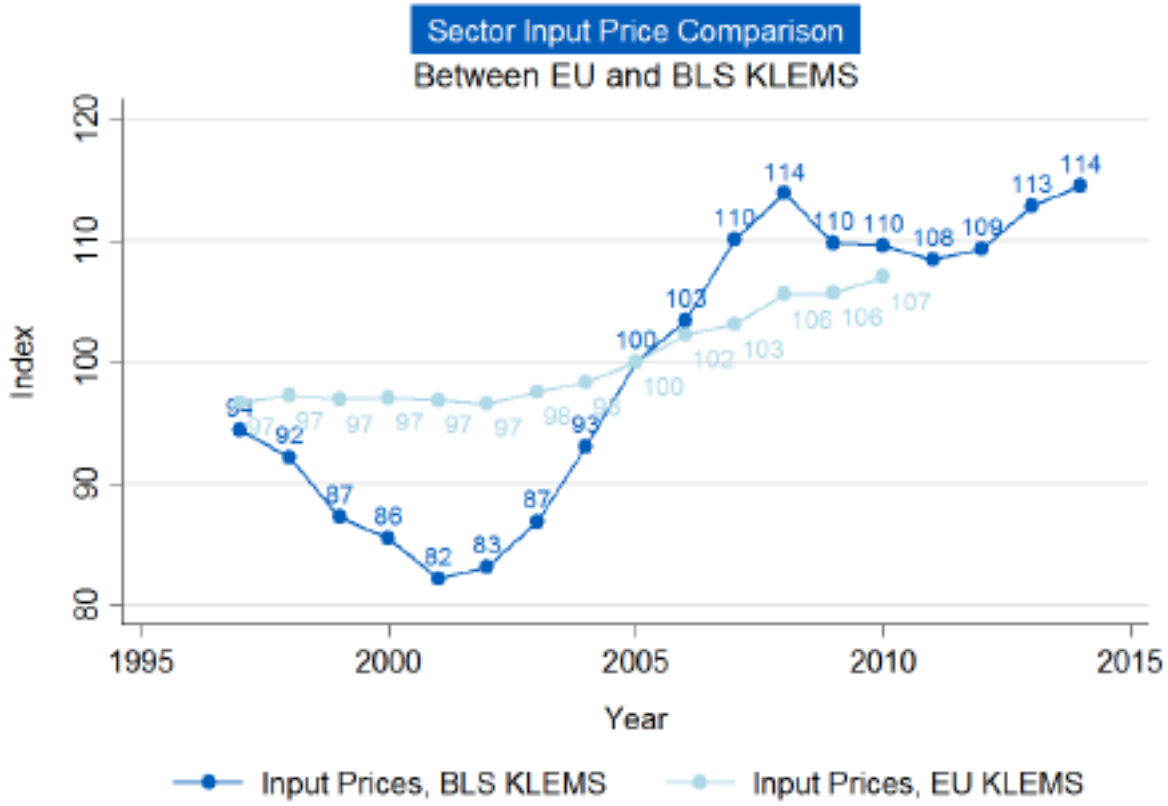
Figure 2: Comparison of sector input prices from EU-KLEMS and BLS KLEMS data



Source: CRA, with EU-KLEMS and BLS KLEMS data

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Table 2: Reset needed to correct for ad hoc regulation over the 2000- 2014 period

Year	GDPPI, %	X-factor, % (CALLS Order)	Sector Input price growth, % (based on KLEMS data)	Sector TFP growth, % (based on KLEMS)	Price Cap adjustment, %, direct method (based on KLEMS)
2000	2.28	3	-2.04	-2	-0.04
2001	2.28	6.5	-3.91	-2.6	-1.31
2002	1.53	6.5	1.22	1.3	-0.08
2003	1.99	6.5	4.47	5.2	-0.73
2004	2.75	2.75	7.09	8.5	-1.41
2005	3.22	3.22	7.48	10.1	-2.62
2006	3.07	3.07	3.41	4.2	-0.79
2007	2.67	2.67	6.49	5.3	1.19
2008	1.93	1.93	3.39	2.7	0.69
2009	0.79	0.79	-3.54	-1.6	-1.94
2010	1.23	1.23	-0.21	0.1	-0.31
2011	2.06	2.06	-1.04	-0.9	-0.14
2012	1.84	1.84	0.76	-0.2	0.96
2013	1.63	1.63	3.28	3.3	-0.02
2014	1.64	1.64	1.45	1.70	-0.25

Source: The variable "X-factor, % (CALLS Order)" is set to 3% in 2000, 6.5% in 2001 to 2003, and equal to GDP-PI thereafter. The sector TFP data is taken from the variable "Multifactor productivity" in Table 1.2, and for the sector input prices a list of variables is used: "Price of Capital Services", "Price of Labor", Price of Energy", "Price of Materials" and "Price of Purchased Services" from Table 2.3 and "Capital Factor Shares", "Labor Factor Shares", Energy Factor Shares", "Materials Factor Shares" and "Purchased Services Factor Shares" from Table 5.1 for "Broadcasting and telecommunications (NAICS 515, 517)" from the Bureau of Labor Statistics (BLS), accessed via http://www.bls.gov/mfp/mprdload.htm, last accessed: 30/06/2016.

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Table 3: Cumulative Adjustment Factors and Reset for 2000-2014 and 2005-2014

Period	GDPPI, CAGR	X-factor, CAGR (CALLS order)	Direct Price adjusted CAGR (based on KLEMS)	Cumulative adjustment (CALLS Order)	Cumulative adjustment (unadjusted direct approach)	Implied Reset
2005-2014	1.2%	1.2%	-0.05%	0.0%	-0.4%	-0.4%
2000-2014	2.0%	3.0%	-0.5%	-12.7%	-6.6%	+7.0%

Source: The input data for these calculations is taken from the previous table. The Cumulative adjustment (CALLS order) has been calculated as (1+GDPPI-XFACTOR)^14 - 1, the Cumulative adjustment (based on the unadjusted direct approach) has been calculated as (1+Direct P adj.)^14 - 1.

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Figure 2: Decreasing Average Costs and Shifting Residual Demand

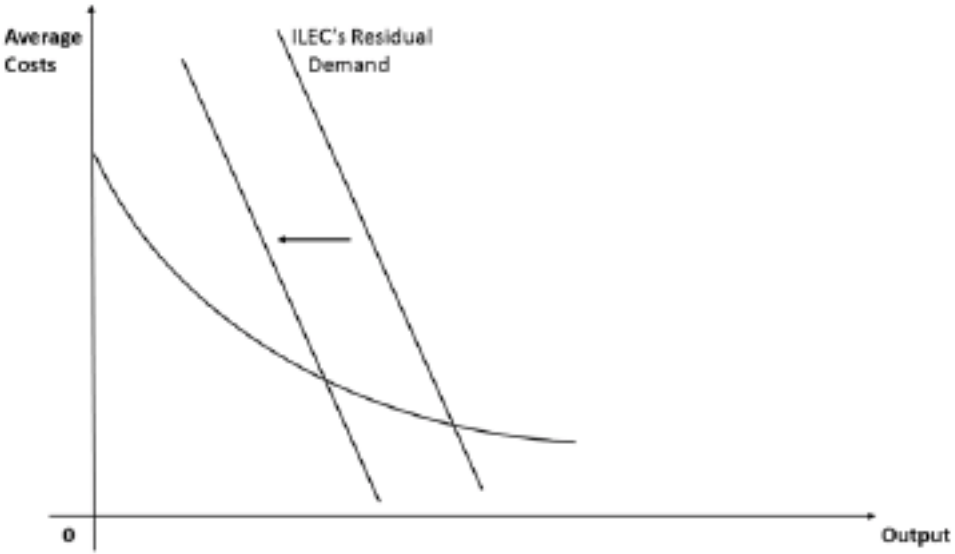

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Figure 3: The Effect of Shrinking Residual Demand

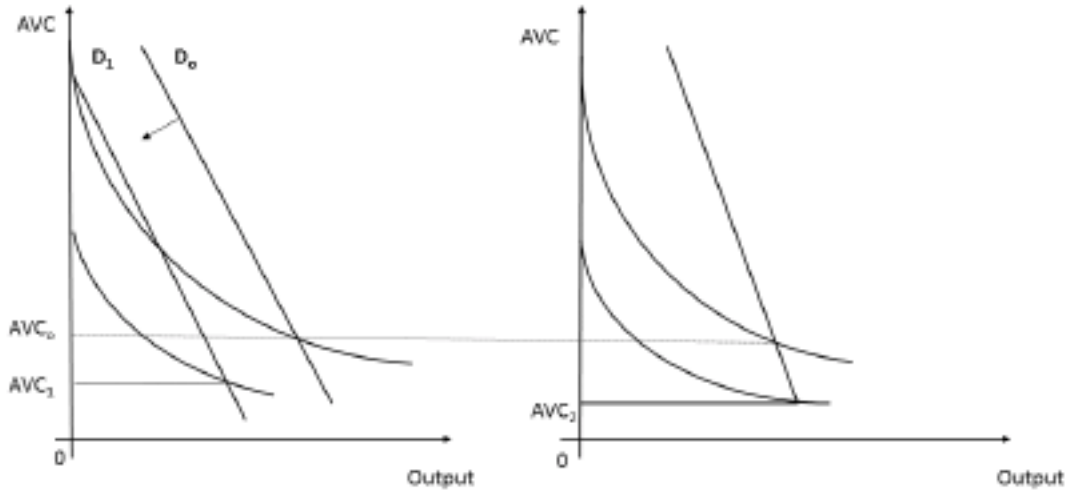

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Table 4: Difference between TFP growth for the sector and the ILEC, calibrated on CenturyLink data

	Total Cost Elasticity		
	$\varphi = 0.7$	$\varphi = 0.75$	$\varphi = 0.8$
$\theta = 0.06$	0.54%	0.45%	0.36%
$\theta = 0.07$	0.63%	0.53%	0.42%
$\theta = 0.08$	0.72%	0.6%	0.48%
$\theta = 0.09$	0.81%	0.68%	0.54%

Source: Calculated by CRA

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Table 5: Annual Rate of Change in TFP without and with an Adjustment for cyclical movements in Capacity Utilization

Period	% change in TFP, unadjusted	% change in TFP, adjusted/all factors	% change in TFP, adjusted/capital only
2005 – 2014	1.60%	1.50%	1.60%
2000 – 2014	2.60%	2.60%	2.60%

Source: The TFP series from KLEMS refers to the variable "Multifactor productivity" in Table 1.2, for "Broadcasting and telecommunications (NAICS 515, 517)" from the Bureau of Labor Statistics (BLS), accessed via http://www.bls.gov/mfp/mprdload.htm, last accessed: 30/06/2016. From the same source, the variable "Capital Factor Shares" is taken, see Table 5.1. The utilization rate for the economy is calculated from the variable "dutil: Utilization of capital and labor" from the FED database, precise citation: John G. Fernald, "A Quarterly, Utilization-Adjusted Series on Total Factor Productivity" FRBSF Working Paper 2012-19 (updated March 2014).

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Table 6: Cumulative % Adjustment Required to "Reset" the Regulated Price

Period	Direct Approach, unadjusted	Direct Approach, adjusted for all factors	Direct Approach, adjusted, capital only
2005 – 2014	-0.4%	0.1%	-0.3%
2000 – 2014	+7%	+6.1%	+6.8%

Source: This table uses data described in detail in earlier tables. As an overview, the following variables are used here: the TFP variable for NAICS classifications 515 and 517 from the BLS KLEMS data and the input price based on tables 2.3 and 5.1 from the same source. For adjustments, utilization rates of the economy (data from the FED) and the capital share from KLEMS for the NAICS sectors 515 and 517 are used.

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Table 7: Indirect Approach, Annual percentage change in regulated prices

Period	Annual price cap change
2005 – 2014	0.10%
2000 – 2014	-0.20%

Source: In addition to variables described earlier, the following variables are used here: for the aggregate TFP, the variable "dtfp: Business sector TFP" is used, from the FED database, precise citation: John G. Fernald, "A Quarterly, Utilization-Adjusted Series on Total Factor Productivity" FRBSF Working Paper 2012-19 (updated March 2014), and the variable "Input Price" in Table 4.2 in the XG tab (Excluding Government Enterprises), from the Bureau of Labor Statistics (BLS), accessed via http://www.bls.gov/mfp/mprdload.htm, last accessed: 30/06/2016.

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Table 8: Indirect Approach: Cumulative Reset of the Regulated Price

Period	Cumulative reset
2005 – 2014	1%
2000 -2014	10.9%

Source: As per the previous table. Note that the data herein refers to the unadjusted data.

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Table 13: Difference between TFP growth for the sector and the ILEC, calibrated on CenturyLink data, annual rate 2013 – 2015.

		Total Cost Elasticity	
	$\varphi = 0.7$	$\varphi = 0.75$	$\varphi = 0.8$
$\theta = 0.06$	0.15%	0.13%	0.1%
$\theta = 0.07$	0.18%	0.15%	0.12%
$\theta = 0.8$	0.2%	0.17%	0.14%
$\theta = 0.9$	0.33%	0.19%	0.15%

Source: Calculated by CRA

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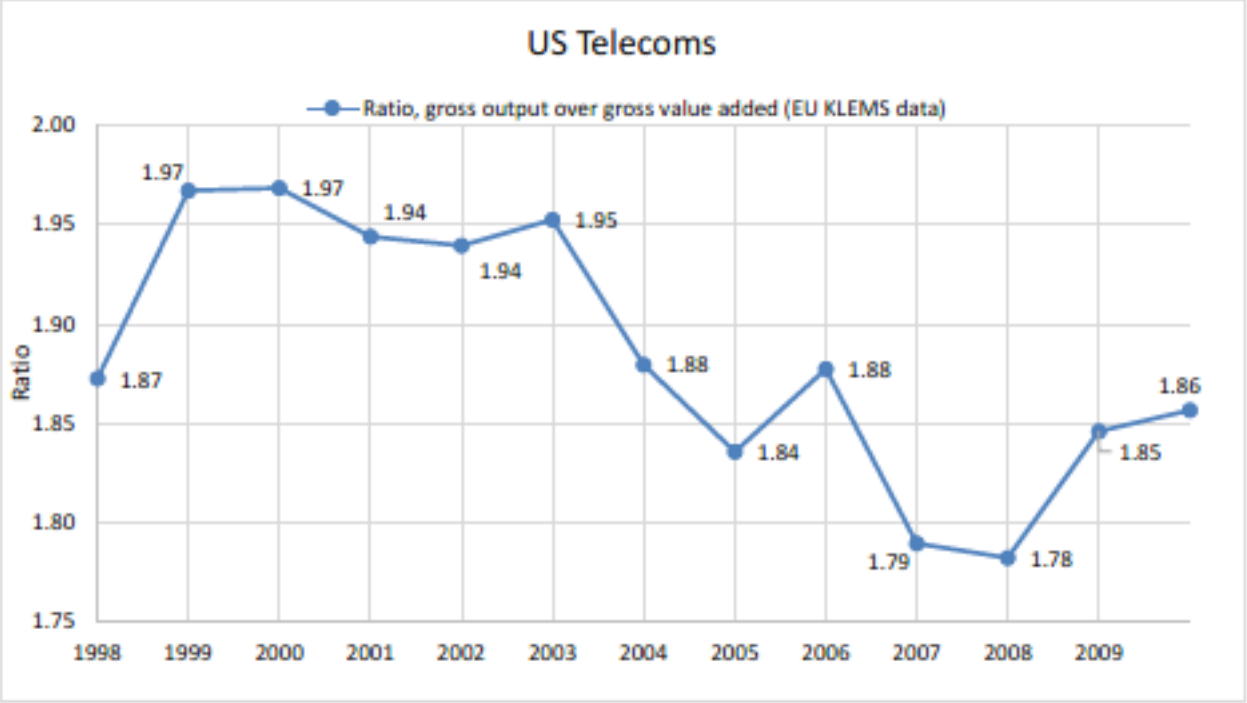
7.1. Appendix 1: Gross Output to Value added Ratio

Gross Output to Value Added Ratios, US Telecoms (from EU-KLEMS)



Source: The gross output and gross value added series from EU KLEMS refer to the variables "GO: Gross output at current basic prices (in millions of US Dollars)" and "VA: Gross value added at current basic prices (in millions of US Dollars)" respectively, both for "Telecommunications" in the EUKLEMS database, March 2013 release, accessed via http://euklems.net/, last accessed: 13/07/2016

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Equations & Explanations

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3.3 Direct and indirect approaches

24. Let us define the maximum price allowed as P_{max} and the competitive price level as $P_c = (1+m)AVC$, where AVC is the average variable cost and m is a profit margin that compensates those inputs that are fixed over the time horizon considered ("quasi-fixed" inputs), so $m = 0$ in the long run. Let us assume that, in period 0, the initial maximum price has to be set equal to the competitive level, i.e. $P_{max}(0) = P_c(0)$. In order to ensure that the maximum allowed price remains at the competitive level over time, one must set the change in the maximum price equal to the change in the competitive price. Expressed in terms of percentage changes (denoted by a "d"), this implies that:

$$dP_{max} = dAVC$$

Or, equivalently,

$$\%\ change\ in\ regulated\ price = \%\ change\ in\ AVC$$

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3.2 Direct and indirect approaches

25. In turn, for a company that constantly adjusts its input mix to minimise costs, the change in average variable cost can be decomposed into a change in input prices and a change in total factor productivity. Defining w_i^S as the price of input i in sector *s* (where there are N different inputs) used by the company and s_i as the cost share of this input, we have:

$$dP_{max} = \sum_{i=1}^{N} s_i^S dw_i^S - dTFP_s$$

Or, equivalently:

% change in regulated (output) price =

% change in index of input prices in the sector - % change in sectoral TFP

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3.3 Direct and indirect approaches

28. The alternative, "indirect" approach links the regulated prices to the change in output prices at the level of the U.S. economy-wide private sector, which is easy to collect, adjusted by an appropriate X-factor. Again, as with the direct approach, it is not necessary to assume that the economy as a whole is competitive (only that the degree of market power is roughly constant over the period of regulation).

29. Following the same logic as above, we can derive the appropriate X-factor by decomposing the percentage change in the maximum regulated price into the percentage change in input prices and the percentage change in productivity, but now we can do that both for the sector/market to be regulated and for the economy as a whole. We index factors referring to the sector with an "S" and those referring to the economy as a whole by "E":

$$dP^S_{Max} = \sum_{i=1}^{N} s_i^S \, dw_i^S - dTFP^S$$

$$dP^E = \sum_{i=1}^{N} s_i^E \, dw_i^E - dTFP^E$$

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3.3 Direct and indirect approaches

30. We now need to assume, reasonably, that the change in the input price faced by the sector to be regulated differs from the change in the index of input prices in the economy as a whole by a constant percentage amount, which we will label as D. Thus we have

$$\sum_{i=1}^{N} s_i^S dw_i^S = \sum_{i=1}^{N} s_i^E dw_i^E + D$$

For example, if D =2% it would mean that the regulated sector's input prices go up by 2% more than for the economy as a whole.

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3.3 Direct and indirect approaches

31. Combining this with the two relationships above for the % changes in output prices at the sector and economy levels, we get the basic formula for the price cap:

$$dP^{S}_{Max} = dP^{E} - [dTFP^{s} - dTFP^{E}] + D \equiv dP_{E} - X$$

Or, equivalently:

% change in the regulated price = % change in GDPPI – difference between % change in TFP in the sector and in the economy +(constant) difference between the % change in the input price index for the sector and for the economy as a whole

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3.3 Direct and indirect approaches

34. Although the manner in which price-cap formula is presented in the Further Notice does not at first appear to follow either of these two traditional approaches, it is actually equivalent to the "direct" approach discussed above. To show this, we use the same notation as above and follow the steps outlined in paragraphs 404 to 408 of the Further Notice. The point of departure is that the annual change in the price cap index is

35.

$$dP^S_{Max} = dP^E - X$$

where the adjustment factor is defined as[7]

$$X = dP^E - \sum_{i=1}^{N} s_i^S dw_i^S + dTFP^s$$

Combining these two equations, we get:

$$dP^S_{Max} = dP^E - \left[dP^E - \sum_{i=1}^{N} s_i^S\, dw_i^S + dTFP^s\right] = \sum_{i=1}^{N} s_i^S\, dw_i^S - dTFP^s$$

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3.3 Direct and indirect approaches

36. While it might look like the changes in the aggregate price index might cancel out (yielding the "direct" approach), this is not so in practice because the first change in GDPPI that is used is the actual change in a given period, while the GDPPI term is the X-factor that is used by the FCC is the historical average over the period used to estimate the X-factor. Therefore, if we denote this historical average change in economy-wide output prices as dP^E_{Av} *and* making the *additional* assumption that

$$dP^E_{Av} = dW^E_{Av} - dTFP^E_{Av}$$

where W^E_{Av} is the average growth in the input price index at the economy-wide level, then we get:

$$dP^S_{Max} = dP^E - [(dTPF^S - dTPF^E_{Av}) - (dW^S - dW^E_{Av})] \equiv dP^E - X$$

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4.3.4 Adjusting for economies of scale and the erosion of demand for DS1/DS3 services

81. A simple numerical example helps illustrate that this overestimation of the actual unit cost reduction can potentially be significant, and in fact is likely to be so. We simplify by supposing that ILEC's and CLEC's sell both regulated TDM-based services (output 1) and other telecommunication services (output 2). As we derive in Appendix 3, the following relationship holds between the growth in TFP, the growth (or decline) in the two output levels of the company and the shift in the company's cost function (which represents technological change):

$$dTFP = (1 - \varphi)\{r_1 dY_1 + r_2 dY_2\} - dC$$

where dC is the (percentage) downward shift in the total cost function which reflects the rate of technological change, dY_i is the rate of growth (or decline) in output i, r_i is the revenue share of output i and φ is the sum of the cost elasticities of the two outputs. Hence, economies of scale imply that φ is smaller than one (doubling all outputs would less than double total costs).

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4.3.4 Adjusting for economies of scale and the erosion of demand for DS1/DS3 services

82. We can use this formula to compute the relevant change in TFP for both the sector (indexed by S) and the ILECs (indexed by i). To keep matters simple, we assume for this illustrative calculation that 1) the ILEC and the sector as a whole experience the same rate of growth for DS1 and DS3 services, and the same rate of growth for other telecommunication services, and 2) that the rate of technological change is the same for the ILECs and the sector as a whole. Thus the ILEC only differs from the sector because DS1/DS3 services represent a larger share of its total business than for CLECs. In this simple case, the discrepancy between TFP growth for the (telecommunications) sector and TFP growth for the ILECs is:

$$DISCREPANCY \equiv TFP^S - dTFP^I = (1-\varphi)(r_1^S - r_i^I) * [dY_1 - dY_2]$$

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4.3.5 Controlling for cyclical fluctuations in capacity utilization

87. Total factor productivity is widely acknowledged to be pro-cyclical – it increases in boom periods and declines in recessions.[19] When using past data to compute an adjustment factor for future use, when the shape and duration of future economic fluctuations are unknown, it is important to ensure that this X-factor is correct, on average, over the business cycle. This means that, it is important to use an X-factor from which the effect of changes in capacity utilization over the business cycle have been removed. We make an explicit adjustment to the computations of the X-factors in each of years over the relevant 2005-2014 period. Formally, the "capacity utilization adjusted" growth in TFP for year t is:

$$\Delta TFP_t^{adj} = \Delta TFP_t - \mu_t$$

where μ_t is the rate of change in capacity utilization. This formulation implicitly assumes that the change in capacity utilization affects all factors of production in a similar manner. Alternatively, one can assume that fluctuations in capacity utilization affect only capital (i.e., that capital is quasi-fixed and labor is fully flexible). In this case, the adjusted TFP is

$$\Delta TFP_t^{adj} = \Delta TFP_t - s_k \mu_t$$

where s_k is the share of capital in total costs.

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Appendix 3: TFP, Economies of Scale, and Erosion of DS1/DS3 Markets

Using two outputs, multifactor productivity is defined by BDS as follows:

$$dTFP = r_1 dY_1 + r_2 dY_2 - \sum s_j dX_j$$

Where d denotes a rate of growth, $r_i = p_i Y_i / R$ is the revenue share of output i and $s_j = w_j X_j / C$ is the cost share of input j. In this, we interpret Y_1 as TDM services and Y_2 as other services.

The cost function is given as $C(Y_1, Y_2, w, t)$, where w is a vector of input prices. Hence:

$$dC = v_1 dY_1 + v_2 dY_2 \sum s_j dw_j + \frac{\frac{\partial C}{\partial t}}{C}$$

Where

$$v_i = MC_i \frac{Y_i}{C} = \epsilon_i$$

Is the elasticity of costs with respect to output I and MC is marginal cost, and $\frac{\frac{\partial C}{\partial t}}{C}$ is the time shift in the cost function. By definition, $C = \sum w_j X_j$, so log differentiation gives us:

$$dC = \sum s_j dw_j + \sum s_j dX_j$$

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Appendix 3: TFP, Economies of Scale, and Erosion of DS1/DS3 Markets

Setting our two expressions for dC equal to each other and solving for the shift in the cost function:

$$\frac{\frac{\partial C}{\partial t}}{C} = \sum s_j dX_j - \epsilon_1 dY_1 - \epsilon_2 dY_2$$

Substituting this into our expression for dTFP, we get:

$$dTFP = (r_1 - \epsilon_1)dY_1 + (r_2 - \epsilon_2)dY_2 - \frac{\frac{\partial C}{\partial t}}{C}$$

Which means that the measured growth in TFP captures the shift in the cost function and changes in the levels of output if $r_i - \epsilon_i \neq 0$.

Denote the cost elasticity as $\varphi \equiv \epsilon_1 + \epsilon_2$ so that increasing returns to scale imply $\varphi < 1$. To simplify further, we assume for this calculation that $\epsilon_1 = \epsilon_2 \equiv e$ and that the firm prices at average cost and thus earns a normal rate of return, so $R = C$.[29] Using these equations, after some further manipulations we obtain:

$$dTFP = (1 - \varphi)\{r_1 dY_1 + r_2 dY_2\} - \frac{\frac{\partial C}{\partial t}}{C}$$

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