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Consequences of Vertical Separation and Monopoly: Evidence from the Telecom Privatizations

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Executive Summary

Two common policy instruments used by governments around the world to increase the availability of basic telephony (*i.e.*, local, long distance, and international service) have been: (1) award monopoly rights on basic services to cross-subsidize residential local telephony; and (2) separate vertically (*i.e.*, structural separation) the owner of the local fixed network from the provider of long distance or international telephone services. I use data from a panel of 67 countries during the seven years following the privatization of the telephone monopoly and find that contrary to wide spread beliefs: (1) monopoly on basic services is not associated with lower residential telephony prices; quite the opposite, monopoly increases residential local prices; (2) monopoly does not help universal service provision and lowers the use of international telephony; and (3) mandatory vertical separation reduces international telephony usage and the number of fixed lines in service. In summary, monopoly and vertical separation harm those consumers that they were precisely designed to help: the downstream (business) users of international telephony and the upstream users of residential local telephony.

Consequences of Vertical Separation and Monopoly: Evidence from Telecom Privatizations

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1. Introduction

The privatization of the telephone monopolies around the world presented policy makers with an unprecedented opportunity to re-structure the whole industry. Once the sale was decided (but before it was undertaken), governments needed to make two major policy decisions. First, they needed to decide whether the status quo of monopoly was to be maintained; second, they needed to decide whether they should mandate structural separation between the upstream local fixed telephony service and downstream services such as long distance or international telephony.[1] The argument in favor of awarding monopoly rights was political. For decades governments had pursued a policy of universal telephone service (*i.e.,* a phone line in each home) by subsidizing residential local telephony from business telephony (*i.e.,* long distance, international, and data communications services);[2] this cross-subsidy scheme could only be maintained under monopoly. Moreover, local fixed telephony was considered a natural monopoly while business services such as long distance or international telephony were deemed potentially competitive. In this view, allowing entry on basic telephony (*i.e.,* local, long distance and international service) would not engender competition in local telephony while entrants on the lucrative market for business telephony would drive down the prices of these services. An increase on local residential rates would follow as the incumbent local service monopoly would struggle to maintain the level of profits it enjoyed before. This was deemed politically unacceptable.[3] To avoid this problem, it

[1] Few privatizing governments such as India, Canada, Japan and others inherited a vertically separated industry. In other cases such as Argentina and Brazil the decision was taken just before privatization.

[2] Empirical evidence suggests that local residential services were priced at below marginal cost while business services such as long distance and international telephony were priced at well above marginal cost (Nambu, Suzuki, and Honda 1989; Crandall 1989; Palmer 1992. Hausman, Tardiff, and Belinfante 1993; Cronin, Colleran, Miller, and Raczkowski 1997).

[3] Although the argument for monopoly (and cross subsidization) was mainly political, Faulhaber (1975) found an economic justification. He proved that cross subsidization can increase social welfare as long as a multi-product monopolist exhibits economies of scope on joint production.

was argued, monopoly and cross subsidization needed to be maintained.[4] As it will become clear later, this policy choice had the opposite effect.

The validity of this argument is suspect on several grounds. For example, it ignores gains on productive efficiency arising from the privatization of these firms. Private property exerts a powerful incentive to use resources more efficiently than under state control (Alchian 1965; Alchian 1969; and Furubotn and Pejovich 1972). Improvements on efficiency would reduce production costs and the price of telephone services holding all else constant. These gains in efficiency are compounded when considering the effect of competition. Product market competition affects managerial behavior reducing the consumption of perquisites and increasing productive efficiency (Alchian and Kessel 1962; Williamson 1963; Leibenstein 1966; Comanor and Leibenstein 1969). Part of these efficiency gains would be passed along to the consumers in the form of lower prices.[5]

A second major policy decision was that of vertically separating the provision of local fixed service from long distance or international service. This time the argument was on economic grounds and supporters came from the pro-competition side.[6] The argument closely follows the modification of the final judgment (MFJ) rationale used in

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[4] Bös (1993: 108) articulates this view clearly: "In contrast to private firms, public enterprises have often been instructed to price according to distributional objectives. This implies charging lower prices for goods which are mainly demanded by lower-income earners. In this case the public enterprises rely on internal subsidization, where the internal deficit of the low-priced goods is financed by the internal profits earned from sales to higher-income or business customers. If the privatized firm operates in a competitive market, this internal subsidization becomes impossible and distributional pricing cannot be upheld." Pilcher (1994: 401) puts it bluntly: "Governments, therefore, need to decide on a strategy to either introduce competition in long-distance and international service or to maintain the cross-subsidy."

[5] Off course, observed prices may increase when other things are changing. For example, after the U.S. allowed competition on basic telephony, local residential prices increased; however, this did not produce a decline on the amount of residential subscribers and thus did not produce a set back on the stated policy of universal telephone service (Hausman, Tardiff, and Belinfante 1993; Cronin, Colleran, Miller and Raczkowski 1997). These results are driven by: (1) the low elasticity of demand for local access in the US; and (2) households perceive local and long distance services as complements. Noting ensures that these conditions prevail in other parts of the world.

[6]This view is spelled out by Bös (1993: 108) clearly: "The government should first attempt to encourage competition, as the UK, for instance, did with its splitting of the electricity industry into electricity generation (a potentially competitive business) and distribution." Also Waterschoot (1994: 511) underscores the influence of the MFJ that split vertically AT&T in shaping the post-privatization regulation of telecommunications around the world: "The influence of UNITED STATES ANTITRUST legislation in shaping the structure of telecommunications cannot be questioned. Divestiture of AT&T, rather than control over rates applied by the dominant carriers, was the main regulatory feature leading to increased competition in long-distance telecommunications services."

the U.S. to justify the split of AT&T into several local fixed telephony providers and one long distance and international service provider. Briefly stated, the argument assumes that competition in local fixed telephony will not arise because of its natural monopoly characteristics while long distance and international service were viewed as potentially competitive. Supporters of mandatory vertical separation (also called structural separation) aim at increasing competition on the (potentially) competitive services. In their view, a vertically integrated local monopoly can effectively keep potential entrants out of the lucrative long distance and international telephony markets by using non competitive tactics. For example, the vertically integrated firm can tie the monopolized local service with long distance and international service eliminating competitors in the latter markets. After competitors are driven out, the integrated firm can raise the price of the tied good reducing social welfare (Whinston 1990). Because the vertically integrated firm owns the monopolized local fixed network it can refuse to interconnect; delay interconnection through lengthy negotiations (Salop and Scheffman 1983); or it can provide low quality access links to degrade the service quality of competitors (Cremer, Rey, and Tirole 2000; Aviram 2003). This would result in too little competition in the downstream markets (*i.e.,* long distance or international service). Moreover, analysts and policy makers feared that a vertically integrated local monopoly would use rate regulation to shift costs from the production of competitive services such as long distance to the monopolized local residential service. This would enable the vertically integrated local monopoly to use predatory pricing to keep competitors at bay on the downstream markets while recovering the losses with higher regulated prices in local service.[7] Vertical separation was seen as a remedy for these problems; it was supposed to keep residential prices low and boast competition on downstream services such as long distance and international telephony. Although these arguments seem plausible to a first approximation, they overlook several important issues. First, with open entry predatory pricing on the competitive downstream markets is unlikely to succeed because once prices are raised it will induce entry by new firms.[8] Second, it overlooks the incentive

[7] See Sappington (1995).

[8] One variant of this is when a monopolist is also the least cost producer and these costs cannot be observed by others. In this case the monopolist can use limit pricing to prevent entry (Milgrom and Roberts 1982;

effect that competition has on productive efficiency. Even if we accept that the prices of regulated local service may increase due to cost shifting, this increase on prices will attract entry on local service which in turn will reduce prices and put pressure on firms to reduce costs. Part of the improvements on productive efficiency will be passed along to the consumers in the form of lower prices for local service. Third and most important; firms integrate to minimize the transaction costs of using the market (Coase 1937). Breaking up a firm by administrative process in the hope that social welfare would increase should be regarded as a perilous road to follow. It implies that the loss in efficiency after the break up more than compensates the gains; nothing ensures this. Indeed, Williamson (1971) identified several cases in which vertical separation may be inefficient: (1) when this creates bilateral monopolies (*i.e.*, double marginalization problem), (2) when bargaining (transaction) costs between parties are likely to be high, or (3) when large sunk investments are part of a transaction with incomplete contracts. Coincidentally, the contracting arrangements of a vertically separated local telephone monopoly with a downstream international or long distance service provider seem to have most of the characteristics just mentioned. These contractual relationships involve investment decisions that are asset-specific and therefore subject to a high risk of opportunistic behavior to appropriate quasi-rents (Klein, Crawford, and Alchian 1978; Williamson 1985). Indeed, when we observe integration within a firm this indicates that the firm's assets are interdependent (Alchian 1984). When assets or investment decisions are interdependent, profit maximizing firms will integrate (Williamson 1979), and integration under a set of plausible assumptions would increase social welfare (Riordan and Williamson 1985; Grossman and Hart 1986).[9]

In this article I test whether monopoly and vertical separation have any effect on the provision of basic telephone service (*i.e.*, local, long distance, and international service). I extend Wallsten's (2004) study increasing the sample of countries and adding a new policy variable: mandatory vertical separation. Several authors have found a

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Tirole 1988, Chapter 9). Note that the low-cost monopolist can effectively prevent entry but it will need to charge a price lower than the monopoly level and thus social welfare would increase.

[9] De Graba (1996) also shows that when goods are complementary, tying and foreclosing competitors can increase social welfare. In a related contribution to the theory of vertical integration, Arrow (1975) showed that firms will integrate vertically when there is uncertainty in the supply of the upstream (intermediate) good.

negative effect of monopoly on the provision of basic telephony across countries.[10] However, vertical separation has attracted little to no attention. My sample consists of 67 countries that privatized their former state-owned monopoly in the past two decades. For each country I use data for seven years following the privatization sale and find that monopoly harms the provision of international and local fixed telephony by reducing the usage of international service and increasing the price of residential local service. Fear of increases in residential telephony prices due to competition in the post-privatization years was unfounded. Contrary to common assertions, vertical separation harms the expansion of downstream phone services such as international telephony suggesting that the rationale behind the MFJ in the U.S. and applied in many countries is actually flawed.[11] Also important; vertical separation harms the expansion of local fixed telephony; an issue largely overlooked in the policy debate of the pre-privatization years.

2.The Data

My dataset includes 67 countries that privatized the dominant telephone firm in the period 1984-2003. This period covers most of the worldwide privatizations of telephone firms. Some countries have multiple sales of blocks of equity in this period. I identified the date of the earliest sale as the privatization date. The main source for these data is Privatisation International (monthly issues) and the Privatisation International Yearbook (annual issues). I recorded every upcoming or completed privatization of a telephone firm. Additional data on sales transactions were gathered from the Multilateral Investment Guarantee Agency's database on privatizations (Privatization Link)[12] and from the Economist Intelligence Unit's Viewswire and Country Information databases to cover the feasible universe of sales transactions. Next, I collected information on the vertical structure of the telephone industry; namely whether basic telephone services (*i.e.*,

[10] See for example Ros (1999), and Fink et al (2003). For a study closely related to this (circumscribed to the post-privatization years) see Wallsten (2004).
[11] See Alchian (1995), Sappington (1995), and Crandall and Sidak (2002).
[12] Available at http://www.privatizationlink.com

Table 1: Definition of variables and sources

Variable	Definition	Source
Dependent variables		
Intl. minutes	Number of outgoing international minutes per person in year t.	ITU. WTI 2004
Fixed lines/pop	The country's fixed telephone lines in service per person in year t.	ITU. WTI 2004
Res Price1	The price of one year of residential local fixed service in year t. Res Price 1 = Connection charge + 12 x monthly rate. In US dollars of 2005.	ITU. WTI 2004
Res Price2	The price of residential local fixed service in year t (perpetuity formula with a discount rate of 5 percent). Res Price2 = Connection charge + monthly rate/0.05. In US dollars of 2005.	ITU. WTI 2004
Explanatory variables		
Intl. monopoly	Number of years until end of monopoly on international telephony in year t.	Own database
Local monopoly	Number of years until end of monopoly on local fixed telephony in year t.	Own database
Basic monopoly	Average years until end of monopoly on local, long distance, and international service.	Own database
Vertical separation	Number of years since the incumbent fixed line operator was separated from the main provider of international telephony.	Own database
Income	Country's real GDP per capita (thousand PPP US dollars of 2005) in year t.	World Bank. WDI 2004
Foreign born	Stock of foreign-born population in year t (% of total population)	World Bank. WDI 2004
Tourists	Annual tourist arrivals in year t (% of total population).	World Bank. WDI 2004
Inflation 25+	Dummy variable has the value of one if annual inflation is higher than 25 percent and zero otherwise.	World Bank. WDI

		2004
Left-wing	Dummy variable has the value of one if the chief executive is classified as left-wing and zero otherwise.	Beck et al (2001). The World Bank. DPI 2004.
Fixed lines/pop	The country's fixed telephone lines in service per person in year t.	ITU. WTI 2004
Urban	Proportion of people living in urban areas (% population).	World Bank. WDI 2004
Paved roads	Density of paved roads. Kilometers of paved roads divided by a country's surface area at time t (km/square kilometers).	World Bank. WDI 2004
Durable	Number of years a political regime has been in place (at time t).	University of Maryland. Polity IV database
Mobile	The country's number of cellular mobile subscriber per person in year t.	ITU. WTI 2004
Vehicles	The number of vehicles per thousand people in year t.	World Bank. WDI 2004
Pop 0-14	Population in the range of 0 to 14 years old at time t (% of total)	World Bank. WDI 2004
Fixed lines	The number of fixed lines in service at time t (million lines).	ITU. WTI 2004
Faults	The number of telephone faults per 100 main lines at time t.	ITU. WTI 2004
Digital	Percentage of digitalization of the main fixed line network in year t (% of total).	ITU. WTI 2004

ITU = International Telecommunications Union. WTI = World Telecommunications Indicators. WDI = World Development Indicators. DPI = Database of Political Institutions.

Table 2: Summary statistics

Variable	Obs.	Mean	Std. Dev.	Min.	Max.
Intl. minutes	397	51.760	75.255	0.213	466.096
Fixed lines/pop	397	0.269	0.197	0.004	0.745
Res Price2	375	343.490	292.830	7.005	3,611.444
Res Price1	375	265.394	262.988	4.606	3,441.068
Intl. monopoly	400	3.315	7.450	-10	36
Local monopoly	400	3.018	7.527	-10	36
Basic monopoly	400	3.166	7.452	-10	36
Vertical separation	397	3.655	11.083	0	51
Income	399	13.505	9.948	1.119	40.297
Foreign-born	402	8.665	12.072	0.114	76.474
Tourists	286	50.222	54.307	0.228	235.822
Urban	405	64.239	18.519	21.070	100
Paved roads	297	0.825	1.083	0.001	4.516
Inflation 25+	405	0.099	0.299	0	1
Left-wing	405	0.346	0.476	0	1
Durable	383	30.159	32.040	0	153
$(\text{Durable})^2$	383	1,933.475	3,798.334	0	23,409
Mobile	397	0.163	0.234	0	0.937
Vehicles	292	256.530	187.854	5.360	609.632
Fixed lines	405	6.068	10.227	0.006	60.69
Faults	287	38.308	42.381	0.5	228
Digital	392	78.977	25.736	0.8	100
Pop 0-14	405	27.311	9.545	14.209	46.420

fixed local telephony, national long distance, or international telephony) were vertically integrated or not. In addition, I collected data on the number of years since the industry was vertically separated and on the years of monopoly awarded to the privatized firms. These data were mainly collected from the Economist Intelligence Unit Viewswire and Country Information database, each firm's annual reports, each country regulator's websites, and from the Commission of the European Communities. I also gathered information of basic telephony usage from the International Telecommunications Union's World Telecommunication Indicators (2004). Country-wide data such as income and population were obtained from the World Bank's World Development Indicators database. Table 1 presents the full list of variables used along with definitions and sources while Table 2 shows the summary statistics.

3. Empirical Analysis

In this section I test the effect of monopoly and vertical separation on international and local telephony. I use panel data estimation with unobserved heterogeneity assumed to be time-invariant and specific to each country. My unit of analysis is a country at time t. For each country I use eight years of data starting with the year in which the first privatization sale took place (t_0) and ending seven years later (t_{0+7}). I want to estimate the following equation:

$$y_{it} = c_i + x_{it}\beta + w_{it}\gamma + \mu_{it}, \quad (1)$$

where y_{it} is a vector that contains observations of an indicator of basic telephony in country i at time t; c_i is the time-invariant unobserved heterogeneity of county *i* which may be arbitrarily correlated with x_{it} and w_{it}. Matrix x_{it} contains observations in country i at time t of a set of industry or country variables. w_{it} is a matrix containing observations in country i at time t of the two policy variables of interest: monopoly and vertical separation.

The fixed effect transformation provides consistent estimators of β and γ as long as the x_{it} and w_{it} are uncorrelated (conditional on c_i) with the error term u_{it} in equation one. As it will become clear later, some of my x_{it} may violate this strict exogeneity assumption. For example if past values of y_{it} are correlated with future values of x_{it} strict exogeneity is violated and fixed-effect estimates will be inconsistent (Wooldridge 2002: 265-7). On the other hand, my policy variables (w_{it}) do not seem to violate strict exogeneity. Past or current values of y_{it} do not seem to affect future or current values of w_{it} (my policy variables). The reason being is that once governments decide to privatize they need to set the terms of the license before the sale. Important terms that governments need to establish are whether they would award monopoly rights and whether the privatized firm will be barred from the provision of upstream or downstream services (*i.e.*, vertical separation); these are the variables in matrix w_{it}. Once these terms are set, they are part of a contract and remain fixed for the entire period of the license agreement which may extend over 20 or 25 years.

Governments set these terms through several mechanisms which may include the legislature passing a new telecommunications law; the executive changing regulations of

entry; the executive drafting license or concession contracts; or more often a combination of these. Of course, changes in regulations and the terms of the license agreement are shaped by interest groups, government's preferences and political institutions prevailing at one point in time;[13] but once the decision on the license terms is made, these remain fixed. Therefore, past values of y_{it} (say y_{it-1} or y_{it-2}) are uncorrelated with w_{it}, and thus, strict exogeneity is not violated.

Some studies argue that policy variables should be treated as endogenous. Besley and Case (2000) analyze the influence of worker's compensation insurance (the policy variable) on economic variables such as wages or employment (the dependent variable). They rightly stress the need to treat worker's compensation (the policy variable) as endogenous because state regulators frequently change the amount of indemnity payments or reimbursements for medical expenses. These changes in turn may be influenced by past wages and employment level (the dependent variable). A similar argument is made by Duso and Röller (2003) in the context of entry in cellular telephony. They rightly point out that the amount of licensed cellular providers (the policy variable) is endogenous when the dependent variable is the number of mobile subscribers per worker. The reason why this variable is endogenous is that the regulator has discretion to award new licenses for mobile telephony and thus, one can plausibly argue that current or past values of mobile subscribers (the dependent variable) may influence future or current decisions on whether to grant one more cellular license or not.

This situation is very different from the one encountered at the time of the privatization of the dominant fixed network provider. If the license terms granted ten years of monopoly to the firm, regulators have no authority to unilaterally alter the terms of this contract during the duration of the license.[14] Therefore, whether a policy variable should be regarded as endogenous depends on the specific case under analysis. As Besley and Case (2000: 674) conclude: "investigating the determinants of policies is an important prerequisite to understanding when and whether one can legitimately put

[13] See Viani (2005) for an analysis of the factors influencing the length of monopoly rights awarded in the privatization of telephone firms.

[14] In fact, many countries sought to increase the credibility of their commitment by signing the Convention on the Settlement of Investment Disputes with the International Centre of Settlement of Investment Disputes (ICSID). This intends to circumvent poor systems of rule of law prevailing in many less developed countries (http://www.worldbank.org/icsid/about/main.htm).

policy on the right hand side…(…)…the source of policy variation must be fully understood by the researcher."

The approach I follow here is similar to that used by Papke (1994) to analyze the effect of enterprise zones on the performance of the local economy (the y_{it}). Although designation of enterprise zones could be correlated with unobserved variables affecting y_{it}; once a community is designated as enterprise zone, it remains as such during the period of analysis. Therefore, future values of designation (the policy variable) do not depend on past performance of the local economy (past values of y_{it}) and as such designation is considered strictly exogenous.[15]

3.1 Effect of vertical separation and monopoly on international telephony

I test the hypothesis that vertical separation increases competition and therefore output on international telephony (*i.e*, the rationale behind the MFJ in the US and applied in some countries around the world). I focus on output rather than competition. Country data on long distance calls is limited so I use the more readily available data on international outgoing minutes. I test the following null hypothesis:

H_{01}: Vertical separation of local fixed service from international service increases international telephony usage.

In addition, I want to test whether monopoly has any effect on international telephony; therefore I test a second null hypothesis:

H_{02}: Monopoly has no effect on international telephony usage.

I estimate equation one using the natural logarithm of outgoing international minutes per person in country *i* at time *t* as the dependent variable (y_{it}). In matrix w_{it} I include observations of my two policy variables: monopoly and vertical separation. I expect monopoly to be negatively correlated with output on international service. Rate regulation could in theory make the monopolist price at Ramsey levels increasing output and social welfare. In practice, regulators face a tremendous problem of asymmetric information because they cannot observe, nor elicit accurate information on costs from regulated firms. Given that rate regulation typically incorporates an implicit rate of return, inefficiency has zero (or low) cost to the regulated monopoly and rational utility-

maximizing managers will increase the consumption of perquisites producing a decline on productive efficiency (Sappington 1980).[16]

I assume monopolies may behave differently if they hold monopoly rights for, say, 20 years instead of two years. Thus, my monopoly variable is continuous and denotes the remaining number of years of monopoly on international service. I apply a similar rationale for vertical separation and use a continuous variable denoting the number of years since the dominant fixed telephone provider was excluded from the provision of downstream international telephony. I expect a negative relationship between vertical separation and international telephony usage. Mandatory vertical separation increases the risk of opportunistic behavior and transaction costs (Williamson 1971, Klein, Crawford, and Alchian 1978; Williamson 1985) which in turn reduces efficiency. Agreements between downstream and upstream firms on access fees require lengthy negotiations. Typically if no agreement is reached within a reasonable time frame the regulator determines the level of access fees necessary to compensate the fixed network owner for using his property. It can hardly be emphasized the large information burden imposed on a regulator trying to estimate optimal Ramsey access fees.[17] Optimal access fees become even more elusive if we consider the political process by which they are set. Self-interested politicians and bureaucrats may choose a set of access fees far from the optimal levels as they do not bear the full cost of these choices. This would also invite rent-seeking activities (Tullock 1967, Posner 1975) increasing further the welfare losses due to mandatory vertical separation.

In matrix x_{it} I include a set of exogenous variables that affect the quantity demanded of international telephony. For example, I include the real income per capita. If international service is a normal good I expect a positive relationship between income and the amount of international minutes used. I also control for the number of foreign-born residents and the number of tourist arrivals per year. Foreign-born residents and tourists have family members abroad with whom they like to communicate; therefore, I expect these two variables to have a positive effect on international telephone usage.

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[15] See also Wooldridge (2002: 306)

[16] For a good illustration of this and related problems see Berg and Tschirhart (1988: 505-511). See Alchian and Kessel (1962), Williamson (1963), Leibenstein (1966) and Comanor and Leibenstein (1969) for the effect of monopoly on the consumption of perquisites.

Finally, I add the number of fixed lines per person as a right-hand side variable. Local access and international service are complementary goods because one cannot make an international call without local access. Except for fixed lines per person, all other variables seem to be strictly exogenous. It seems highly unlikely that current or past values of international telephony usage (y_{it}) will cause an increase on future immigration, tourist arrivals, or income (my variables in x_{it}). However, the level of past international telephony usage may affect the amount of future lines in service violating strict exogeneity. This seems plausible if we consider that international telephony (and other services aimed mainly at businesses) has traditionally been an important source of funds for the expansion of the fixed telephone network.[18] To overcome this potential endogeneity problem I use two-stage least squares (2SLS) estimation. As instruments I use all the exogenous regressors plus two additional ones: (1) the degree of urbanization, and (2) the density of paved roads in a country. Urbanization and road density should be partially correlated with fixed lines per person but uncorrelated with international telephony usage. The cost of digging trenches, laying down cables, and interconnecting towns and cities is lowered as the amount of people per mile of cable increases (*i.e.*, as urbanization increases) and as the number of miles of paved roads increase.[19] I expect a positive partial correlation between these instruments and fixed lines per person. The results of the first-stage regression (see column one in appendix) suggests that these are suitable instruments because their coefficients are highly significant, exhibit the expected sign, and can plausibly be regarded as uncorrelated with international telephony usage. Finally, I include year dummy variables to control for unobserved technological changes in the telecommunications industry; a dummy variable to control for high inflation, and a dummy variable to control for the existence of a left-wing chief executive. High inflation erodes the real price of basic telephone services because these prices are regulated and thus, cannot adjust automatically with inflation. Regulated firms need approval from the regulator before increasing their prices; this process could take weeks or months. In a

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[17] For a theoretical exposition of this see Laffont and Tirole (2000: 80-83 and 97-105).

[18] For example in 1991 the share of international service on total revenue for the Jamaican telephone monopoly was 77 percent (Wint 1996: 59).

[19] For example Limão and Venables (2001:452) found that poor road infrastructure increases transport cost and reduces trade flows across countries. They state that "poor infrastructure accounts for 40 percent of predicted transport costs for coastal countries and up to 60 percent for landlocked countries."

highly inflationary environment real prices would fall and the quantity demanded of international telephony would increase holding all else constant. On the other hand, if the head of the executive branch belongs to a left-wing party, I expect the regulator (typically part of the executive branch) to subsidize the price of residential service with this subsidy being paid by business users. Because businesses are heavy users of international telephony, I expect the price of this service to increase and the quantity demanded to decline.

I follow Wooldridge (2002:282-283) and Drukker's (2003) procedure to test for first-order serial correlation on the error terms within countries (clusters) and found evidence of it. Accordingly, I report robust standard errors that correct for heteroskedasticity and within country (cluster) correlation assuming independence between countries.[20] Finally, I use Hausman procedure (Hausman 1978, 1983) to test whether fixed lines per person (in logs) can plausibly be regarded as endogenous. Surprisingly, I cannot reject the hypothesis that this variable is exogenous.[21] Therefore, I present the results using OLS and 2SLS estimation in Table 3. Using the results from 2SLS estimation I reject the null hypothesis H_{01} with 95 percent confidence. The purported benefits of baring the local fixed line operator from downstream services (*i.e.*, international telephony), does not exist. Although the US is not part of my sample, it is reassuring to know that my conclusions agree with the findings after the break up of AT&T. The US experience indicates that vertical separation did not produce the expected efficiency gains because access charges to long distance and international service providers were kept high to keep local residential rates subsidized preventing lower prices on long distance and international service (Crandall 1988; Crandall 1989; Hausman, Tardiff and Belinfante 1993). Using the results from OLS estimation I can also reject H_{01} but only with 80 percent confidence. As Crandall and Sidak (2004: 410)

[20] See Froot (1989) and Williams (2000).
[21] Table 3 shows (at the bottom) the p-values of rejecting incorrectly the null hypothesis (H_0) in Hausman's test; where H_0 is the hypothesis that fixed lines per person (in logs) is exogenous.

Table 3: Effect of monopoly and vertical separation on outgoing international minutes per person.

		Dependent Variable = Log Intl. minutes				
Variable	(1)	(2)	(3)	(4)	(5)	(6)
Intl. monopoly	-0.046	-0.046	-0.045	-0.058	-0.058	-0.058
	(1.74)***	(1.74)***	(1.73)***	(2.65)*	(2.64)*	(2.62)*
Vertical separation	-0.067	-0.069	-0.069	-0.100	-0.103	-0.099
	(1.39)	(1.41)	(1.42)	(2.11)**	(2.13)**	(2.08)**
Log Income	-0.090	-0.070	-0.060	0.488	0.549	0.573
	(0.24)	(0.19)	(0.16)	(1.50)	(1.65)	(1.68)***
Log Foreign-born	0.561	0.561	0.550	0.584	0.569	0.530
	(2.49)**	(2.48)**	(2.45)**	(1.93)***	(1.85)***	(1.68)***
Log Tourists	-0.042	-0.044	-0.046	0.028	0.033	0.033
	(0.46)	(0.48)	(0.50)	(0.17)	(0.19)	(0.19)
Log Fixed lines/pop	0.366	0.374	0.376	0.499	0.505	0.491
	(1.69)***	(1.72)***	(1.72)***	(1.66)***	(1.67)***	(1.63)
Inflation 25+		0.051	0.052		0.102	0.101
		(0.68)	(0.68)		(1.81)***	(1.78)***
Left-wing			-0.026			-0.044
			(0.48)			(0.84)
Constant	3.436	3.407	3.416	2.321	2.187	2.157
	(2.42)**	(2.41)**	(2.41)**	(1.89)***	(1.76)***	(1.73)***
N	271	271	271	196	196	196
Countries	54	54	54	51	51	51
Estimation	OLS	OLS	OLS	2SLS	2SLS	2SLS
p-value Hausman test[a]	n.a.	n.a.	n.a.	0.610	0.614	0.707
R-squared (within)	0.3951	0.3960	0.3965	n.a.	n.a.	n.a.

Notes: Panel data estimation with country fixed effects and year dummies. Robust standard errors corrected for heteroskedasticity and within country correlation. Absolute value of t-statistics in parenthesis. * = 99 percent confidence; ** = 95 percent confidence; *** = 90 percent confidence. Potentially endogenous variable in specifications 4 to 6 is Log fixed lines/pop. Instruments are: Log Urban and Log Paved roads in addition to all the exogenous variables above.

[a] Hausman test of endogeneity. Ho: Instrumented variable is exogeneous. P-value is the probability of rejecting Ho incorrectly.

concluded in the context of the U.S. experience: "Mandatory structural separation is unnecessary because the putative benefits that it would produce are, in fact nonexistent."

As expected, monopoly on international service significantly lowers international telephony usage. Using the results from 2SLS estimation I am able to reject the null hypothesis H_{02} with 99 percent confidence, while using the OLS results I can reject this with 90 percent confidence.[22] The other variables have the expected sign and for the most part are highly significant. Table 3 reveals that my conclusions regarding monopoly and vertical separation are fairly stable. I test further the robustness of these results using specification five. Instead of using monopoly on international service I use the average number of years of monopoly in all three basic services (Basic monopoly); the main results (not reported) continue to hold. I also estimate this equation without the year dummies and my conclusions are not altered (not reported).

Using specification five I estimate the negative impact of vertical separation and monopoly on international telephony. An additional year of vertical separation reduces the amount of international telephony usage by 10.3 percent, while one additional year of monopoly is associated with a 5.8 percent decline on international telephony usage all other things constant.

3.2 Effect of vertical separation and monopoly on local fixed telephony

I proceed to test other two common assertions made in the pre-privatization years: (1) monopoly helps advance universal telephone service (through cross subsidization); and (2) allowing competition on basic services would lead to a break down of the cross-subsidy scheme and thus an increase on residential local rates. I test the following null hypotheses:

H_{03}: Monopoly on local fixed telephony is associated with more lines in service.

H_{04}: Monopoly on local fixed telephony is associated with lower residential telephone rates.

[22] See also Wallsten (2004) for similar findings with a smaller sample and using OLS estimation.

Again I use panel data estimation with country fixed effects. I estimate equation one using the natural logarithm of fixed lines per person in country *i* at time *t* as my dependent variable (y_{it}). In matrix w_{it} I include again my two policy variables: monopoly and vertical separation. As before, I include in matrix x_{it} observations of a set of exogenous variables that affect the quantity demanded of fixed lines per person. For example, I include the real income per capita, the degree of urbanization, and the density of paved roads. Urbanization and road density should affect the cost of digging trenches, laying cables, erecting telephone poles, and so on. Assuming a central office with a fixed switching capacity of say, ten thousand lines, as the network expands toward less densely populated areas or areas less accessible by paved roads (especially in less developed countries) the marginal cost per line should increase; this in turn would reduce the amount of lines in service holding other things constant. I also add a dummy variable to control for high inflation because getting approval for rate increases could be a lengthy process. This lag would cause the real price of phone services to decline and the amount of lines in service to increase. Inflation however, could also have the opposite effect on the number of lines in service. If price adjustments continue to trail inflation, soon profits will fall along with new investment to expand the telephone network. The net effect of inflation on fixed lines is therefore ambiguous. I also add a variable to control for political stability. Given that the provision of fixed telephone service involves large sunk costs my dependent variable may be susceptible to political instability as this would tend to discourage investment.[23] From the Polity IV database I use the durability of political regimes as an indicator of political stability. I expect a positive relationship between political stability and fixed lines in service. Finally, I add the number of mobile phones per person (in logs) because studies have shown that fixed and mobile phones could be closed substitutes (Gruber and Verboven 2001, Sung and Lee 2002). Except for this last variable, all others seem to be strictly exogenous. It seems highly unlikely that the current or past values of the number of fixed lines in service would cause an increase on income, migration to cities, or more paved roads being built. Neither would it change political stability or inflation. However, the level of past fixed lines in service may affect

[23] See for example Barro (1991) and Brunetti (1997) on the effect of political instability on investment and economic growth.

the future number of mobile phones which violates strict exogeneity. This may occur for example if these goods are substitutes or complements. To overcome this potential problem I use two-stage least squares (2SLS) estimation. As instruments for mobile phones per person (in logs) I use all the exogenous regressors in x_{it} plus the amount of vehicles per person (in logs). Vehicles per person should be partially correlated with mobile phones per person and partially uncorrelated with fixed lines per person. As the amount of vehicles increases, the demand for mobile phones should increase. The results from the first-stage regression (see column two in appendix) suggests that vehicles per person (in logs) is a suitable instrument because its coefficient is highly significant and exhibit the expected sign. Again, I include year dummy variables and a dummy variable to control for a left-wing chief executive. I found evidence of first-order serial correlation in the error terms within clusters and therefore, report robust standard errors. I also use Hausman procedure (Hausman 1978, 1983) to test whether mobile phones per person (in logs) could plausibly be regarded as endogeneous. Surprisingly, I cannot reject the hypothesis that it is exogenous. Therefore, Table 4 shows the results using OLS and 2SLS estimation.

Using the results from either OLS or 2SLS I cannot reject the null hypothesis H_{03}; monopoly appears not related to the quantity of telephone lines per person. Wallsten (2004) found similar results in a related study with a smaller sample.[24] Notice however, the significant negative effect of vertical separation on fixed lines in service per person. Vertical separation not only harms the provision of downstream international service but also the upstream local fixed service. This finding suggests that vertical separation engenders inefficiencies in the production of (the upstream) local access service and these are passed onto the production of (the downstream) international service. Three things may be influencing this; first, transaction costs to coordinate investment decisions between upstream and downstream firms on assets that are specific or interrelated increases. Second, vertical separation increases the uncertainty to the downstream firm on the supply of essential inputs from the upstream firm.[25] As firms try to contract to

[24] In a different study Wallsten (2001) use the number of mobile operators as a proxy for competition and finds that competition is positively associated with the number of fixed lines in service. The sample included state-owned and private telephone firms.

[25] See Arrow (1975) for the effect of uncertainty on the incentive on firms to integrate vertically.

reduce uncertainty, transaction costs would increase for both firms, and investment would fall. Third, as access fees between upstream and downstream firms are regulated; firms will use resources on rent seeking activities (Tullock 1967, Posner 1975) reducing productive efficiency and investment on network expansion.

The coefficients of the other regressors have the expected sign but for the most part lack significance. It is evident from Table 4 that my conclusions regarding monopoly and vertical separation are fairly robust. I test the robustness of these results further by using specification four and changing the monopoly variable to monopoly in all basic services (Basic monopoly). The results are unchanged (not reported). I also estimate this equation without the year dummies and the main conclusions continue to hold (not reported). Next, I use specification four in Table 4 to estimate the negative impact of vertical separation on the quantity of fixed lines in service per person. Each additional year of vertical separation reduces the amount of fixed lines per person by 0.8 percent.

Finally, I assess the effect of monopoly and vertical separation on the price of local residential telephony. As stated before, monopoly was justified to keep local residential rates low through cross-subsidization. Specifically, I test the null hypothesis H_{04} stated at the beginning of this sub-section: H_{04}: Monopoly on local fixed telephony is associated with lower residential telephone rates. Again I use panel data estimation with country fixed effects. I estimate equation one using the natural logarithm of the price of local residential telephony in country *i* at time *t* as my dependent variable (y_{it}). As before, I include in matrix w_{it} observations of my two policy variables (monopoly and vertical separation) and in matrix x_{it} I include observations of a set of exogenous variables that affect the price of residential local telephony. Most of the variables included in x_{it} appear to violate strict exogeneity. For example, I include the number of fixed lines in service and expect a negative relationship between price and quantity. However, quantity can also affect price and therefore it should be treated as endogeneous. Other variables that appear to violate strict exogeneity are: the number of faults per line, and the degree of digitalization of the local fixed network. Past prices of local service may affect the future quality (*i.e.*, faults per main line) of the phone service.

Table 4: Effect of monopoly and vertical separation on fixed lines per person

	Dependent Variable = Log fixed lines/pop					
Variable	(1)	(2)	(3)	(4)	(5)	(6)
Local monopoly	-0.009	-0.009	-0.010	-0.066	-0.074	-0.060
	(0.66)	(0.62)	(0.72)	(0.81)	(0.83)	(0.81)
Vertical separation	-0.010	-0.009	-0.010	-0.008	-0.007	-0.008
	(5.49)*	(4.82)*	(5.15)*	(2.26)**	(1.92)***	(2.55)**
Log Income	-0.055	0.067	-0.040	-0.096	0.131	-0.060
	(0.22)	(0.30)	(0.17)	(0.35)	(0.48)	(0.23)
Log Urban	2.403	1.886	2.442	3.231	2.400	3.177
	(3.06)*	(2.27)**	(3.07)*	(2.38)**	(2.23)**	(2.35)**
Log Paved roads	0.027	0.009	0.028	0.133	0.113	0.118
	(0.28)	(0.10)	(0.32)	(0.72)	(0.67)	(0.71)
Durable	0.011	0.013	0.011	0.026	0.030	0.023
	(0.90)	(1.03)	(0.90)	(1.09)	(1.19)	(1.15)
$(\text{Durable})^2$	-0.0003	-0.0003	-0.0003	-0.0004	-0.0005	-0.0004
	(2.10)**	(2.39)**	(2.13)**	(1.89)***	(1.92)***	(2.10)**
Inflation 25+	-0.053		-0.056	-0.092		-0.091
	(2.09)**		(1.95)***	(1.37)		(1.36)
Log Mobile	0.070	0.074	0.065	-0.074	-0.088	-0.062
	(3.11)*	(2.92)*	(2.54)**	(0.37)	(0.40)	(0.33)
Left-wing		0.023	0.027		0.057	0.055
		(0.54)	(0.59)		(0.75)	(0.75)
Constant	-11.155	-9.305	-11.375	-15.013	-12.181	-14.836
	(3.51)*	(2.79)*	(3.57)*	(2.52)**	(2.50)**	(2.49)**
N	141	141	141	141	141	141
Countries	40	40	40	40	40	40
Estimation	OLS	OLS	OLS	2SLS	2SLS	2SLS
p-value Hausman test[a]	n.a.	n.a.	n.a.	0.478	0.447	0.493
R-squared (within)	0.801	0.798	0.803	n.a.	n.a.	n.a.

Notes: Panel data estimation with country fixed effects and year dummies. Robust standard errors corrected for heteroskedasticity and within country (cluster) correlation. Absolute value of t-statistics in parenthesis. * = 99 percent confidence; ** = 95 percent confidence; *** = 90 percent confidence. Potentially endogenous variable in specifications 4 to 6 is Log Mobile. Instruments are: Log Vehicles in addition to all the exogenous variables above.[a] Hausman test of endogeneity. Ho: Instrumented variable is exogeneous. P-value is the probability of rejecting Ho incorrectly.

For example, if regulators force the firm to price below cost, profits will decline along with the quality of service. Something similar may occur with the degree of digitalization. Past prices of phone service may affect the ability of firms to upgrade the telephone network. To avoid endogeneity problems I use two-stage least squares estimation. As instruments I use all the exogenous regressors plus the degree of urbanization, the density of paved roads, and a measure of political stability. As stated before, highly urbanized areas and the abundance of paved roads should lower marginal and average cost of production and thus have a positive effect on the number of lines in service. The same should be true for the adoption of digital technology because upgrading the network should cost less in urban areas and areas with abundance of roads. I expect a positive partial correlation between digitalization and these two instruments. I also expect the third instrument: political stability, to be positively related with the number of fixed lines and with digitalization because both represent investment on infrastructure. As it was mentioned before, investment can be sensitive to political instability (Barro 1991, Brunetti 1997). The effect of these instruments on the number of faults per lines in service is harder to predict. I posit that the availability of roads and a higher degree of urbanization may help reduce the cost of repairs and maintenance and thus lower the number of telephone faults. On the other hand, political stability should be related with higher investment and this includes expenditures on network maintenance, repairs, and upgrading. I expect political stability to be negatively correlated with the amount of telephone faults. These instruments seem to have adequate properties as they should be partially correlated with the three instrumented variables but unlikely to be correlated with the price of local residential telephony. The results of the first-stage regressions (see columns 3 to 5 in appendix) supports this assertion because for the most part they are partially correlated with the instrumented variables and have the expected sign. Again, I include year dummy variables and a dummy variable to control for the existence of a left-wing chief executive. I also find evidence of first-order serial correlation in the error terms within clusters and therefore, report robust standard errors. The results of Hausman's test (Hausman 1978, 1983) of endogeneity suggest that the three instrumented variables are indeed endogenous. The p-values of Hausman test appear on Table 5 at the bottom. Using specification four I reject exogeneity with 99

percent confidence and using the other two specifications I can only reject exogeneity with 80 percent confidence. For comparison purposes I present the OLS and 2SLS results.

Using the results of 2SLS estimation I reject the null hypothesis H_{04} with more than 90 percent confidence level. Monopoly in local telephony is associated with higher prices not lower prices of local residential telephony. The pre-privatization fear that a sharp increase on the prices of the subsidized residential service would follow the end of monopoly was unwarranted. Even AT&T's chairman Charles Brown (cited in Temin 1987: 307) agreed with the conventional view: "with competition, this subsidization of local rates by AT&T's long distance service is no longer possible and will be gradually phased out. Long distance rates will come down, and local rates will rise." Analysts underestimated the power of private property and competition to enable gains in productive efficiency that would more than compensate private investor's appetite for above marginal cost pricing in the post-privatization years.

The lack of significance in the coefficient of vertical separation suggests that it has no effect on the price of local residential telephony. However, if we take into account that vertical separation also reduces the number of lines in service per person (see Table 4) it seems clear that the net effect of vertical separation on local service is negative. Other results indicate that the degree of digitalization and the number of fixed lines in service have the expected sign and are highly significant while the coefficients of the other regressors lack significance. The results are fairly robust to alternative specifications. Using specification five and changing the monopoly variable to indicate monopoly in all basic services (Basic monopoly) does not alter the conclusions (not reported). Changing the dependent variable to an alternative indicator of the price of residential telephony; Res price1 (see Table 1 for definition), does not alter my conclusions (not reported). Using specification five in Table 5, I estimate that each additional year of monopoly increases the price of residential local service by 9.6 percent holding all else constant.

Table 5: Effect of monopoly and vertical separation on the price of local residential fixed telephony.

	Dependent Variable = Log Res price2					
Variable	(1)	(2)	(3)	(4)	(5)	(6)
Local monopoly	0.056	0.067	0.056	0.109	0.096	0.108
	(1.18)	(1.49)	(1.20)	(1.92)***	(2.17)**	(1.89)***
Vertical separation	-0.018	-0.021	-0.018	-0.016	-0.012	-0.016
	(0.73)	(0.89)	(0.77)	(0.84)	(0.60)	(0.82)
Log Income	0.960	0.449	1.016	0.437	0.514	0.496
	(0.99)	(0.40)	(1.08)	(0.36)	(0.38)	(0.40)
Log Fixed lines	-0.529	-0.488	-0.541	-1.601	-1.360	-1.608
	(2.14)**	(2.02)**	(2.19)**	(2.36)**	(1.94)***	(2.32)**
Log Faults	-0.068	-0.070	-0.068	-0.012	0.007	-0.029
	(1.05)	(1.18)	(1.05)	(0.04)	(0.02)	(0.10)
Digital	0.002	-0.003	0.001	0.020	0.024	0.020
	(0.36)	(0.49)	(0.25)	(2.20)**	(1.77)***	(2.10)**
Log Pop 0-14		-4.547			3.198	
		(1.66)***			(0.80)	
Left-wing			0.115			-0.068
			(1.04)			(0.54)
Constant	3.641	19.704	3.527	3.976	-6.994	3.940
	(1.64)	(1.88)***	(1.63)	(1.57)	(0.49)	(1.45)
N	273	273	273	201	201	201
Countries	54	54	54	48	48	48
Estimation	OLS	OLS	OLS	2SLS	2SLS	2SLS
p-value Hausman test[a]	n.a.	n.a.	n.a.	0.199	0.002	0.209
R-squared (within)	0.197	0.233	0.204	n.a.	n.a.	n.a.

Notes: Panel data estimation with country fixed effects and year dummies. Robust standard errors corrected for heteroskedasticity and within country (cluster) correlation. Absolute value of t-statistics in parenthesis. * = 99 percent confidence; ** = 95 percent confidence; *** = 90 percent confidence. Potentially endogenous variables in specifications 4 to 6 are Log Fixed lines, Log Faults, and Digital. Instruments used are Log Urban, Log Paved roads, Durable, and $(\text{Durable})^2$ in addition to all the exogenous variables above.

[a] Hausman test of endogeneity. Ho: All three instrumented variables are exogeneous. P-value is the probability of rejecting Ho incorrectly.

4. Conclusion

Two myths have been dispelled analyzing the post-privatization experience of telecommunications around the world. The first myth is that monopoly on basic telephone services is needed to maintain low (subsidized) prices of local residential telephony. The second myth is that vertical separation between the local fixed network provider and that of downstream services such as international telephony (or long distance) is needed to boost competition and output in these markets. The empirical evidence shows that monopoly increases the price of residential service. Moreover, it also harms downstream (international) markets by reducing the usage of international telephony. Therefore, monopolizing basic telephone services does not advance the stated policy of universal service; it retards it. Vertical separation also harms universal service provision by reducing the number of fixed lines per person. In addition, vertical separation reduces the usage of downstream international service. In summary, monopoly and vertical separation reduce social welfare and harm those consumers that were precisely designed to help: the downstream (business) users of international telephony and the upstream users of residential local telephony. The findings in this article could help illuminate current policy discussions on the desirability of vertical separation in telecommunication (see for example OECD 2003).

APPENDIX: Results of first-stage regressions (from Tables 3, 4 and 5)

	Dependent Variables				
	(1) [a]	(2) [b]	(3) [c]	(4) [c]	(5) [c]
Variables	Log Fixed lines/pop	Log Mobile	Log Fixed lines	Log Faults	Digital
Intl. monopoly	-0.006 (0.70)				
Local monopoly		-0.373 (10.37)*	-0.075 (5.73)*	0.217 (3.52)*	-4.708 (2.98)*
Vertical separation	0.010 (0.18)	0.016 (2.21)**	-0.006 (0.83)	0.009 (0.86)	-0.241 (0.46)
Log Income	0.286 (1.94)***	-1.132 (0.98)	0.024 (0.08)	3.436 (2.11)**	1.608 (0.10)
Log Foreign-born	-0.262 (1.57)				
Log Tourists	0.073 (1.07)				
Log Urban	4.498 (2.65)*	5.727 (1.09)	2.368 (5.10)*	-3.064 (1.30)	-125.390 (2.72)*
Log Paved roads	0.166 (2.15)**	0.714 (1.60)	0.118 (1.50)	0.358 (1.40)	-2.603 (0.37)
Inflation 25+	-0.030 (0.51)	-0.304 (1.88)***			
Durable		0.102 (3.21)*	0.009 (2.70)*	-0.059 (3.18)*	0.813 (2.53)**
$(\text{Durable})^2$		-0.001 (1.74)***	-0.0004 (6.15)*	0.001 (3.44)*	-0.022 (2.45)**
Log Vehicles		1.213 (1.74)***			
Log Pop 0-14			1.308 (1.75)***	0.593 (0.18)	-206.79 (2.60)**
Constant	-20.741 (2.97)*	-31.374 (1.41)	-12.664 (3.68)*	5.566 (0.34)	1283.237 (4.96)*

N	196	141	201	201	201
Countries	51	40	48	48	48

Notes: Panel data estimation with country fixed effects and year dummies. Robust standard errors corrected for heteroskedasticity and within country (cluster) correlation. Absolute value of t-statistics in parenthesis. * = 99 percent confidence; ** = 95 percent confidence; *** = 90 percent confidence. The dependent variables in this table are the instrumented variables that appear in Tables 3, 4, and 5.

[a] First-stage for specification 5 in Table 3.

[b] First-stage for specification 4 in Table 4.

[c] First-stage for specification 5 in Table 5.

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