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THE IMPACT OF PRIVATIZATION AND COMPETITION IN THE TELECOMMUNICATIONS SECTOR AROUND THE WORLD*

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ABSTRACT

q1 Using a comprehensive country-level panel data set covering the period from 1990 to 2001, we investigate the impact of privatization and competition in the telecommunications sector around the world. Full privatization, which gave private owners control rights, contributed substantially to improving the allocation of labor and capital, expanding service output and network penetration, and improving labor and total factor productivities. But partial privatization, which retained the state's control rights, showed no significant impact. The increase in competitive pressure contributed substantially to growth in the sector by raising both factor inputs and total factor productivity. We also found evidence of complementarity between privatization and competition in deepening network penetration and in restraining the rise of service pricing among privatized operators. Our results are robust to plausible alternative specifications.

I. INTRODUCTION

UNTIL recently in most countries, telecommunications service providers were state owned, state operated, and often monopolistic. With the privatization of British Telecom and the introduction of competition in the U.S. long-distance telephone services, the late 1980s and 1990s witnessed the

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most dramatic policy changes the telecommunications world had ever seen.[1] National carriers were privatized, new competitors licensed, and new services allowed. More than 150 countries introduced new legislation or modified existing regulations. In 1980, only 2 percent of telecommunications operators in 167 countries had private owners; by 1998, the number increased to 42 percent.[2] The privatization trend was part of a global movement toward liberalization as countries introduced competition in this sector, especially in the mobile segment. The monopoly-based system of service provision, which dominated the world's telecommunications markets for over three-quarters of the last century, gave way to more competitive supply in many markets.

The worldwide movement toward privatization and competition in the telecommunications sector in the 1990s provides an economic experiment and an industry context for studying the effects of privatization and competition in general. Given the sector's economic, political, and technological importance,[3] its privatization and liberalization have often been the headline news in national media. Countries often use privatization and liberalization in this sector to signal their seriousness about instituting pro-market reforms. Bernardo Bortolotti and coauthors find that telecommunications share-issue privatization almost always represents the largest share offerings in many countries, and telecommunications stocks often are the "bellweather" stocks on national exchanges.[4]

Although there has been much theoretical and empirical research on the effects of privatization and competition in infrastructure in general, relatively little empirical work has been done on how the degree of privatization and competition affects performance and how components of the policies interact with each other in shaping the reform outcomes. For instance, does full privatization, which gives private owners control rights, improve the per-

[1] Factual information here is drawn from three reports: International Telecommunications Union (ITU), Trends in Telecommunication Reform, Convergence and Regulation (1999) (hereafter Trends 1999); ITU, World Telecommunications Development Report (1999); ITU, Trends in Telecommunication Reform: Effective Regulation (2002) (hereafter Trends 2002); ITU, Telecommunication Reform: Interconnection Regulation (2001); and Pyramid Research, Will the Internet Close the Gap? (2000).

[2] Wei Li & Lixin Colin Xu, The Impact of Privatization and Competition in the Telecommunications Sector around the World (Working Paper No. 02-13, Univ. Virginia, Darden Bus. Sch. 2002).

[3] Telecommunications is often one of the fastest growing high-tech industries in most countries. Wei Li & Lixin Colin Xu, The Political Economy of Privatization and Competition: Cross-Country Evidence from the Telecommunications Sector, 30 J. Comp. Econ. 439 (2002), finds that currently its service revenue alone (equipment sales not included) accounts for approximately 2–3 percent of gross domestic product (GDP) in most countries. Lars-Hendrik Roller & Leonard Waverman, Telecommunications Infrastructure and Economic Development: A Simultaneous Approach. 91 Am. Econ. Rev. 909 (2001), suggests that the sector also offers substantial positive externalities for the economy as a whole.

[4] Bernardo Bortolotti *et al.*, Source of Performance Improvement in Privatized Firms—a Clinical Study of the Telecommunication Industry (Working paper, Univ. Oklahoma, Econ. Dep't 2001).

formance of a country's telecommunications sector more than partial privatization, which leaves control rights in the hands of bureaucrats? Is privatization (or competition) alone sufficient in improving economic performance, or are privatization and competition complementary policies? And finally, how do privatization and competition affect a comprehensive list of performance measures, including total factor productivity (TFP)?

In this paper we study the impact of privatization and competition on employment, investment, output and service pricing, network expansion in both fixed-line and mobile market segments, labor productivity, and total factor productivity in the telecommunications sector around the world. We start by reviewing in Section II the literature on how privatization and competition might affect performance in the telecommunications sector. The available data, which we describe in Section III, are comprehensive in coverage: they contain information on privatization from 177 countries and information on competition from up to 162 countries between 1990 and 2001.[5] Since our sample period covers the building-up and the bursting of the telecommunications bubble in financial markets around the world, we have chosen to focus on variables that measure economic rather than accounting or financial performance. In addition, since investment in this sector had been very strong in the 1990s, it is important that we include total factor productivity as a performance measure.

Subject to qualifications, our analysis presented in Section IV shows that privatization and competition had a large positive impact on telecommunications performance and that more reforms were associated with more performance gains. Full privatization, which gave private owners control rights, were much more effective in improving performance than partial privatization, which retained control rights in the hands of bureaucrats. After controlling for other factors, countries that implemented full privatization moved more aggressively to rationalize input mix by increasing capital intensity in the industry in which politicians had traditionally substituted labor for capital for political patronage. These countries also experienced faster output growth, network expansion, and improvements in both labor and total factor productivities. The increase in competitive pressure, as measured by an index variable summarizing the observed market structure in both fixed-line and mobile phone segments in each country, was associated with rising employment, investment, output, teledensities, labor, and total factor productivities. We also find evidence of complementarity between privatization and competition in deepening network penetration and in restraining service pricing among privatized operators. The analysis also shows that our results are robust

[5] Ideally, the study of the effects of privatization and competition should be based on firm-level data, which unfortunately are unavailable. However, since the industry tends to be dominated by a very small number of players in any given country, the distinction between country-level and firm-level data in telecommunications industry is not as significant as in many other industries.

to plausible alternative specifications, including a potential reverse causation in which a government introduces reforms because it expects that its telecommunications sector has a higher potential to improve performance under the market-oriented reforms. We discuss the welfare implications of the findings in Section V.

Before moving on to the next section, we outline the key differences between this paper and those in the existing literature on the effects of telecommunications reforms. To begin with, our data have wider and more up-to-date coverage and contain more comprehensive information on the reforms and on performance measures than most existing studies.[6] For instance, Agustin J. Ros examines the effects of changes in ownership and in the number of mobile phones from a sample of 110 countries.[7] Scott Wallsten uses data from 30 developing countries, and his reform variables include privatization dummies and the number of mobile competitors as a proxy for competition.[8] Olivier Boyland and Giuseppe Nicoletti focus on 23 countries in the Organisation for Economic Cooperation and Development in the 1990s, while Ben. A. Petrazzini and Theodore H. Clark as well as Carsten Fink, Aaditya Mattoo, and Randeep Rathindran use samples of developing countries.[9] Bernardo Bortolotti and coauthors look at 25 countries and focus on the impact of a specific type of privatization—share-issue privatization.[10] Robert McNary covers over 200 countries between 1987 and 1998 and considers the effects of privatization and competition on network penetration for

[6] Besides the econometric analysis we summarize here, there are also many important case studies on the effects of reforms on the telecommunications sector. They include Brian Levy & Pablo Spiller, Regulations, Institutions, and Commitment: Comparative Studies of Telecommunications (1996); Sunita Kikeri, John Nellis, & Mary Shirley, Privatization: The Lessons of Experience (1992); Ben A. Petrazzini, The Political Economy of Telecommunications Reform in Developing Countries: Privatization and Liberalization in Comparative Perspective (1995); and Gabriel Roth, The Private Provision of Public Services in Developing Countries (1987).

[7] Agustin J. Ros, Does Ownership or Competition Matter? The Effects of Telecommunications Reform on Network Expansion and Efficiency, 15 J. Reg. Econ. 219 (1999).

[8] Scott Wallsten, An Empirical Analysis of Competition, Privatization, and Regulation in Africa and Latin America, 49 J. Indus. Econ. 1 (2001). In addition, Scott Wallsten, Telecommunication Privatization in Developing Countries: The Real Effects of Exclusivity Periods (Working paper, World Bank, Res. Dep't 2000), examines the effects of exclusivity on 20 privatized telecommunication companies in 15 countries and finds that exclusivity periods reduce telecommunications capacity and investment incentives. Since data on exclusivity are not available for many countries in our sample, our measure of competition is based on observed market structure in both fixed-line and mobile phone segments.

[9] Olivier Boyland & Giuseppe Nicoletti, Regulation, Market Structure and Performance in Telecommunications (Working Paper No. 237, Org. Econ. Cooperation & Dev., Econ. Dep't 2000); Ben. A. Petrazzini & Theodore H. Clark, Costs and Benefits of Telecommunications Liberalization in Developing Countries (Working Paper, Hong Kong Univ. Sci. & Tech., Econ. Dep't 1996); Carsten Fink, Aaditya Mattoo, & Randeep Rathindran, An Assessment of Telecommunications Reform in Developing Countries (Working paper, World Bank, Res. Dep't 2002).

[10] Bortolotti *et al.*, *supra* note 4.

both fixed-line and mobile phone segments.[11] In addition, given the relatively comprehensive coverage of both privatized and nonprivatized countries, our study may avoid the potential sample selection biases that might have affected the results in previous studies that used samples consisting exclusively of privatized firms or countries.

II. Analytical Framework

Previous theoretical and empirical work has shown that the relationship between ownership and product market competition, on the one hand, and the allocative and productive efficiency of the affected firm, on the other, is complex.[12] Liberalization reforms that change ownership and market structure affect the firm's performance through multiple channels. Below we consider how the reforms can alter the firm's objectives, reduce bureaucratic intervention, and realign managerial incentives, which in turn affect the firm's performance.

Politicians who control state-owned firms often choose not to maximize profits, which are owned by the public and controlled by the treasury. While a benevolent and selfless politician may maximize social welfare, most politicians will give weights in their objective function to patronage motives—redistribution preference to favored interest groups, subsidization of loss-making public enterprises, and excessive wage and employment in public sectors, as suggested by Andrei Shleifer and Robert Vishny.[13] Privatization, which transfers both the control rights and the residual cash-flow rights to private owners, should in principle increase productivity and improve input allocation. However, even private firms do frequently face government intervention. But it is likely that private firms will face less government intervention than public ones. While privatization does not imply that politicians will not increase employment beyond the profit-maximizing level or subsidize loss-making firms, excessive employment and subsidization are clearly easier under public ownership.

Privatization can also affect managerial efforts. Given politicians' lack of profit motives, it is not surprising that managers of public enterprises face less incentive to reduce costs since they cannot capture the cost savings directly. In general, as argued by John Vickers and George Yarrow,[14] poli-

[11] Robert McNary, The Network Penetration Effects of Telecommunications Privatization and Competition (Working paper, Stanford Univ., Econ. Dep't 2001).

[12] For excellent summaries of this theoretical and empirical literature, see John Vickers & George Yarrow, Privatization: An Economic Analysis (1995); World Bank, Bureaucrats in Business (1995); Andrei Shleifer, A Theory of Privatization, 106 Econ. J. 309 (1996); Andrei Shleifer, State versus Private Ownership, 12 J. Econ. Persp. 133 (1998); and William Megginson & Jeffry Netter, From State to Market: A Survey of Empirical Studies on Privatization, 39 J. Econ. Literature 321 (2001).

[13] Andrei Shleifer & Robert Vishny, Politicians and Firms, 109 Q. J. Econ. 995 (1994).

[14] Vickers & Yarrow, *supra* note 12.

ticians may lack strong incentives to monitor managers if their political fortunes are not very sensitive to the overall performance of state-owned enterprises. Under private ownership, managers may face stronger incentives to reduce costs and to innovate. Because of the higher incentives to innovate and to save costs, we expect the telecommunications sector to have higher total factor productivity after privatization.

There are, however, qualifications to the benefits of privatization. Privatized firms might experience deteriorating economic performance in the presence of externalities and economies of scale and scope. They might increase profitability by restricting output or by sacrificing certain nonprofit objectives (such as the provision of universal telephone services). But rapid technological innovations in the past 3 decades have significantly reduced economies of scale and scope in this sector, attenuating the economic rationale for a state-owned natural monopoly in the telecommunications sector. In addition, externalities and universal services provision may be handled by regulation. More importantly, privatization without a simultaneous introduction of competition will simply create private monopolies. Most economists therefore argue that privatization works best when there is competition that limits the market power of the incumbent(s).[15] Competition is thus seen as a complement to privatization.

Product market competition is a potent force that affects—and most likely improves—performance in its own right.[16] It tends to weed out inefficient firms, if they face hard budget constraints. The threat of bankruptcy may compel existing operators to be more efficient so as to minimize the probability of a corporate failure. Since state-owned firms rarely operate under hard budget constraints, the positive impact of market competition on performance is more likely to be present in privatized firms, further suggesting a complementarity between privatization and competition.

Competition also makes it possible for the principal of a telecommunications service provider and the regulator to compare the firm's performance with that of its competitors. With more information to infer managerial efforts, the principal can write better incentive contracts for the managers, and the regulator can design and implement regulations more efficiently and more

[15] See, for example, George Yarrow, Privatization in Theory and Practice, 2 Econ. Pol'y 324 (1986); J. A. Kay & D. J. Thompson, Privatisation: A Policy in Search of a Rationale, 96 Econ. J. 18 (1986); Vickers & Yarrow, *supra* note 12.

[16] For a thorough summary of the effects of competition on performance, see Stephen Nickell, Competition and Corporate Performance, 104 J. Pol. Econ. 724 (1996). Nickell also finds positive effects of competition on performance. Even for state-owned enterprises, Wei Li (The Impact of Economic Reform on the Performance of Chinese State Enterprise: 1980–1980, 105 J. Pol. Econ. 1080 (1997)) finds that there is evidence that competition is one of the most important determinants of performance.

transparently.[17] In addition, as market competition makes managerial efforts more observable, managers should face added incentives from the managerial labor market to improve firm performance so as to protect their reputation and human capital.[18] Performance is therefore expected to improve with competition.

Not every model of competition, however, predicts productivity improvement.[19] The Schumpeterian view, for instance, suggests that firms with more market power face less uncertainty, have a larger cash flow, and can fund research and development (R&D) and innovations more readily. But in countries that have developed and sophisticated capital markets, even new entrants may be able to fund the development and adoption of new technology. To the extent that new entrants are more likely to adopt new and cheaper technologies and the incumbent has ample stranded assets in old technology, competition is likely to change the composition of the sector in favor of new technology and therefore leads to higher productivity.

Our review suggests that while there is a strong presumption that privatization and competition in the telecommunications sector improve economic performance, there remain significant qualifications. Whether this presumption is true remains largely an empirical question.

III. Data

Our empirical work relies mainly on data from the International Telecommunications Union (ITU)[20] and the World Bank–Stanford telecommunications project. With the available data, we are able to distinguish two types of privatization. Full privatization, measured by the dummy variable Full_priv, equals one for a country in a year if nonstate owners hold controlling shares of the privatized firm(s) and zero otherwise. Partial privatization, measured by the dummy variable Partial_priv, equals one if the state holds controlling shares and zero otherwise. Full_priv and Partial_priv are available for 177 countries between 1990 and 2001.

To measure the degree of competition in the telecommunications sector, we use available information from ITU and the World Bank–Stanford data to construct a competition index variable, Competition.[21] This variable is

[17] Barry Nalebuff & Joseph Stiglitz, Prizes and Incentives: Towards a General Theory of Compensation and Competition, 14 Bell J. Econ. 21 (1983); Oliver Hart, The Market Mechanism as an Incentive Scheme, 14 Bell J. Econ. 266 (1983).

[18] M. A. Meyer & J. Vickers, Performance Comparisons and Dynamic Incentives (Working Paper No. 1107, Ctr. Econ. Pol'y Res. 1995).

[19] Nickell, *supra* note 16.

[20] See ITU, Trends 1999, *supra* note 1; ITU, Telecommunication Reform, *supra* note 1; ITU, Trends 2002, *supra* note 1; ITU, World Telecommunications Development Report, *supra* note 1; Pyramid Research, *supra* note 1.

[21] This variable is available from 89 countries in 1990 and increases to 162 countries in 2001.

assigned a value of zero if the telecommunications sector is served by a national monopoly operator, a value of one if the sector has more than one operator in either the fixed-line or the mobile market segment but not both, and a value of two if the sector has more than one operator in both fixed-line and mobile market segments.

The sample with available privatization and competition data consists of both developed and developing countries. (A list of the 162 sample countries q3 is available from the authors on request.) In Table 1, we report in part A summary statistics of four macroeconomic indicators of the sample countries in 1990 and in 2001: population, share of urban population, gross domestic product (GDP) per capita, and consumer price index (CPI). There are large cross-country variations in these macroeconomic indicators.

In part B, we list sample statistics of the privatization and competition variables in 1990 and 2001. Of the 177 countries in our sample, only 9 percent had nonstate equity participation in the telecommunications sector in 1990; by 2001, 49 percent of the countries did. Most of the privatization in this sector was partial, however. The proportion of countries that had partial privatization rose from 6 percent in 1990 to 41 percent in 2001. In contrast, the proportion of countries that had full or control privatization rose from 3 percent in 1990 to only 8 percent in 2001. Changes in the industrial organization in this sector were also significant. The sample average competition index rose sharply from .09 to 1.13 between 1990 and 2001, which suggests that in the majority of sample countries, this sector shifted from a monopolistic market structure to one that featured some competition.

In part C, we list the set of available variables from the ITU that describe the conduct and performance of the telecommunications sector. Given our interests in testing whether privatization reduces the effects of patronage on input allocation, we include employment (Lindex) and investment in telecommunications fixed assets per capita (Inv_PC), measured in 1998 U.S. dollars using the market exchange rate and the U.S. GDP deflator as outcome variables. To measure of the effects of privatization and competition on service volumes and local pricing, we construct an output index (Qindex) by dividing the reported total revenue by the cost of a 3-minute local call on a fixed-line telephone[22] and a telecom price index using data on the cost of a 3-minute phone call valued in 1998 U.S. dollars in order to make the cost comparable across countries.[23] The two indexes are normalized to be one for each country in 1990. The output index can thus be interpreted as an estimate of the growth of the volume of network traffic in each country. Using our measure of output and labor, we construct an index of labor productivity (LPindex) for each country as Qindex/Lindex, with the value

[22] We do not have data on the breakdown of revenue into fixed-line and mobile segments or data on the cost of other telecommunications services.

[23] We used the market exchange rate and the U.S. GDP deflator to make the conversion.

in 1990 normalized to equal one. Given the lack of telecommunications infrastructure in many developing countries, one of the main yardsticks in measuring the success of telecommunications reforms is the pace of network and services expansion. For our analysis, we include the number of fixed phone lines per 100 inhabitants (Fixed_Density), and the number of mobile phone lines per 100 inhabitants (Mobile_Density) as outcome variables. In order to measure the total factor productivity, we also construct an index of capital stock using the perpetual inventory method and data on fixed asset investment and network densities. A description of the procedure that we used is given in the Appendix.

The sample statistics listed in part C of Table 1 show that most of the dynamics in the telecommunications sector around the world was in the mobile phone segment. While the fixed-line density grew at 3.6 percent per year between 1990 and 2001, the mobile density raced at a breakneck pace of nearly 25.7 percent per year. The telecommunications sector as a whole saw a growth of 3.3 percent per year between 1990 and 2001 in call volumes, as the cost of making phone calls became slightly cheaper. It is worth noting that this growth record was achieved with virtually no increase in the number of workers employed in this sector between 1990 and 2001. The improvement in labor productivity in this sector around the world was thus a major contributor to the sector's expansion. A good portion of the improvement in labor productivity was undoubtedly the result of robust investment in this sector, which averaged $46 (1998 constant U.S. $) per capita in 1990 and $52 in 2001. But to what extent can the observed changes in productivity, input usage, output pricing and network expansion be attributed to privatization and competition? This is the question to which we now turn.

IV. The Impact of Privatization and Competition

In this section, we estimate the impact of privatization and competition on employment, investment, fixed-line density, mobile density, service output and pricing, labor productivity, and total factor productivity in the telecom sector between 1990 and 2001.[24] We first use a fixed-effects treatment-response empirical model to obtain our baseline regression results. We then test the consistency and robustness of the baseline results by examining results from alternative regression specifications.

A. Baseline Regression Analysis

Our baseline regression analysis estimates a fixed-effects treatment-response equation:

$$y_{it} = \gamma' R_{it} + \beta' X_{it} + \alpha t + \phi_i + \varepsilon_{it}, \quad (1)$$

[24] The sample countries differ by the dependent variables.

TABLE 1

SUMMARY STATISTICS

VARIABLE	DEFINITION	MEAN (SD) 1990		MEAN (SD) 2001	
A. Country economic indicators:					
Population	The population of a nation, in millions	27.80	(11.00)	32.40	(12.70)
UrbanPop	The share of urban population of a nation	50.58	(24.18)	54.84	(23.63)
GDP_PC	GDP per capita of a nation, in 1995 U.S. $	5,441.15	(8,638.16)	6,382.31	(10,489.74)
log(CPI)	Logarithm of CPI (CPI = 1 in 1990)	0	(0)	1.483	(2.720)
B. Telecom reform variables:					
Ful_priv	A dummy of full (or control) privatization, which is one for a nation in a year in which the majority owners are nonstate	.03	(.18)	.08	(.28)
Partial_priv	A dummy of partial (or revenue) privatization, which is one for a nation in a year when there was positive private ownership but state ownership still dominates	.06	(.24)	.41	(.49)
Priv	A dummy of privatization, which is one for a nation in a year when there was either full or partial privatization	.09	(.29)	.49	(.50)
Competition	An index measuring the degree of competition in the telecom sector; it is zero when a national monopoly exists in the sector, one when there is competition (that is, more than one operators) in either the fixed or the cellular segment, and two when there is competition in both segments	.09	(.36)	1.13	(.77)
C. Telecom performance variables:					
Inv_PC	Telecom investment per capita, in 1998 U.S. $	45.68	(70.46)	51.53	(71.73)

PLocal	The local price index, with local price measured as a three-minute local call (in constant 1998 U.S. $)[#]	1.00	(.00)	.95	(.59)
Qindex	The output index; real output is measured as total revenue divided by the cost of a 3-minute local phone call; the base year is 1990, when the index is set to equal one	1.00	(.00)	1.43	(1.30)
LPindex	The index of labor productivity, which is measured as real output per employee; the base year is 1990, when the index is set to equal one	1.00	(.00)	1.44	(1.39)
Lindex	The labor index, constructed based on the reported number of employees; the index is set to equal one in 1990	1.00	(.00)	1.04	(.38)
Kindex	The capital stock index; the base year is 1990; a description on how we constructed capital stock is given in the Appendix	1.00	(.00)	1.44	(.41)
Fixed_Density	Fixed-line telephone density, as measured by the number of fixed-line telephone subscribers per 100 inhabitants	13.85	(17.17)	20.63	(21.81)
Mobile_Density	Mobile telephone density, as measured by the number of mobile telephone subscribers per 100 inhabitants	1.28	(.84)	21.72	(26.51)

NOTE.—CPI = consumer price index.

where y_{it} is one of the outcome measures in country i and year t, R_{it} is a vector of telecommunications reforms, and ε_{it} is the idiosyncratic error term. We also include in the specification a set of control variables, X_{it}, country-specific effects, ϕ_i, and a time trend, t.[25] To estimate total factor productivity, we also include factor inputs on the right-hand side of equation (1). Since the four macroeconomic indicators listed in part A of Table 1 offer a summary description of the economic environment in each sample country, they are expected to affect the demand and supply of telecommunications services in a country and hence telecommunications outcomes. We include them in the baseline equation as control variables.[26] We include a time trend in the equation to capture the effects of technological changes, which are expected to be statistically significant given the rapid adoption of new technology in this sector in the 1990s. The included country fixed effects represent country-specific heterogeneity, which might influence both policy changes and industry performance. To obtain consistent standard errors for estimates of the coefficients in equation (1), we follow Mariane Bertrand, Esther Duflo, and Sendil Mullainathan and take into account potential within-country serial correlation of the idiosyncratic errors by allowing for unrestricted covariance structure over time within any country (that is, clustering by country).[27]

Under the assumptions that R_{it} are not correlated with ε_{it} and that the effects of reforms, γ, reach their permanent levels in the event year, we can obtain consistent estimates of the coefficients in equation (1) using fixed-effects regressions. These baseline estimates of γ can be interpreted as within-country estimates of the effects of the reforms conditional on the changing economic environment in each country. Later in this section, we will consider alternative empirical models that relax the above assumptions and examine the consistency and robustness of the baseline estimates.

For each outcome variable, we estimate equation (1) under three different specifications and report the results in Tables 2–5. In the first specification, we include three reform variables—Full_priv, Partial_priv, and Competition—as explanatory variables, together with the control variables listed in panel A of Table 1, country-specific effects and a time trend as captured by

[25] We have also experimented with including time dummies instead of the time trend, and the results are very similar. For ease in checking the tendency of the time trend and reporting the results, we therefore use the time trend specification.

[26] The four variables are per capita income, population, degree of urbanization, and consumer price index. We also conducted a series of robustness tests of the above specification by adding additional control variables including trade orientation, ICRG index on the risk of expropriation, and the size of economic aid received with respect to GDP. We found that our reported results of the reform effects remained qualitatively similar and that these additional control variables were largely statistically insignificant. As a result, we shall not report estimates of these alternative regression specifications. These additional regression results are available from the authors on request.

[27] Mariane Bertrand, Esther Duflo, & Sendil Mullainathan, How Much Should We Trust Difference-in-Difference Estimates? 119 Q. J. Econ. 249 (2004).

TABLE 2

THE IMPACT OF PRIVATIZATION AND COMPETITION ON EMPLOYMENT AND INVESTMENT PER CAPITA ESTIMATED USING FIXED-EFFECTS REGRESSION

	log(Lindex)			log(Inv_PC)		
	(1)	(2)	(3)	(4)	(5)	(6)
Full_priv	−.164	−.142	−.158	.584	.653	.578
	(.80)	(.68)	(.76)	(3.23)**	(2.66)**	(2.50)*
Partial_priv	−.105	−.092	−.099	−.043	−.006	−.045
	(1.59)	(1.05)	(1.09)	(.21)	(.03)	(.20)
Competition	.008	.018	.011	.293	.322	.318
	(.22)	(.47)	(.24)	(2.19)*	(1.79)+	(1.99)*
Priv × Competition		−.021	−.009		−.063	.004
		(.39)	(.15)		(.34)	(.02)
post00			−.040			−.232
			(.77)			(.96)
post00 × Ful_priv			.069			.193
			(.60)			(.51)
post00 × Partial_priv			.048			.182
			(.55)			(.56)
post00 × Competition			.031			.062
			(.72)			(.32)
post00 × Priv × Competition			−.055			−.196
			(.83)			(.88)
log(population)	.877	.879	.907	2.437	2.421	2.262
	(2.14)*	(2.14)*	(2.22)*	(1.30)	(1.29)	(1.15)
UrbanPop	−.004	−.005	−.005	−.018	−.019	−.023
	(.27)	(.29)	(.32)	(.45)	(.47)	(.57)
log(GDP_PC)	.120	.122	.128	.953	.952	.955
	(.81)	(.83)	(.87)	(1.13)	(1.13)	(1.11)
Year	−.004	−.004	−.003	−.040	−.039	−.019
	(.44)	(.44)	(.34)	(.91)	(.89)	(.41)
log(CPI)	−.027	−.027	−.027	.135	.134	.113
	(1.34)	(1.36)	(1.38)	(1.21)	(1.20)	(.99)
Observations	1097	1097	1097	913	913	913
R^2	.99	.99	.99	.86	.86	.87
F-test[a]*		.936			.770	

NOTE.—The dependent variables are the logarithm of employment or labor input index in the telecommunications sector, log(Lindex) and the logarithm of telecommunications investment per capita, log(Inv_PC). Time-invariant country heterogeneity is controlled using country fixed effects. In parentheses are *t*-statistics estimated using robust standard errors that accounted for time-series autocorrelation within each country (clustering by country). Estimates of the country fixed effects and the intercept term are omitted.

[a] Post-2000 reforms = 0.

+ Significant at the 10 percent level.

* Significant at the 5 percent level.

** Significant at the 1 percent level.

the variable *Year*. In the second specification, we add an interaction variable between privatization and competition in order to estimate any complementarities that may exist between the two reforms. An implicit assumption in the first and second specifications is that the equation coefficients are time invariant. But given the dramatic shift in market conditions brought about by the bursting of the technology bubble in 2000, it is possible that the response of the industry to reforms would be different before and after 2000. To test this hypothesis, we include in the third specification a dummy variable, Post00, on the right-hand side and interact it with all the included reform variables. The dummy variable Post00 equals one for years 2000 and 2001 and zero for earlier years.

1. *Employment and Investment.* Table 2 presents estimates of equation (1) with employment (columns 1–3) and capital investment per capita (columns 4–6) in logarithm as the dependent variables, each under the three different specifications as discussed above. Inspection of the results reported in columns 1–3 reveals that, consistent with the patronage hypothesis, both full and partial privatizations reduce employment and full privatization appears to have larger effects. But the estimated effects are not statistically significant. The estimated effects of competition on employment are small and also statistically insignificant. In columns 2 and 3, estimates of the coefficient on the interaction variable between the privatization dummy and the competition index, Priv × Competition, are negative but small and statistically insignificant. The end of the technology bubble does not have much impact on telecom employment either directly or indirectly via the effects of the reforms. The variables with the largest explanatory power appear to be population and country dummies. The regression analysis offers therefore at best a weak support for the patronage theory outlined in Section II.

Inspection of the results in columns 4–6 shows that full privatization has large and statistically significant positive effect on telecom investment. A move to full privatization that gives nonstate owners majority control would increase annual telecom investment per capita by about 60 percent. In contrast, partial privatization appears to have little impact on investment in the telecom sector. Competition is also found to increase telecom investment substantially. An increase in competition index by one (for example, a move from a monopoly market structure to competition in either fixed-line or mobile market segment) would raise telecom investment per capita by about 30 percent. But the small and insignificant estimates of the coefficient on Priv × Competition suggest that there is little complementarity between privatization and competition in effecting telecom investment. The end of the technology bubble does not appear to have much impact on telecom investment either directly or indirectly via the effects of the reforms. The observed impact of privatization and competition is therefore more pronounced on investment than on employment in the telecommunications sector.

However, when we consider jointly the effects of the reforms on employ-

ment and investment, our results suggest that the reforms are clearly biased toward capital intensity and away from labor-intensive operations. Since telecommunications companies likely employ excessive number of workers before the reforms, our findings here suggest that the reforms appeared to have effectively reversed the perverse tendency to substitute labor for capital. In a capital-intensive industry like telecommunications, this shift in factor intensity should improve economic efficiency.

2. *Fixed-Line and Mobile Phone Densities.* Table 3 reports the estimates of equation (1) with Fixed_Density (columns 1–3) and Mobile_Density (columns 4–6) in logarithm as the dependent variables, each under three different specifications. Consider first the impact of privatization on network expansion. Inspection of the estimates in Table 3 clearly shows that it is the move q5 to private ownership and control (that is, full privatization) that is positively associated with the expansion of service coverage in fixed-line telephony as well as mobile telephony. The impact of partial privatization is small and statistically insignificant from zero. A move to full privatization from either state ownership or partial privatization would increase fixed-line density by 26.4 percent (column 1) and mobile density by 46.7 percent (column 4) after controlling for competition policy.

Turn next to the impact of competition and joint impact of privatization and competition. Table 2 shows that after controlling for privatization, competition has a positive and large impact on mobile density but no detectable effects on fixed-line density. An increase in competition index by one is found to be associated with a 39.1 percent increase in mobile phone density (column 4) after controlling for the effects of privatization. Inspection of columns 2–3 and 5–6 also shows that estimates of the joint effects of privatization and competition—the coefficient on the interaction variable Priv × Competition—are positive and statistically significant. This finding suggests that there is complementarity between competition and privatization in raising both fixed-line and mobile teledensities.

It is interesting to note that the end of the technology bubble in 2000 appears to have significant impact on network densities. Holding everything else (including the positive time trend) constant, the postbubble years were associated with a 6.8 percent decline in fixed-line phone density but a 35.2 percent increase in mobile phone density. The effects of both full and partial privatization on mobile teledensity are also substantially higher in 2000 and 2001 than in the 1990s, although the effects of competition are statistically indistinguishable between the two time periods. There is, however, little difference in the effects of privatization and competition on fixed-line teledensity before and after the end of the technology bubble, a fact confirmed by the *F*-test listed in column 3 in Table 2.

In addition to the reforms, technological improvements and a country's macroeconomic environment are also expected to affect the pace of network expansion. The estimates in Table 3 are in agreement with this expectation.

TABLE 3

THE IMPACT OF PRIVATIZATION AND COMPETITION ON FIXED-LINE AND MOBILE DENSITIES ESTIMATED USING FIXED-EFFECTS REGRESSION

	ln(Fixed_Density)			ln(Mobile_density)		
	(1)	(2)	(3)	(4)	(5)	(6)
Full_priv	.264	.203	.182	.467	.170	.175
	(4.21)**	(2.76)**	(2.50)*	(2.84)**	(1.14)	(1.44)
Partial_priv	−.006	−.042	−.033	.210	.035	−.069
	(.17)	(.93)	(.81)	(1.61)	(.25)	(.56)
Competition	.010	−.015	−.017	.391	.265	.263
	(.51)	(.72)	(.90)	(5.01)**	(2.98)**	(3.37)**
Priv × Competition		.058	.058		.282	.239
		(1.77)+	(1.93)+		(2.60)*	(2.55)*
post00			−.068			.352
			(2.45)*			(2.84)**
post00 × Full_priv			.062			.776
			(.83)			(2.78)**
post00 × Partial_priv			.007			.538
			(.13)			(2.36)*
post00 × Competition			.030			−.122
			(1.22)			(1.14)
post00 × Priv × Competition			−.020			−.180
			(.51)			(1.12)
log(population)	−.770	−.777	−.739	−4.059	−4.092	−3.982
	(2.51)*	(2.56)*	(2.47)*	(3.71)**	(3.72)**	(3.85)**
UrbanPop	.016	.017	.015	−.035	−.030	−.015
	(1.21)	(1.30)	(1.16)	(1.49)	(1.26)	(.63)
log(GDP_PC)	.440	.433	.439	.544	.510	.529
	(3.35)**	(3.30)**	(3.40)**	(1.17)	(1.15)	(1.29)
Year	.057	.056	.060	.235	.235	.194
	(6.92)**	(7.00)**	(7.07)**	(7.99)**	(8.04)**	(7.15)**
log(CPI)	−.020	−.019	−.020	−.080	−.076	−.059
	(3.58)**	(3.51)**	(3.76)**	(1.82)+	(1.76)+	(1.64)
Observations	1139	1139	1139	1134	1134	1134
R^2	.99	.99	.99	.91	.91	.92
F-test[a]*		.403			.006	

NOTE.—The dependent variables are the logarithm of fixed-line density, log(Fixed_Density) and the logarithm of mobile density, log(Mobile_Density). Time-invariant country heterogeneity is controlled using country fixed effects. In parentheses are *t*-statistics estimated using robust standard errors that accounted for time-series autocorrelation within each country (clustering by country). Estimates of the country fixed effects and the intercept term are omitted.

[a] Post-2000 reforms = 0.

+ Significant at the 10 percent level.

* Significant at the 5 percent level.

** Significant at the 1 percent level.

The estimates of the time trend as the coefficient on Year, which is a proxy for technology, are positive and statistically significant in all specifications. Consistent with our expectation that mobile telephony experienced much faster improvement in technology, estimates of the time trend on Mobile_Density in columns 4–6 are much higher than those on Fixed_Density in columns 1–3. It is also not surprising to observe that smaller and richer countries tend to have higher teledensities. But it is interesting to note that countries with a higher inflation rate and hence a less stable macroeconomic environment tend to have lower teledensities, even after controlling for income and population. One possible interpretation of this finding is that countries with high inflation often impose price control on telecommunications services, thereby reduce the incentive of the operators to expand their network and services. This interpretation is also consistent with the findings below.

3. *Output and Pricing.* A main policy concern about telecommunications privatization is the extent to which privatized incumbents, facing less government intervention, may choose to exercise their market power. Did privatized companies restrict output and raise prices? To what extend did the increase in competition help mitigate this distortion? To address these questions, we run fixed-effects regression on equation (1) under three different specifications with log(Qindex) and log(Pindex) as the dependent variables. We report the results in Table 4. q6

Estimates in columns 1–3 in Table 4 show that full privatization has a positive impact on real output. A move from public ownership to full privatization is associated with an increase in output by between 31.5 and 36 percent depending on specification (columns 1–3). Partial privatization, however, appears to have small and statistically insignificant effects on output. This finding is consistent with the earlier finding that full privatization increases teledensities since call volumes often rise with network penetration. The results in columns 1–3 also confirm the output-enhancing role of competition. An increase in the competition index by one is associated with an increase in output by about 13.5 percent. However, we do not see strong evidence of the complementarity between privatization and competition on output expansion. While estimates of the coefficient on the interaction variable Priv × Competition are positive as expected, they are small and statistically insignificant. The end of the technology bubble does not appear to have much impact on output either directly or indirectly.

Estimates in columns 4–6 in Table 4 show that full privatization also increases the real cost of local phone calls. Under partial privatization, the cost of local phone calls tends to fall a little. Interestingly, competition appears to increase the real cost of local phone calls, albeit by an amount that is statistically insignificant (column 5 or 6). However, we do find evidence of complementarity between privatization and competition in restraining the rise in the cost of local phone calls. For countries that are privatized, competition has a significantly negative effect on the cost of local phone calls. The end

TABLE 4

THE IMPACT OF PRIVATIZATION AND COMPETITION ON OUTPUT AND THE PRICE OF LOCAL PHONE CALLS USING FIXED-EFFECTS REGRESSION

	log(Qindex)			log(Pindex)		
	(1)	(2)	(3)	(4)	(5)	(6)
Full_priv	.360	.340	.315	.093	.416	.465
	(2.59)*	(2.18)*	(2.09)*	(.43)	(2.07)*	(2.35)*
Partial_priv	.100	.088	.069	−.207	−.017	−.090
	(1.05)	(.75)	(.56)	(2.02)*	(.13)	(.70)
Competition	.141	.132	.135	−.007	.107	.133
	(3.48)**	(2.82)**	(2.82)**	(.10)	(1.49)	(1.57)
Priv × Competition		.019	.029		−.269	−.223
		(.30)	(.44)		(2.57)*	(2.24)*
post00			−.055			−.005
			(.93)			(.04)
post00 × Full_priv			.170			−.201
			(.88)			(.80)
post00 × Partial_priv			.120			.106
			(.71)			(.57)
post00 × Competition			.010			−.063
			(.19)			(.65)
post00 × Priv × Competition			−.073			−.037
			(.67)			(.26)
log(population)	.003	.002	.063	−.422	−.376	−.560
	(.00)	(.00)	(.09)	(.71)	(.67)	(.97)
UrbanPop	−.017	−.017	−.017	.022	.014	.011
	(.97)	(.95)	(.95)	(1.15)	(.77)	(.66)
log(GDP_PC)	1.153	1.153	1.162	.086	.166	.106
	(3.90)**	(3.90)**	(3.94)**	(.31)	(.62)	(.41)
Year	.069	.069	.069	−.004	−.002	.007
	(3.43)**	(3.43)**	(3.32)**	(.27)	(.15)	(.48)
ln(CPI)	−.946	−.946	−.946	−.038	−.040	−.041
	(25.41)**	(25.41)**	(25.08)**	(2.30)*	(2.38)*	(2.35)*
Observations	989	989	989	819	819	819
R^2	.98	.98	.98	.52	.53	.54
F-test[a]*		.935			.201	

NOTE.—The dependent variables are the logarithm of output index, log(Qindex) and the logarithm of local phone price index, log(Pindex). Time-invariant country heterogeneity is controlled using country fixed effects. In parentheses are t-statistics estimated using robust standard errors that accounted for time-series autocorrelation within each country (clustering by country). Estimates of the country fixed effects and the intercept term are omitted.

[a] Post-2000 reforms = 0.

* Significant at the 5 percent level.

** Significant at the 1 percent level.

of the technology bubble does not appear to have much impact on the pricing of phone calls either directly or indirectly via the price effects of the reforms between 2000 and 2001.

The finding that full privatization increases industry output and prices is puzzling. Since our output and pricing data are not adjusted for changes in service quality, one possible explanation is that full privatization increases output and improves service quality and hence the cost of phone calls. Another possible explanation is the combination of strong network externality in phone services and noncompetitive behavior among existing operators. Even as the operators raises prices, the demand for phone services may still grow at a rapid pace as more and more users are connected to the network. An implicit assumption embedded in this explanation is that demand for phone services before the reforms was largely met at the market-clearing prices. While this assumption is innocuous in some developed economies, it does not describe the institutional setting in many developing countries, where the combination of price control in the industry and high inflation resulted in artificially low pricing on phone services. At such low prices, operators had little incentive to invest in network expansion while demand for phone services was artificially high. The end result was often a long waiting list for service activation. Indeed, we find in Table 4 that an increase in the CPI is strongly associated with a decline in both real output and the real cost of local phone calls. Therefore, another plausible explanation of our finding is that privatized operators, when freed from price control (although they could still face a more liberal price regulation), would increase price and output simultaneously. The finding that full privatization is associated with an increase in the price of local phone calls still suggests that privatized firms may have taken advantage of their market power in a deregulated environment. But the combination of privatization with competition policies did work as expected. Our results show strong complementarity between the two policies in restraining postprivatization price hikes.

4. *Labor Productivity.* Using labor productivity measured by real output per employee as the dependent variable, we estimate equation (1) and report the results in columns 1–3 in Table 5. There we find that full privatization increases labor productivity significantly by between 46.7 and 52.2 percent depending on specification. Partial privatization also exhibits positive, but smaller and less statistically significant, effects on labor productivity. The effects of competition are positive and statistically significant. An increase in the competition index is found to raise labor productivity by between 11.1 and 13.1 percent depending on specification. In columns 2 and 3, we find little evidence of complementarity between privatization and competition in raising labor productivity. The estimated coefficients on the interaction term Priv × Competition are small and statistically insignificant. The end of the technology bubble does not appear to have much impact on labor productivity

q7

TABLE 5

THE IMPACT OF PRIVATIZATION AND COMPETITION ON LABOR PRODUCTIVITY AND TOTAL FACTOR PRODUCTIVITY ESTIMATED USING FIXED-EFFECTS REGRESSION

	log(LPindex)			log(Qindex)		
	(1)	(2)	(3)	(4)	(5)	(6)
Full_priv	.522	.476	.467	.352	.317	.292
	(4.59)**	(3.34)**	(3.23)**	(2.40)*	(1.97)+	(1.89)+
Partial_priv	.234	.205	.185	.102	.081	.059
	(1.77)+	(1.22)	(1.05)	(1.18)	(.73)	(.50)
Competition	.131	.111	.125	.131	.116	.125
	(2.28)*	(1.93)+	(2.00)*	(3.26)**	(2.45)*	(2.63)**
Priv × Competition		.044	.036		.034	.038
		(.49)	(.38)		(.51)	(.56)
post00			−.050			−.054
			(.73)			(.92)
post00 × Full_priv			.123			.177
			(.60)			(.90)
post00 × Partial_priv			.110			.124
			(.69)			(.71)
post00 × Competition			−.022			−.013
			(.36)			(.26)
post00 × Priv × Competition			−.017			−.054
			(.15)			(.48)
log(Kindex)				−.194	−.203	−.207
				(.54)	(.57)	(.58)
log(Lindex)				−.038	−.036	−.038
				(.19)	(.18)	(.19)
log(population)	−.860	−.861	−.811	.124	.126	.186
	(1.02)	(1.02)	(.95)	(.18)	(.19)	(.27)
UrbanPop	−.013	−.013	−.013	−.017	−.017	−.017
	(.43)	(.41)	(.41)	(.85)	(.83)	(.83)
log(GDP_PC)	1.081	1.082	1.085	1.256	1.261	1.275
	(3.28)**	(3.30)**	(3.30)**	(3.95)**	(3.99)**	(4.02)**
Year	.074	.074	.074	.073	.073	.073
	(2.80)**	(2.82)**	(2.72)**	(3.03)**	(3.04)**	(2.94)**
log(CPI)	−.924	−.923	−.923	−.951	−.950	−.950
	(18.53)**	(18.56)**	(18.29)**	(25.99)**	(25.95)**	(25.64)**
Observations	961	961	961	961	961	961
R^2	.97	.97	.97	.98	.98	.98
F-test[a,*]		.867		.864		

NOTE.—The dependent variables are the logarithm of labor productivity, log(LPindex) and the logarithm of output index, log(Qindex). Time-invariant country heterogeneity is controlled using country fixed effects. In parentheses are t-statistics estimated using robust standard errors that accounted for time-series autocorrelation within each country (clustering by country). Estimates of the country fixed effects and the intercept term are omitted.

[a] Post-2000 reforms = 0.

+ Significant at the 10 percent level.

* Significant at the 5 percent level.

** Significant at the 1 percent level.

either directly or indirectly via the effects of the reforms between 2000 and 2001.

These results are not surprising, given what we know about the effects of the reforms on output and employment, as well as investment. To measure the extent to which the improvements in labor productivity are attributable to the increases in total factor productivity that were brought about by the reform, we estimate a production function that includes reform variables as explanatory variables.

5. *Total Factor Productivity (TFP).* For country i, the value-added generated by the telecommunications sector in year t, V_{it}, can be expressed in the following Cobb-Douglas production function specification:

$$\ln V_{it} = \rho_1 \ln L_{it} + \rho_2 \ln K_{it} + \beta' X_{it} + \gamma' R_{it} + \alpha t + \phi_i + \varepsilon_{it}, \qquad (2)$$

where L_{it} and K_{it} are labor and capital employed, X_{it} is a vector of control variables, R_{it} is a vector of reform variables, ϕ_i is the country-specific effect, and ε_{it} is the error term. Total factor productivity defined by the Solow residual is then $\gamma' R_{it} + \alpha t + \phi_i + \varepsilon_{it}$, where the vector of coefficients measures the marginal impact of reforms on TFP.

As it stands, equation (2) is not directly estimable because data on V_{it} and K_{it} are unavailable. But this problem is not insurmountable. In the Appendix, we discuss the procedure that we use to construct K_{it} using data on investment and the size of the phone network. Since data on the usage of intermediate inputs are not available to construct V_{it}, we take an alternative route. Below we propose a plausible empirical model for V_{it} that relates it to observed variables. In doing so, we impose additional restrictions on the regression model given in equation (2).

Since the usage of intermediate inputs is determined by the prevailing technology, the intensity of primary inputs used in production, and the scale of production, we hypothesize that the relationship between gross output, value added, observable inputs, and the macroeconomic environment in country i can be expressed in the following specification:

$$\ln (Q_{it}/V_{it}) = \rho_1^0 \ln L_{it} + \rho_2^0 \ln K_{it} + \beta^0 X_{it} + \gamma^0 R_{it} + \alpha^0 t + \phi_i^0 + \varepsilon_{it}^0, \qquad (3)$$

where ε_{it}^0 is assumed uncorrelated with explanatory variables in (2). Note that $\ln (Q_{it}/V_{it})$ is a measure of the use of intermediate inputs. Equation (3) can be justified on the ground that the use of intermediate inputs relative to other inputs is determined by the technology and by factor prices prevailing in country i, which in turn are influenced by the country's observable macroeconomic environment and by unobserved country-specific effects. To the extent that the reforms increased productivity through more efficient use of intermediate inputs, we expect that $\gamma^0 \leq 0$. Combining equations (2) and (3) we get

$$\ln (Q_{it}) = \rho_1^* \ln L_{it} + \rho_2^* \ln K_{it} + \beta^* X_{it} + \gamma^* R_{it} + \alpha^* t + \phi_i^* + \varepsilon_{it}^* \qquad (4)$$

where variables with an asterisk are the sums of their corresponding counterparts in (2) and (3).

With both the dependent and explanatory variables available, equation (4) is estimable. But because we do not observe the use of intermediate inputs, our estimation of the coefficients in equation (4) will be biased as a result of omitting intermediate inputs on the right-hand side. Estimates of TFP based on equation (4) will therefore be biased. However, we do know that to the extent that the reformed raised the efficiency at which intermediate inputs were used, we expect $\gamma^* \leq \gamma$. In other words, we expect the marginal effects of the reforms on TFP to be biased downward. The actual marginal effects on TFP should be higher than the estimates. The omitted-variables biases should make it harder for us to reject the null hypothesis that the reforms had no effect on total factor productivity. Similarly, to the extent that capital and labor are substitutes for intermediate inputs,[28] we would expect to observe that $\rho_1^* < \rho_1$ and $\rho_2^* < \rho_2$.

Estimates of the equation (4) are reported in columns 4–6 in Table 5. Since the coefficients of labor and capital and the time trend are likely biased as discussed above, our discussion below focuses on estimates of γ^*. Column 4 shows that full privatization increases TFP—or log output after controlling for the use of inputs—by 35.2 percent, while competition raises TFP by 13.1 percent. Both estimates are statistically significant. Partial privatization also has a positive, but statistically insignificant, impact on TFP. Columns 5 and 6 show that there is little evidence of complementarity between privatization and competition in raising TFP, while column 5 shows that the end of the technology bubble does not appear to have much impact on TFP either directly or indirectly via the effects of the reforms between 2000 and 2001. But considering that actual marginal effects on TFP are likely higher than the estimates, we conclude that the reforms do appear to have large positive effects on total factor productivity in our baseline regressions.

B. Regressions under Alternative Specifications

The consistency and robustness of our baseline regression results depend on the extent to which the underlying assumptions of the baseline specifications are consistent with the data. To check the consistency and robustness of the baseline results, we analyze regression results under alternative specifications. In particular, we first relax the assumption that the reform variables are uncorrelated with the idiosyncratic error terms in the regression equation and reestimate the effects of the reforms using two-stage least squares. We then relax the assumption that the impact of reforms represents a permanent change in performance in the event year and reestimate the impact of reforms

[28] A good example is the adoption of fiber optic networks, which involves a large capital expenditure but relatively much smaller cost of materials.

by including 1-year and 2-year lags and leads of the reform variables on the right-hand side. And finally, we analyze whether the effects of the reforms are different between developed and developing countries.

1. *Two-Stage Least Squares.* The potential of a country's telecommunications industry to improve performance under private ownership and/or in a competitive environment should in principle be an important factor in deciding whether to privatize or to introduce competition or both. To the extent that the reforming government took into account the expected performance gains from the reforms, one would expect to observe improvements in postreform performance. This reverse causation implies that the reform variables are likely endogenous; that is, R_{it} and $\phi_i + \varepsilon_{it}$ are likely correlated.

The country-specific effects ϕ_i will likely be correlated with R_{it} since they represent part of the long-run performance potential of a country's telecommunications sector and are likely observed by the reforming politicians. Using the within-estimation technique with panel data eliminates these specific effects from the regression equation. Consistency of our baseline estimates therefore requires that the reform variables be uncorrelated with the idiosyncratic shocks ε_{it}. Since the decision to privatize and to introduce competition is mostly made by politicians who do not manage the day-to-day operations of telecommunications firms, it is very plausible that the politicians do not observe ε_{it} and hence cannot make decisions based on ε_{it}. Consequently, the reform variables are likely uncorrelated with ε_{it}.

To test this conjecture, we need to identify instrumental variables that are correlated with R_{it} but are uncorrelated with ε_{it}. While the potential for performance improvements under the reforms may be an important factor in determining the reforms, there certainly are other factors. Since the decision to reform is a political one, political economy variables should have predictive power. Indeed Wei Li and Lixin Colin Xu find that variables that describe a country's political economy environment are statistically significant determinants of privatization and competition policies in that country's telecommunications sector.[29] This finding suggests that the above-mentioned political economy variables are strongly correlated with R_{it}. There is also reason to believe that they are unlikely correlated with the idiosyncratic shocks, ε_{it}. Since these political economy variables are shaped in part by performance of the economy as a whole, they are likely correlated with the systematic portion of telecommunications sector's performance as captured by $\gamma' R_{it} +$

[29] Li & Xu, *supra* note 3. These variables are the Gini coefficient, an index measuring the ideological inclination of the country's legislature, an index of financial depth based on stock market capitalization and the size of bank assets relative to GDP, an interaction term between financial depth and the government budget deficit as a proportion of GDP, an index of party polarization that measures the greatest difference in ideological inclination between two veto players in the government, manufacturing value added as a proportion of GDP, adult illiteracy rate, share of the largest city in total population, and a dummy variable that measures whether a country maintains capital control.

$\beta' X_{it} + \alpha t + \phi_i$, which are likely observed by politicians with perhaps varying degrees of noise across countries. But they are unlikely strongly correlated with the idiosyncratic performance shocks, ε_{it}, because politicians, who do not manage day-to-day operations in the sector, may not observe the idiosyncratic shocks. The political economy variables used by Wei Li and Lixin Colin Xu are likely valid instrumental variables.[30]

In Table 6, we list the political economy variables that we use as instrumental variables and report the two-stage least squares regression results for each of the eight performance measures:[31] employment, investment per capita, fixed-line density, mobile density, output, output pricing, labor productivity, and total factor productivity. Compared to results reported in Tables 2–5, the estimates here are not qualitatively different. Full privatization and competition continue to have positive performance effects. But they are less statistically significant as one expects when using two-stage least squares, an estimator that is consistent but less efficient than ordinary least squares. The Wu-Hausman specification test cannot reject the null that the reform variables are correlated with the idiosyncratic error in each of the eight performance regressions. The findings suggest that it is unlikely that our baseline regression estimates are biased upward by possible reverse causation between reform and performance. In what follows, we maintain the hypothesis that the reform variables are uncorrelated with the idiosyncratic error.

2. *Inclusion of Leads and Lags of Reform Variables in the Regressions.*Baseline estimates of the reform effects are obtained under the assumption that the impact of reforms represents a permanent change in performance during the event year. In Table 7, we report estimates obtained under an alternative specification that includes reform variables and their 1-year and 2-year leads and lags as explanatory variables, thus allowing the reforms to affect performance both before and after the reform events.[32] In doing so, we should in principle be able to address the following questions: Does the impact of privatization occur before the event? The impact could precede the event but occur after the state commits to the change, if the state "dresses up" the operator before privatization or if the management takes up defensive postures in an effort to entrench managerial control. Do gains from competition occur before the event as the formerly monopolistic operator restructures in anticipation of increased competition? Does the impact of privatization and competition increase or diminish with time?

Inspection of the estimates in Table 7 shows that the inclusion of leads and lags of the reform variables does not alter the qualitative results in our

[30] Li & Xu, *supra* note 3.

[31] Definitions of these instrumental variables are given in Li & Xu, *supra* note 3, and are available from the authors upon request.

[32] Since we have a relatively short panel, we limited the numbers of lags and leads to 2 years.

baseline estimates. The impact of partial privatization remains quite modest relative to that of full privatization or competition. But the impact of either full privatization or competition is not concentrated in the event year. Rather, estimates in Table 7 reveal some interesting dynamics.

Consider first the impact of full privatization. Since privatization is often preceded by corporatization, one may expect that the impact of privatization would occur before the event. This is, however, not confirmed by our estimates of the coefficients on 1-year and 2-year leads of the full-privatization dummy variable. The estimates are individually and jointly statistically insignificant. Instead, most of the impact of full privatization appears to occur during and after the event year, and the dynamics appear complex. Full privatization is found to reduce employment by 19.9 percent during the event year but to increase employment by 14.2 percent a year later, resulting in a compounded change of -5.7 percent 1 year after the event. The incremental contribution of full privatization on employment during the second year after the event is also negative but small and statistically insignificant. This finding suggests that privatized companies may have taken advantage of the increased flexibility in labor allocation not only to reduce the size of its labor force but also to change its composition, perhaps with a bias toward more skilled workers as privatized firms invested heavily in new technologies. The positive effects of full privatization on investment per capita, fixed-line and mobile densities, output, and total factor productivity are not realized until a year or two after the event. It is also interesting to note that the effects appear to increase over time. For example, the estimated impact of full privatization on fixed-line density up to the event year is small and statistically insignificant, but it registers a large increase (15 percent) in the first postprivatization year and another large increase (13 percent) a year later. The compounded impact is therefore 28 percent 2 years after privatization. However, the impact of full privatization on the price of local phone calls and on labor productivity appears to occur mainly during the event year.

Consider next the impact of competition. Inspection of estimates of the coefficients on competition with 1-year and 2-year leads shows that the impact of competition does not occur before the event on all but one performance measure—mobile density with a 1-year lead. The impact on fixed-line density with a 1-year lead is marginally statistically significant but very small in magnitude and negative. Interestingly, most of the positive impact of competition on fixed-line and mobile densities, output, labor productivity and total factor productivity appears to occur 2 years after the event. Interestingly, the impact of competition on investment per capita is felt mainly during the event year and the first year after the event. It thus appears that competition first induces firms to invest in new technology and network capacity, which in turn results in higher telephone densities, higher output, and higher productivity 1 or 2 years later. Our findings are thus consistent with the existence of a time-to-build lag.

TABLE 6

The Impact of Privatization and Competition on All Performance Variables Using Two-Stage Least Squares Regression

	log(L) (1)	log(Inv_PC) (2)	log(Fixed_Density) (3)	log(Mobile_Density) (4)	log(Qindex) (5)	log(Pindex) (6)	log(LPindex) (7)	log(Qindex) (8)
Full_priv	−.780	.233	.657	−.950	1.313	2.187	2.070	1.141
	(1.24)	(.11)	(1.61)	(.55)	(1.03)	(.95)	(1.49)	(.87)
Partial_priv	−.139	−.083	−.049	−.470	.007	−.252	.291	−.094
	(.38)	(.06)	(.24)	(.40)	(.02)	(.40)	(.48)	(.21)
Competition	−.058	1.964	.177	1.575	.214	−.035	.222	.236
	(.42)	(2.97)**	(1.29)	(2.42)*	(.94)	(.07)	(.80)	(.99)
log(population)	.674	6.404	−.499	−2.677	.153	.444	−.423	.154
	(1.13)	(2.00)*	(1.10)	(1.51)	(.20)	(.35)	(.44)	(.21)
UrbanPop	−.003	−.073	.012	−.060	−.015	.024	−.013	−.018
	(.19)	(1.34)	(.76)	(1.64)	(.69)	(.85)	(.40)	(.78)
log(GDP_PC)	.138	.826	.438	.615	1.192	.152	1.093	1.183
	(.69)	(.76)	(2.61)*	(.84)	(3.62)**	(.37)	(3.00)**	(3.36)**
Year	.008	−.185	.043	.182	.056	−.028	.046	.061
	(.38)	$(1.70)^{+}$	(2.87)**	(2.52)*	$(1.82)^{+}$	(.56)	(1.14)	$(1.87)^{+}$

log(CPI)	−.023	.177	−.024	−.086	−.951	−.042	−.931	−.952
	(1.28)	(1.08)	(4.12)**	(2.68)**	(28.77)**	(1.97)+	(22.00)**	(28.35)**
log(Kindex)								−.007
								(.02)
log(Lindex)								−.035
								(.12)
Observations	934	912	956	951	830	621	814	961
R^2	.99	.78	.99	.63	.97	.37	.96	.98
Hausman's test (*p*-value)	.991	.310	.728	.999	.890	.960	1.000	1.000

NOTE.—Time-invariant country heterogeneity is controlled using country fixed effects. Instrumental variables used are Gini coefficient, an index measuring the ideological inclination of the country's legislature, an index of financial depth based on stock market capitalization and the size of bank assets relative to GDP, an interaction term between financial depth and the government budget deficit as a proportion of GDP, an index of party polarization measuring the greatest difference in ideological inclination between two veto players in the government, manufacturing value added as a proportion of GDP, adult illiteracy rate, share of the largest city in total population, and a dummy variable measuring whether a country maintains capital control. In parentheses are *t*-statistics estimated using robust standard errors that accounted for time series autocorrelation within each country (clustering by country). Estimates of the country fixed effects and the intercept term are omitted.

+ Significant at the 10 percent level.

* Significant at the 5 percent level.

** Significant at the 1 percent level.

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TABLE 7

THE DYNAMIC IMPACT OF PRIVATIZATION AND COMPETITION ALL PERFORMANCE VARIABLES USING FIXED-EFFECTS REGRESSION

	log(L) (1)	log(Inv_PC) (2)	log(Fixed_Density) (3)	log(Mobile_Density) (4)	log(Qindex) (5)	log(Pindex) (6)	log(LPindex) (7)	log(Qindex) (8)
$Full\_priv_{t+2}$	.050	−.467	.046	.138	.175	.048	.123	.182
	(.60)	(.86)	(1.32)	(1.22)	(1.60)	(.10)	(1.46)	(1.49)
$Full\_priv_{t+1}$	−.048	.204	−.013	.012	−.101	.713	−.056	−.108
	(.58)	(.93)	(.30)	(.09)	(1.06)	(1.13)	(.69)	(1.03)
Full_priv	−.199	−.031	.043	.042	.079	−.189	.272	.047
	(1.63)	(.16)	(1.50)	(.48)	(.67)	(1.73)$^{+}$	(2.93)**	(.33)
$Full\_priv_{t-1}$	.142	1.026	.150	.139	.011	−.241	−.133	.028
	(1.86)$^{+}$	(1.79)$^{+}$	(4.58)**	(1.32)	(.11)	(.71)	(.79)	(.25)
$Full\_priv_{t-2}$	−.028	−.208	.130	.451	.322	.305	.347	.316
	(.11)	(.79)	(2.20)*	(2.92)**	(3.47)**	(1.24)	(1.41)	(3.13)**
$Partial\_priv_{t+2}$	.012	.026	−.008	.129	−.123	.033	−.093	−.127
	(.21)	(.09)	(.30)	(1.10)	(1.09)	(.34)	(.75)	(1.11)
$Partial\_priv_{t+1}$	−.043	.054	.007	−.022	−.039	−.306	−.017	−.049
	(1.42)	(.27)	(.44)	(.52)	(.30)	(2.00)*	(.10)	(.37)
Partial_priv	−.052	.019	−.017	−.074	.168	.109	.248	.157
	(.68)	(.09)	(.87)	(1.05)	(1.34)	(1.12)	(1.21)	(1.40)
$Partial\_priv_{t-1}$	−.019	.286	.014	.068	.052	−.016	.075	.051
	(.78)	(1.82)$^{+}$	(1.15)	(1.15)	(1.44)	(.11)	(1.78)$^{+}$	(1.30)
$Partial\_priv_{t-2}$	−.049	−.183	.048	.115	.122	.170	.203	.128
	(1.13)	(.83)	(1.51)	(1.37)	(.97)	(1.31)	(1.12)	(1.04)

Competition_{t+2}	−.004	.023	.018	−.019	.069	.048	.078	.065
	(.15)	(.16)	(.83)	(.39)	(1.38)	(.48)	(1.41)	(1.31)
Competition_{t+1}	.006	−.043	−.014	.106	.027	.113	.021	.026
	(.38)	(.40)	(1.70)+	(2.87)**	(.87)	(.88)	(.60)	(.79)
Competition	.002	.272	−.009	.221	.010	−.236	.002	.004
	(.05)	(2.15)*	(.43)	(2.65)**	(.17)	(1.42)	(.03)	(.07)
Competition_{t-1}	.073	.212	−.021	.105	.013	−.096	−.059	.020
	(1.26)	(2.18)*	(1.11)	(1.36)	(.25)	(.72)	(.66)	(.36)
Competition_{t-2}	−.057	−.103	.055	.372	.149	.201	.183	.146
	(1.15)	(.88)	(2.27)*	(4.16)**	(2.26)*	(1.64)	(2.15)*	(2.10)*
Observations	636	523	643	640	564	445	554	554
R^2	.99	.88	.99	.88	.98	.68	.97	.98
p for F-test:								
Lagged reforms = 0	.216	.183	.000	.000	.000	.266	.089	.001
Lead reforms = 0	.816	.922	.213	.045	.188	.008	.075	.244
Lag and lead reforms = 0	.007	.008	.000	.000	.000	.000	.010	.000

NOTE.—Time-invariant country heterogeneity is controlled using country fixed effects. In parentheses are t-statistics estimated using robust standard errors that accounted for time series autocorrelation within each country (clustering by country). Estimates of the country fixed effects, the intercept term, and the coefficients on all control variables are omitted.

+ Significant at the 10 percent level.

* Significant at the 5 percent level.

** Significant at the 1 percent level.

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TABLE 8

THE IMPACT OF PRIVATIZATION AND COMPETITION ALL PERFORMANCE VARIABLES USING FIXED-EFFECTS REGRESSION: HIGH-INCOME COUNTRIES VERSUS LOW-INCOME COUNTRIES

	log(L) (1)	log(Inv_PC) (2)	log(Fixed_Density) (3)	log(Mobile_Density) (4)	log(Qindex) (5)	log(Pindex) (6)	log(LPindex) (7)	log(Qindex) (8)
Full_priv	−.065	.742	.179	.471	.347	.243	.414	.367
	(.18)	(3.17)**	(2.06)*	(3.56)**	(1.32)	(1.42)	(3.37)**	(1.38)
Partial_priv	−.159	−.168	.027	.011	.114	−.383	.293	.121
	(1.49)	(.57)	(.54)	(.07)	(.92)	(3.15)**	(1.52)	(1.03)
Competition	.028	.241	.009	.211	.102	.083	.067	.078
	(.72)	(.99)	(.30)	(2.15)*	(1.89)$^+$	(.87)	(1.01)	(1.47)
Full_priv × high-income dummy	−.175	−.213	.141	.094	.044	−.201	.216	.008
	(.41)	(.64)	(1.39)	(.37)	(.15)	(.63)	(1.21)	(.03)
Partial_priv × high-income dummy	.115	.267	−.075	.449	−.029	.382	−.127	−.032
	(.98)	(.68)	(.96)	(2.08)*	(.16)	(2.09)*	(.51)	(.17)
Competition × high-income dummy	−.055	.088	.014	.382	.086	−.211	.145	.106
	(.90)	(.34)	(.33)	(3.25)**	(1.11)	(1.55)	(1.24)	(1.39)
Kindex								−.196
								(.54)
Lindex								−.032
								(.16)

log(population)	.793	2.642	−.737	−3.488	.111	−.558	−.660	.248
	(2.00)*	(1.40)	(2.52)*	(3.33)**	(.17)	(1.00)	(.81)	(.37)
UrbanPop	−.003	−.015	.015	−.024	−.017	.023	−.014	−.017
	(.20)	(.35)	(1.16)	(1.10)	(.98)	(1.28)	(.45)	(.85)
log(GDP_PC)	.127	.962	.438	.473	1.152	.109	1.083	1.258
	(.87)	(1.14)	(3.35)**	(1.13)	(3.89)**	(.41)	(3.25)**	(3.98)**
Year	−.003	−.048	.056	.217	.066	−.002	.069	.070
	(.35)	(1.09)	(7.26)**	(7.66)**	(3.39)**	(.11)	(2.73)**	(2.98)**
log(CPI)	−.026	.155	−.021	−.065	−.945	−.039	−.923	−.948
	(1.37)	(1.34)	(3.84)**	(1.85)$^{+}$	(24.97)**	(2.30)*	(18.57)**	(25.33)**
Observations	1,097	913	1,139	1,134	989	819	961	961
R^2	.99	.86	.99	.91	.98	.53	.97	.98
F-test: reforms × high-income dummies = 0	.667	.805	.392	.000	.712	.092	.259	.564

NOTE.—Time-invariant country heterogeneity is controlled using country fixed effects. In parentheses are *t*-statistics estimated using robust standard errors that accounted for time series autocorrelation within each country (clustering by country). Estimates of the country fixed effects and the intercept term are omitted.

$^{+}$ Significant at the 10 percent level.

* Significant at the 5 percent level.

** Significant at the 1 percent level.

3. *Low-Income versus Medium- and High-Income Countries.* To analyze whether the effects of the reforms change with income across countries, we rerun the baseline regressions allowing the reform effects to differ between low-income countries (those with GDP per capita lower than the median income of $1,670, measured in 1995 constant dollars) and higher-income countries. We do so by including interaction terms between the higher-income dummy variable with the three reform variables. The regression results are reported in Table 8. Higher-income countries appear to experience similar reform impact on employment, investment per capita, fixed-line density, output, labor productivity, and total factor productivity. But the impact of competition and partial privatization on mobile phone density does appear to be higher in higher-income countries. Higher-income countries also appear to raise the price of local phone calls more if the telecommunications sector is privatized only partially. Overall, the impact of the reforms appears to be similar in direction and magnitude across countries at different levels of economic development.

V. Conclusion

By analyzing the impact of privatization and competition in the telecommunications sector in up to 177 countries between 1990 and 2001, we find robust evidence that both privatization and competition contributed substantially to improved performance along multiple dimensions. Countries that implemented more aggressive programs of reforms—full privatization and competition in both fixed-line and mobile sectors—experienced significantly more performance gains than countries that implemented less aggressive reform policies. We also find complementarity between privatization and competition in that competition restrained service pricing in countries that privatized fully. Our empirical results lend support to the argument that optimal policies require bundling competition policies with privatization.

What can we infer from the findings regarding the distribution of the observed performance gains among various stakeholders? Given the limited data available, it would be a tall order to conduct a detailed quantitative welfare analysis. But we can still make some informative remarks.

To begin with, consumers or users of telecommunications services in general are likely net winners. Between 1990 and 2001, the price of phone calls measured in constant U.S. dollars remained roughly the same, while output and teledensity grew substantially. Users should therefore have benefited from expanded service availability and network externalities. They should also have benefited from intensified market competition that brought them more choices in services and possibly better quality and more customer-oriented services. However, there remains a possibility that some users were made worse off. Pensioners who had access to subsidized phone services prior to the reforms, for example, could have preferred price control under public

ownership. The government and the taxpayers should in general have benefited from privatization as subsidies were reduced or eliminated and phone companies began to show improved profitability.[33] If the government implemented share-issue privatization, proceeds from selling ownership shares would be an additional source of fiscal revenue. To the extent that total factor productivity is positively correlated with economic value added, private and public investors should have benefited from privatization and competition. However, not all investors benefited financially from the gain in productivity because of the overvaluation of telecommunications stocks in the late 1990s and the subsequent market crash. Similiarly, not all employees benefited financially from the improved performance. Employees who were laid off after privatization could have suffered lost earnings, depreciated human capital, and the uncertainties of job transition. However, both existing employees who remained on the job and new hires may well have benefited from higher wages and in some countries even stock options.[34] As more data become available in the future, it would be interesting to address the distributional issues more systematically.

APPENDIX

Capital Stock

In this appendix we describe our procedure for constructing K_{it}. The available data that we use include capital investment in constant prices, obtained by deflating nominal capital expenditure using the GDP deflator and the total number of installed fixed-line telephones.

Given the real investment I_{it} in each country, the real value of capital stock can be constructed using the equation

$$K_{it} = (1 - \delta)K_{i,t-1} + I_{it}, \tag{A1}$$

if we know the initial value of capital stock, K_{i0}, and the depreciation rate, δ. Our next step is to propose an empirical model for estimating K_{i0} and δ.

In principle, the size of the capital stock as a measure of telecommunications capacity should be tightly correlated with the total number of installed fixed-line telephones, especially in earlier years when wireless services did not exist or were not widely deployed. We therefore hypothesize that the following empirical relationship holds before 1986:

$$K_{it} = \psi_1 F_{it} + \psi_2 F_{it}^2 + \zeta_i + \eta_{it}, \tag{A2}$$

where F_{it} is the number of fixed-line telephones, ζ_i represents country-specific effects,

[33] Bortolotti *et al.*, *supra* note 4.

[34] Data on employee wages are not available from our data sources. But according to statistics published in many countries, the average wage per telecommunications job post increased substantially during our sample period. In Israel, the average wage increased by 35 percent (http://www.cbs.gov.il/publications/hitech/engl/engl_2.pdf) between 1995 and 1999.

and η_{it} represents the approximation error, which we intend to minimize. Combining equations (A1) and (A2), we get

$$I_{it} = \psi_1[F_{it} - (1-\delta)F_{it-1}] + \psi_2[F_{it}^2 - (1-\delta)F_{it-1}^2] + \delta\zeta_i + \eta_{it}^* \quad \text{(A3)}$$

for t in the early part of the sample. Here $\eta_{it}^* = \eta_{it} - (1-\delta)\eta_{i,t-1}$ is the error term.

To minimize the sum of squares of η_{it}^*, we run nonlinear least squares regression based on equation (A3) using available data between 1977 and 1986. (The regression results are available from the authors upon request.) We then use the estimates of the coefficients and the fixed effects in equation (A2) to construct K_{i0} for each country for the first year with observable information. On the basis of the imputed K_{i0} for each country in 1986 based on equation (A2) and the estimate of depreciation rate (14.5 percent), we construct a time series of capital stock in constant prices using equation (A1).

BIBLIOGRAPHY

Bertrand, Mariane; Duflo, Esther; and Mullainathan, Sendil. "How Much Should We Trust Difference-in-Difference Estimates?" *Quarterly Journal of Economics* 119 (2004): 249–75.

Bortolotti, Bernardo; D'Souza, Juliet; Fantini, Marcella; and Megginson, William L. "Source of Performance Improvement in Privatized Firms—a Clinical Study of the Telecommunication Industry." Working paper. Norman: University of Oklahoma, 2001.

Boyland, Olivier; and Nicoletti, Giuseppe. "Regulation, Market Structure and Performance in Telecommunications." Working Paper No. 237. Paris: Organization for Economic Cooperation and Development, Economics Department, 2000.

Fink, Carsten; Mattoo, Aaditya; and Rathindran, Randeep. "An Assessment of Telecommunications Reform in Developing Countries." Working paper. Washington, D.C.: World Bank, 2002.

Hart, Oliver. "The Market Mechanism as an Incentive Scheme." *Bell Journal of Economics* 14 (1983): 266–82.

International Telecommunications Union. 1999. *Trends in Telecommunication Reform, Convergence and Regulation.* Geneva: International Telecommunications Union.

International Telecommunications Union. 1999. *World Telecommunications Development Report.* Geneva: International Telecommunications Union.

International Telecommunications Union. 2001. *Telecommunication Reform: Interconnection Regulation.* Geneva: International Telecommunications Union.

International Telecommunications Union. 2002. *Trends in Telecommunication Reform: Effective Regulation.* Geneva: International Telecommunications Union.

Kay, J. A., and Thompson, D. J. "Privatisation: A Policy in Search of a Rationale." *Economic Journal* 96 (1986): 18–32.

Kikeri, Sunita; Nellis, John; and Shirley, Mary. *Privatization: The Lessons of Experience*. Washington, D.C.: World Bank, 1992.

Levy, Brian, and Spiller, Pablo. *Regulations, Institutions, and Commitment: Comparative Studies of Telecommunications*. Cambridge: Cambridge University Press, 1996.

Li, Wei. "The Impact of Economic Reform on the Performance of Chinese State Enterprise: 1980–1980." *Journal of Political Economy* 105 (1997): 1080–1106.

Li, Wei, and Xu, Lixin Colin. "The Political Economy of Privatization and Competition: Cross-Country Evidence from the Telecommunications Sector." *Journal of Comparative Economics* 30 (2002): 439–62.

Li, Wei, and Xu, Lixin Colin. "The Impact of Privatization and Competition in the Telecommunications Sector around the World." Working Paper No. 02–13. Charlottesville: University of Virginia, Darden Business School, 2002b.

McNary, Robert. "The Network Penetration Effects of Telecommunications Privatization and Competition." Working paper. Stanford, Calif.: Stanford University, 2001.

Megginson, William L.; and Netter, Jeffry. "From State to Market: A Survey of Empirical Studies on Privatization." *Journal of Economic Literature* 39 (2001): 321–89.

Meyer, M. A., and Vickers, J. "Performance Comparisons and Dynamic Incentives." Working Paper No. 1107. London: Centre of Economic Policy Research, 1995..

Nalebuff, Barry, and Stiglitz, Joseph. "Prizes and Incentives: Towards a General Theory of Compensation and Competition." *Bell Journal of Economics* 14 (1983): 21–43.

Nickell, Stephen. "Competition and Corporate Performance." *Journal of Political Economy* 104 (1996): 724–46.

Petrazzini, Ben A. *The Political Economy of Telecommunications Reform in Developing Countries: Privatization and Liberalization in Comparative Perspective*. Westport, Conn.: Greenwood Press, 1995.

Petrazzini, Ben. A., and Clark, Theodore H. "Costs and Benefits of Telecommunications Liberalization in Developing Countries." Working paper. Hong Kong: Hong Kong University of Science and Technology, 1996.

Pyramid Research. *Will the Internet Close the Gap?* Report prepared for InfoDev., Washington, D.C., 2000.

Roller, Lars-Hendrik, and Waverman, Leonard. "Telecommunications Infrastructure and Economic Development: A Simultaneous Approach." *American Economic Review* 91 (2001): 909–23.

Roth, Gabriel. *The Private Provision of Public Services in Developing Countries*. New York: Oxford University Press, 1987.

Ros, Agustin J. "Does Ownership or Competition Matter? The Effects of

Telecommunications Reform on Network Expansion and Efficiency." *Journal of Regulatory Economics* 15 (1999): 219–44.
Shleifer, Andrei. "A Theory of Privatization." *Economic Journal* 106 (1996): 309–19.
Shleifer, Andrei. "State versus Private Ownership." *Journal of Economic Perspectives* 12 (1998): 133–50.
Shleifer, Andrei, and Vishny, Robert. "Politicians and Firms." *Quarterly Journal of Economics* 109 (1994): 995–1025.
Vickers, John, and Yarrow, George. *Privatization: An Economic Analysis*. Cambridge, Mass.: MIT Press, 1998.
Wallsten, Scott. "Telecommunication Privatization in Developing Countries: The Real Effects of Exclusivity Periods." Working paper. Washington, D.C.: World Bank, 2000.
Wallsten, Scott. "An Empirical Analysis of Competition, Privatization, and Regulation in Africa and Latin America." *Journal of Industrial Economics* 49 (2001): 1–19.
World Bank. *Bureaucrats in Business*. London: Oxford University Press, 1995.
Yarrow, George. "Privatization in Theory and Practice." *Economic Policy* 2 (1986): 324–64.

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