Efficiency Differences within Pakistan Telecommunication Sector: A Non-Parametric Investigation

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Among communication modes, telecommunication technology is the most commonly used one. It has been growing as a sector around the globe, even in developing countries like Pakistan. This paper estimates the trend of total factor productivity growth in seven main listed telecommunication operator companies and members of Pakistan Telecommunication Authority (PTA). Data from annual reports of 2007-2012 is borrowed to calculate Malmquist Total Factor Productivity (TFP) growth indices using non-parametric approach – Data Envelopment Analysis (DEA). This approach reveals configurations of productivity change and gives an elucidation along with the technological implication of all components. On the whole PTCL is found to be the forefront of Pakistan telecom industry as evident from average of efficiency scores. Recommendations based on empirical analysis are made consequently.
Keywords: *Telecom Sector, Total Factor Productivity (TFP), Data Envelopment Analysis (DEA), Malmquist Productivity Index (MPI)*

1 Introduction

Telecommunication technology has become a necessity from a luxury during last few decades in developing countries. Its contribution towards national exchequer has headlined the national income accounts consistently over last decade. For Pakistan, the stats are Rs. 132.5 billion in 2011-2012. It is a general consensus that telecommunication infrastructure development and economic growth proceed together. Empirical evidence has shown desired effects of ICT (telecommunication development) on national income, employment and poverty reduction, see for example [5], [3].

From a sectoral point of view, the market structure of telecom sector in most of countries is oligopoly. With such market structure, it is worthwhile to investigate their relative efficiencies. Such provides insights in the telecom industry at firm level. Accordingly, this study evaluates the relative efficiency of telecom service operators in Pakistan. The specific objective of the paper is as follows.

1.1 Objective

This study aims at analyzing the efficiency of telecom operators competing under the Pakistan Telecommunication Authority (PTA) using non-parametric approach. This shall provide insights into the telecom sector in Pakistan via comparison of firms' efficiencies.

2 Literature Survey

To highlight the current state of debate of the conflicting results, literature review is furnished in this section. [10] applied data envelopment analysis to measure both scale and technical efficiencies of individual local exchange carriers (LECs) during 1988-1998 of United States. The results concluded that most of the LECs were technically efficient during the entire period of study. [7] applied DEA to measure the efficiency of 39 Forbes 2000 graded leading global telecom operators. Empirical results indicate that top Forbes telecom operators are not the same as those having highest CCR efficiency measures. [2] analyzed the significance of marketing orientation across the Greek telecommunications companies using DEA technique and to make a tool for measuring the level of marketing orientation in companies. [9] examined the efficiency measures that can maintain the implementation of diverse forms of incentive regulation in the context

of United States telecommunications with the use of DEA.

[13] assessed the magnitude of performance differences between the ICT firms in Taiwan by deploying DEA on multiple outputs and inputs. The empirical results reveal that the overall technical inefficiencies of firms are primarily due to pure technical inefficiencies rather than scale inefficiencies. [12] used cross sectional data of 43 call centers of Korea for comparing relative efficiency. The resorted to DEA technique. It helps them to measure the operational efficiency of call centers in Korea in order to identify the present status and issues of call centers operations. [8] examined the efficiency of telecom firms of APEC member countries during the period 1999-2004 using DEA. The results show that scale and scope economies have positive impact on the efficiency improvement in telecom firms of Asia Pacific.

[16] estimated the efficiency of twenty two mobile carriers from seven countries from time span 1995-2007 by the use of data envelopment analysis DEA. The results concluded that measures of efficiency and total factor productivity (TFP) change are fairly sensitive to the choice of methodology and suggests that increased technical efficiency does not necessarily require firms to be privatized. However, he is of the view that a privatized firm is more likely to enhance its TFP growth and efficiency. [14] measured the productivity efficiency of India telecommunication sector by using data envelopment analysis (DEA). The results concluded that none of the firms with high estimates are exceedingly efficient in terms of DEA. Moreover, wireless operators are found more proficient than full-service telecoms in terms of profitability and marketability.

Review of literature shows that ample work is done on efficiency analysis of telecom firms both developed and developing countries, but to our knowledge such research has been absent in Pakistan. To fill this gap, this paper uses the following research methodology.

3 Data and Methodology

For efficiency analysis, inputs and outputs are used in a linear programming framework called Data Envelopment Analysis (DEA). DEA is a non-parametric technique is attributed to [1]. It is used to assess the efficiency of decision making units DMUs that are in fact production units/firms. Efficiency is accorded as the quotient of weighted-sum of outputs to weighted-sum of inputs. Data envelopment analysis has been widely employed for comparing the efficiencies of nonprofit and profit organizations for example schools, shops, hospitals, branches of banks and other production or service units in which there are comparatively homogeneous DMUs ([4]; [11]; [15]).

As per requirements of DEA, variables are arranged into inputs and outputs. These inputs and outputs are selected as per availability of data, theoretical and practical considerations of the telecom sector. This paper uses 'total revenue of a telecom operator' as outputs whereas staff members, investment in telecom operator, traffic of fixed telephony and total market expense (current assets, reserves and current liabilities and fixed capital expenditure) as inputs of the operators. Data is taken from annual reports of the operators to form a panel dataset of 6 years (2007-12) of 7 telecom operators. These operators are Pakistan Telecommunication Company Limited (PTCL), Worldcall Telecom (WDCL), Wateen Telecom (WTEN), Ufone Telecom (UFON), Telenor Telecom (TLNR), Warid Telecom (WRID) and Mobilink Telecom (MBLK).

DEA allows efficiency of DMUs determining an envelopment surface analysis for multiple inputs and outputs. DMUs that lie on envelopment surface has the value 1 and is considered as efficient whereas one lying below the surface is allocated value smaller than 1 and is nominated as inefficient. DEA does not require information about prices of either outputs or inputs. Under DEA there are two assumptions namely 'constant returns to scale' (CRS) and 'variable returns to scale' (VRS). Efficiency calculations found using VRS as-

sumption are normally higher than those found using CRS.

DEA model used in this paper calculates 'Malmquist Productivity Indices' (MPI). MPI is used to calculate variations in output relative to inputs in production process. Increase in productivity is referred as increase in technical efficiency and technological change via which inputs are converted into outputs. Production efficiencies have two types viz.; 'technical efficiency' (TE) and 'allocative efficiency' (AE). TE represents a firm's capability to attain maximum outputs through given set of inputs. Productivity change over consecutive period of times is given as:

Productivity Change = Technical Efficiency Change × Technological Change

The MPI with respect to time period t is $\boldsymbol{M^t} = \frac{\boldsymbol{D^t(x^t,y^t)}}{\boldsymbol{D^t(x^{t+1},y^{t+1})}}$ and for time period t+1 it is $\boldsymbol{M^{t+1}} = \frac{\boldsymbol{D^t(x^t,y^t)}}{\boldsymbol{D^t(x^{t+1},y^{t+1})}}$.

Where

$\mathbf{x^t}$ = input vector in time period t

$\mathbf{y^t}$ = output vector in time period t

$\mathbf{D^t}$ = distance function at time period t

$\mathbf{D^{t+1}}$ = distance function at time period t+1

$\mathbf{x^{t+1}}$ = input vector at time period t+1

$\mathbf{y^{t+1}}$ = output vector at time period t+1

The geometric mean of the above two equations is $\boldsymbol{M(x^{t+1},y^{t+1},x^t,y^t)} = \sqrt{\frac{\boldsymbol{D^t(x^{t+1},y^{t+1})}}{\boldsymbol{D^t(x^t,y^t)}} \times \frac{\boldsymbol{D^{t+1}(x^{t+1},y^{t+1})}}{\boldsymbol{D^{t+1}(x^t,y^t)}}}$. MPI > 1 is interpreted as productivity gain, MPI < 1 as productivity loss and MPI = 1 as no change in productivity from time period t to t+1. Neither MPI require price information nor does it require any assumption based on profit maximization or cost minimization. Improved productivity equation including scale efficiency is:

Productivity Change = Scale Efficiency Change × Technical Efficiency Change × Technological Change

Using the methodology explained above, the data is analyzed and is interpreted as follows:

4 Interpretation

The data of the operators has yielded the efficiency scores that are interpreted as follows:

4.1 Efficiency Estimates of Firm Averages

Table 1 gives the average efficiency estimates of the telecom operators in Pakistan. Telecom operators' average technical efficiency under constant returns to scale (TECRS) is 93.09% and under variable returns to scale (TEVRS) 97.62%. Consequently, average scale efficiency (SE) is 95.27%, where, $\text{SE} = \frac{\text{TECRS}}{\text{TEVRS}}$. Under CRS, two operators are efficient while five are inefficient. VRS has the highest efficiency estimates showing that the operators that were inefficient under CRS are efficient under VRS. Among all the operators, TLNR has the lowest technical efficiency estimates for both CRS and VRS. Summary of these efficiency scores w.r.t banks is given in Table 2.

Table 1: Technical Efficiency Estimates of Operators' Averages

Operator	TECRS	TEVRS	SE
PTCL	1.000	1.000	1.000
WDCL	1.000	1.000	1.000
WTEN	0.985	1.000	0.985
UFON	0.969	1.000	0.969
TLNR	0.807	0.880	0.918
WRID	0.902	0.963	0.936
MBLK	0.853	0.991	0.861
Mean	**0.9309**	**0.9762**	**0.9527**

Notes: Inputs: Staff members working in company, Investment in company during a fiscal year, Traffic of fixed Telephony in minutes per million and Total market expense including current assets. **Outputs:** Total Revenue of company during fiscal year.
Model: Output oriented model, **Scale Assumption:** Constant returns-to-Scale, **CRS** = Constant Return to Scale, **VRS** = Variable Return to Scale, **SE** = Scale Efficiency.
Source: Authors' estimates using annual reports of Operators and Data Envelopment Analysis Program (DEAP) 2.1.

Table 2 gives the summary of efficiency aggregates. It includes the number of efficient and inefficient operators, maximum, minimum and average of their efficiencies. Using technical efficiency scores from table 1, maximum, minimum and average under assumption of constant returns to scale and variable returns to scale are tabulated.

Table 2: Summary of Efficiency Aggregates

Efficiency Aggregates	CRS	VRS	SE
No. of Efficient Operators	2	4	2
No. of In-efficient Operators	5	3	5
Maximum Efficiency (%)	100	100	100
Minimum Efficiency (%)	80.7	88.0	86.1

Average Efficiency (%)	93.09	97.62	95.27

Notes: CRS = Constant Return to Scale, **VRS** = Variable Return to Scale, **SE** = Scale Efficiency.
Source: As above.

4.2. Interpretation of Productivity

Malmquist Productivity Index (MPI) is used to measure change in total factor productivity (TFP) over two time periods t and t+1 (where t+1 > t). Total factor productivity change is obtained as a product of technological change and technical efficiency change:

Total Factor Productivity Change = Technological Change × Technical Efficiency Change

4.3. Dynamics of Productivity Scores from 2008 to 2012

To capture the dynamics of productivity scores over time, a year wise analysis of productivity scores is furnished:

4.3.1 Productivity Scores for 2008

Table 3: Productivity Estimates for the Year 2008

Operator	effch	techch	pech	Sech	tfpch
PTCL	1.000	1.012	1.000	1.000	1.012
WDCL	1.000	1.033	1.000	1.000	1.033
WTEN	1.097	1.561	1.000	1.097	1.712
UFON	1.000	1.000	1.000	1.000	1.000
TLNR	0.757	1.286	0.898	0.843	0.973
WRID	0.857	1.185	0.945	0.907	1.016
MBLK	0.806	1.246	0.970	0.831	1.004
Mean	**0.931**	**1.189**	**0.973**	**0.954**	**1.107**

Note: effch = Technical Efficiency Change, **techch** = Technological Change, **pech** = Pure Efficiency Change, **sech** = Scale Efficiency Change, **tfpch** = Total Factor Productivity Change.
Source: As above.

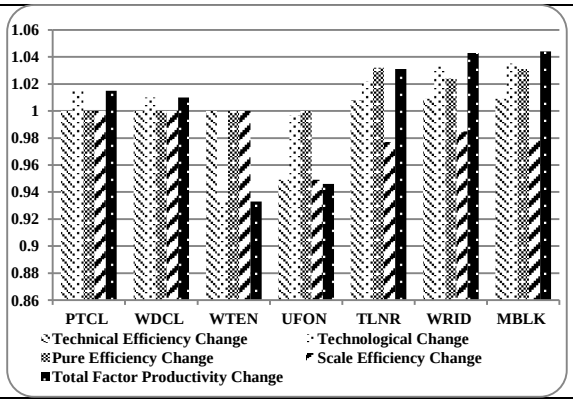


Table 3 represents productivity scores for the year 2008. Technological change has been favorable for all operators in 2008. TFP change has only been unfavorable for TLNR while for the rest of operators it has increased. Both efficiency scores are in lines with technologically advanced sector of telecommunication. Nearly, half of the firms are scale efficient and as well as show improvement in pure technical efficiency (better understood as managerial efficiency). Same division exists for efficiency change. On the whole, the technological change and TFP change have improved. Since (techch>1 and tfpch>1) while effch, pech and sech have declined.

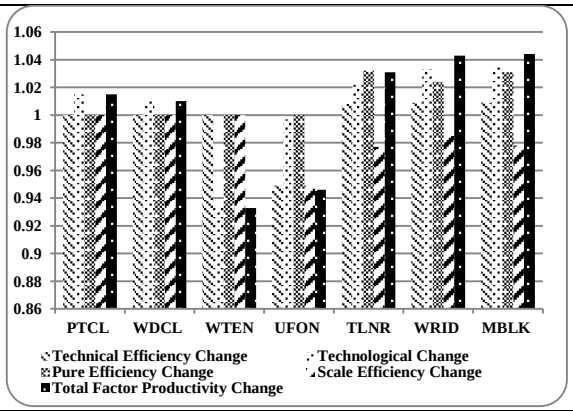
4.3.2 Productivity Scores for 2009

Table 4 shows similar results for TFP in 2009. The highest productivity gains are for MBLK and WRID. Pure efficiency change for all operators has improved (pech>1). On the whole, the technical efficiency, pure efficiency and total factor productivity have shown improvement.

Table 4: Productivity Estimates for the Year 2009

Operator	effch	techch	pech	sech	tfpch
PTCL	1.000	1.015	1.000	1.000	1.015
WDCL	1.000	1.010	1.000	1.000	1.010
WTEN	1.000	0.933	1.000	1.000	0.933
UFON	0.949	0.997	1.000	0.949	0.946
TLNR	1.008	1.022	1.032	0.977	1.031
WRID	1.009	1.033	1.024	0.985	1.043
MBLK	1.009	1.035	1.031	0.978	1.044
Average	**0.996**	**1.006**	**1.012**	**0.984**	**1.003**

Note: effch = Technical Efficiency Change, **techch** = Technological Change, **pech** = Pure Efficiency Change, **sech** = Scale Efficiency Change, **tfpch** = Total Factor Productivity Change.
Source: As above.



4.3.3 Productivity Scores for 2010

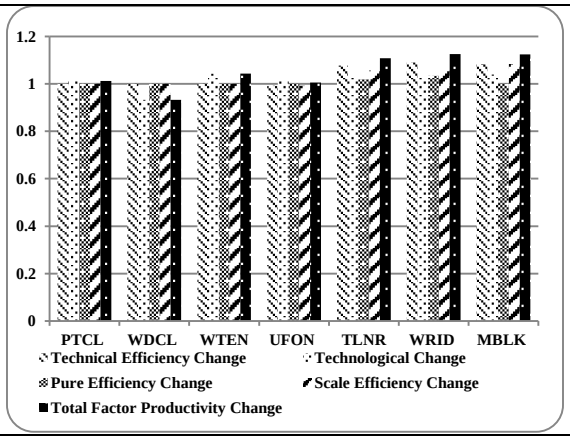
Table 5 represents the TFP change in year 2010. Except for WDCL, TFP of all operators has increased in 2010. The highest TFP increase is of WRID (1.125) showing an increase of 12.5%. The average increment in

TFP is 5.0% which indicates that overall TFP has improved in 2010 as compared to 2009.

Table 5: Productivity Estimates in the Year 2010

Operator	effch	techch	pech	sech	tfpch
PTCL	1.000	1.012	1.000	1.000	1.012
WDCL	1.000	0.932	1.000	1.000	0.932
WTEN	1.000	1.043	1.000	1.000	1.043
UFON	0.991	1.013	1.000	0.991	1.005
TLNR	1.076	1.030	1.018	1.056	1.108
WRID	1.090	1.031	1.033	1.055	1.125
MBLK	1.083	1.039	1.000	1.083	1.124
Mean	**1.034**	**1.014**	**1.007**	**1.026**	**1.050**

Note: effch = Technical Efficiency Change, **techch** = Technological Change, **pech** = Pure Efficiency Change, **sech** = Scale Efficiency Change, **tfpch** = Total Factor Productivity Change.
Source: As above.



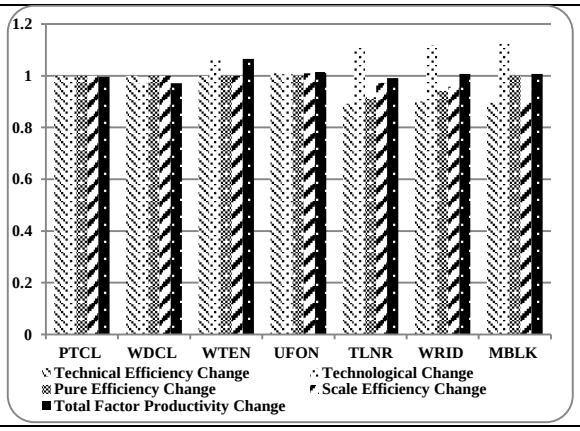
4.3.4 Productivity Scores for 2011

In 2011, TFP of all operators increased has increased except for TLNR. The highest increase in TFP is for WTEN showing 6.5% increase in TFP. This increase in TFP can be attributed to Wateen's "Re-launch" with a new identity "Hello Again" that created an emotional attachment with its potential customers. On average, the TFP had an increase of 0.7% which far from significant. Technological up-gradation during 2011 seems absent as seen by the overall techch (1.000). Both, pure efficiency and scale efficiency show a mix pattern of change.

Table 6: Productivity Estimates for the Year 2011

Operator	effch	techch	pech	Sech	tfpch
PTCL	1.000	0.996	1.000	1.000	0.996
WDCL	1.000	0.971	1.000	1.000	0.971
WTEN	1.000	1.065	1.000	1.000	1.065
UFON	1.010	1.006	1.000	1.010	1.015
TLNR	0.892	1.110	0.917	0.973	0.991
WRID	0.901	1.117	0.942	0.957	1.007
MBLK	0.896	1.123	1.000	0.896	1.007
Mean	**0.996**	**1.000**	**1.000**	**0.996**	**1.107**

Note: effch = Technical Efficiency Change, **techch** = Technological Change, **pech** = Pure Efficiency Change, **sech** = Scale Efficiency Change, **tfpch** = Total Factor Productivity Change.
Source: As above.



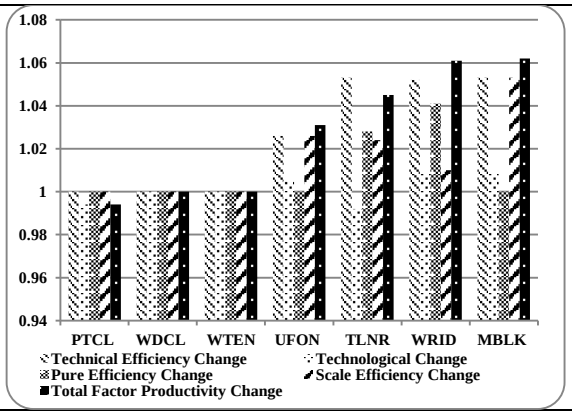
4.3.5 Productivity Scores for 2012

In 2012, highest TFP is of MBLK with an increase of 6.2%. Both scale and pure efficiencies have retained their levels or have increased as compared to 2011. Overall technical has declined while overall technological efficiency and TFP scores have increased. Graph shows that UFON, TLNR, WRID and MBLK have increasing scores while PTCL, WDCL and WTEN have constancy in most of their efficiency scores.

Table 7: Productivity Estimates for 2012

Operator	effch	techch	pech	sech	tfpch
PTCL	1.000	0.994	1.000	1.000	0.994
WDCL	1.000	1.000	1.000	1.000	1.000
WTEN	1.000	1.000	1.000	1.000	1.000
UFON	1.026	1.005	1.000	1.026	1.031
TLNR	1.053	0.992	1.028	1.024	1.045
WRID	1.052	1.009	1.041	1.010	1.061
MBLK	1.053	1.009	1.000	1.053	1.062
Mean	**0.931**	**1.189**	**0.973**	**0.954**	**1.107**

Note: effch = Technical Efficiency Change, **techch** = Technological Change, **pech** = Pure Efficiency Change, **sech** = Scale Efficiency Change, **tfpch** = Total Factor Productivity Change.
Source: As above.



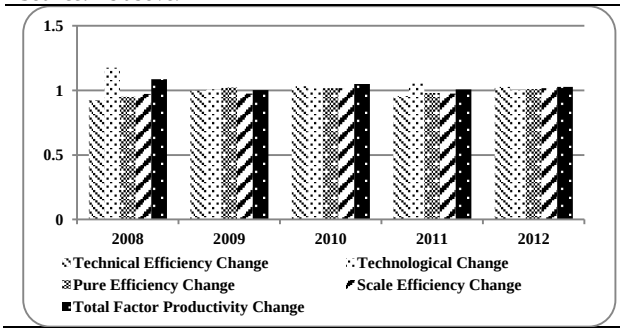
4.4. Malmquist Index Summary of Annual Averages

On average, TFP change is 1.033 for the period 2008-12 which is less than 1 showing a overall increase in TFP score among firms. Moreover, in each year TFP score shows increase. This implies operator-level productivity increase in telecom sector. From the table, it is also evident that technological up-gradation is the main contributor in TFP increase. This result is intuitive for a technology intensive sector of telecom where technological up-gradation is lifeblood. Technological up-gradation is evident both operator and sector levels. Annual averages of Scale and Pure efficiency change do not have any specific pattern over the years 2008-2012.

Table 8: Malmquist Index Summary of Annual Averages

Scores	effch	techch	pech	sech	tfpch
2008	0.924	1.175	0.95	0.972	1.086
2009	0.996	1.006	1.021	0.976	1.002
2010	1.033	1.014	1.017	1.016	1.048
2011	0.956	1.054	0.979	0.976	1.007
2012	1.026	1.001	1.01	1.016	1.027
Mean	**0.986**	**1.048**	**0.995**	**0.991**	**1.033**

Note: effch = Technical Efficiency Change, **techch** = Technological Change, **pech** = Pure Efficiency Change, **sech** = Scale Efficiency Change, **tfpch** = Total Factor Productivity Change.
Source: As above.



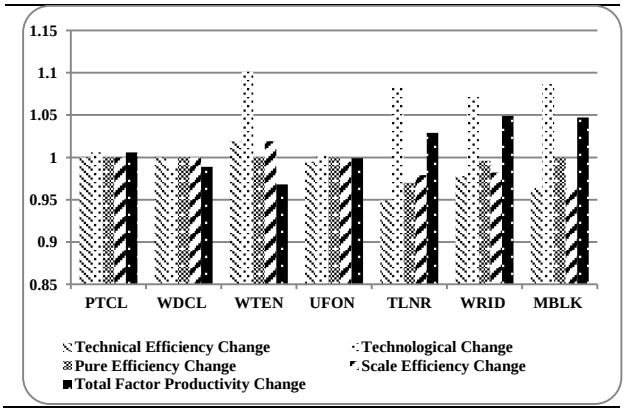
6.5. Malmquist Index Summary of Operator Averages

Table 9 tabulates MPI summary of operator averages. Over the span of 2008-2012, PTCL, TLNR, WRID and MBLK have kept an overall increase in TFP. While, all other operators than WDCL have shown a persistent increase in technological state over time. WDCL seems to be inconsistent in it process of technological up-gradation.

Table 9: Malmquist Index Summary of Operator Averages

	effch	techch	pech	sech	tfpch
PTCL	1.000	1.006	1.000	1.000	1.006
WDCL	1.000	0.989	1.000	1.000	0.989
WTEN	1.019	1.101	1.000	1.019	0.968
UFON	0.995	1.004	1.000	0.995	0.999
TLNR	0.949	1.083	0.970	0.979	1.029
WRID	0.978	1.073	0.996	0.982	1.049
MBLK	0.964	1.087	1.000	0.964	1.047
Average	**0.986**	**1.048**	**0.995**	**0.991**	**1.033**

Note: effch = Technical Efficiency Change, **techch** = Technological Change, **pech** = Pure Efficiency Change, **sech** = Scale Efficiency Change, **tfpch** = Total Factor Productivity Change.
Source: As above.



6.6. TFP Change and Other Productivity Scores across Operators over Time

Following table epitomizes the TFP change across operators over time. Over time, PTCL and especially WRID and MBLK have persistent increase in TFP. More importantly overall sector has continuous increase in TFP. Such result is easy to accept since Pakistan telecom sector has been continuously thriving since deregulation policy in 2003.

Table 10: Matrix of TFP Change across Operators over Time

Code	2008	2009	2010	2011	2012
PTCL	TFP ↑	TFP ↑	TFP ↑	TFP ↓	TFP ↓
WDCL	TFP ↑	TFP ↑	TFP ↓	TFP ↓	$\overline{\text{TFP}}$
WTEN	TFP ↑	TFP ↓	TFP ↑	TFP ↑	TFP ↑
UFON	$\overline{\text{TFP}}$	TFP ↓	TFP ↑	TFP ↑	TFP ↑
TLNR	TFP ↓	TFP ↑	TFP ↑	TFP ↓	TFP ↑
WRID	TFP ↑	TFP ↑	TFP ↑	TFP ↑	TFP ↑
MBLK	TFP ↑	TFP ↑	TFP ↑	TFP ↑	TFP ↑
SECTOR	TFP ↑	TFP ↑	TFP ↑	TFP ↑	TFP ↑

Note: Where **TFP**↑ shows increase and **TFP**↓ shows decrease in Total Factor Productivity respectively, using the values of **Total Factor Productivity Change**.

In similar veins, rest of efficiency scores are portrayed as follows. For technological oriented sector-telecom, Technological change is highly likely to rise. Same is the case with sample operators in Pakistan telecom over

the period 2008-2012. Despite notable decline in FDI and investment in telecom sector, the lagged positive effects seem to persist till 2012 as evident from technological efficiency score.

Table 11: Matrix of Technological Change across Operators over Time

Code	2008	2009	2010	2011	2012
PTCL	techch ↑	techch ↑	techch ↑	techch ↓	techch ↓
WDCL	techch ↑	techch ↑	techch ↓	techch ↓	techch
WTEN	techch ↑	techch ↓	techch ↑	techch ↑	techch
UFON	techch	techch ↓	techch ↑	techch ↑	techch ↑
TLNR	techch ↑	techch ↑	techch ↑	techch ↑	techch ↓
WRID	techch ↑	techch ↑	techch ↑	techch ↑	techch ↑
MBLK	techch ↑	techch ↑	techch ↑	techch ↑	techch ↑
SECTOR	techch ↑	techch ↑	techch ↑	techch ↑	techch ↑

Note: Where **techch**↑ shows increase, **techch** ↓ shows decrease and **techch** shows no change in technological state respectively, using the values of **Technological Change**.

Matrix for technical efficiency shows a state of constancy in PTCL, WDCL and WTEN technical efficiency and mixed trend in rest of operators. It depicts that there is lack of focus on optimal factor combination in telecom sector and heed is on technological upgradation instead.

Table 12: Matrix of Technical Efficiency Change across Operators over Time

Code	2008	2009	2010	2011	2012
PTCL	effch	effch	effch	effch	effch
WDCL	effch	effch	effch	effch	effch
WTEN	effch ↑	effch	effch	effch	effch
UFON	effch	effch ↓	effch ↓	effch ↑	effch ↑
TLNR	effch ↓	effch ↑	effch ↑	effch ↓	effch ↑
WRID	effch ↓	effch ↑	effch ↑	effch ↓	effch ↑
MBLK	effch ↓	effch ↑	effch ↑	effch ↓	effch ↑
SECTOR	effch ↓	effch ↓	effch ↑	effch ↓	effch ↑

Note: Where **effch**↑ shows increase, **effch** ↓ shows decrease and **effch** shows no change in technical efficiency respectively, using the values of **Technical Efficiency Change**.

Pure technical efficiency which is also termed as managerial efficiency, has no mention worthy upward trend. So managerial efficiency remains a neglected aspect among telecom sector operators.

Table 13: Matrix of Pure Technical Efficiency across Operators over Time

Code	2008	2009	2010	2011	2012
PTCL	pech	pech	pech	pech	pech
WDCL	pech	pech	pech	pech	pech
WTEN	pech	pech	pech	pech	pech
UFON	pech	pech	pech	pech	pech
TLNR	pech ↓	pech ↑	pech ↑	pech ↓	pech ↑
WRID	pech ↓	pech ↑	pech ↑	pech ↓	pech ↑
MBLK	pech ↓	pech ↑	pech	pech	pech
SECTOR	pech ↓	pech ↑	pech ↑	pech ↓	pech ↑

Note: Where **pech**↑ shows increase, **pech**↓ shows decrease and **pech** shows no change in Pure Technical Efficiency respectively, using the values of **Pure Technical Efficiency Change**.

Scale efficiency has same pattern as that of technical efficiency. It implies lack of exploitation of long-run economies of scale. Operators have not been producing at the lowest of average cost during 2008-2012.

Table 14: Matrix of Scale Efficiency Change across Operators over Time

Code	2008	2009	2010	2011	2012
PTCL	sech	sech	sech	sech	sech
WDCL	sech	sech	sech	sech	sech
WTEN	sech ↑	sech	sech	sech	sech
UFON	sech	sech ↓	sech ↓	sech ↑	sech ↑
TLNR	sech ↓	sech ↓	sech ↑	sech ↓	sech ↑
WRID	sech ↓	sech ↓	sech ↑	sech ↓	sech ↑
MBLK	sech ↓	sech ↓	sech ↑	sech ↓	sech ↑
SECTOR	sech ↓	sech ↓	sech ↑	sech ↓	sech ↑

Note: Where **sech**↑ shows increase, **sech**↓ shows decrease and **sech** shows no change in scale efficiency change respectively, using the values of **Scale Efficiency Change**.

The role of pure technical efficiency (managerial efficiency) and scale efficiency is found less dynamic as compared to that of technological change. More precisely, pure technical efficiency has insignificant effect on TFP change at all as its value is 1 in all the years suggesting constancy over year.

7. Conclusion

This paper investigated various tiers of efficiency of telecom operators in Pakistan. Its results has unfolded the productivity of telecom sector for the first time in literature. Findings reveal an encouraging picture of telecom industry in terms of productivity. High efficiency scores are found, both over time and across operators. Domestic telecommunication operators (PTCL and UFONE) have their own infrastructure. This allows independence of other operators that can be used as an alternative support for the operators entering the market. They are the price leaders and charge lower rates as compared to other telecom operators. Their promotions to introduce a new product with lowest market rate help them to expand clientele. This research has found loopholes in managerial practices and cost minimizing strategies via low scores. There is a need to pay heed to these two less tapped weak areas.

This can allow Pakistan telecom sector to flourish even better.

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