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I. INTRODUCTION

In many developing countries, the information markets often are inefficient relative to more developed countries. Decision making is inhibited by the long search time needed to find information. The lack of information significantly raises the difference between the offer (supply) price and the price a consumer is willing and able to pay (demand).[1] Economists have long called the difference between the buying and selling price the "transaction cost."[2] High transaction costs can inhibit or even destroy markets that might otherwise exist. Resources that might have been used to produce goods and services are instead used to cover the high cost of gathering market information, lowering the aggregate output of an economy.[3]

A modern telecommunications network can lower both the fixed transaction costs of obtaining information and the variable transaction costs of participating in existing markets. A modern system also has many side effects, such as lowering internal firm costs and operating costs for public bureaucracies.[4] The development of a telecommunications infrastructure and economic development in general appear to be positively related in many countries.[5] The purpose of this paper is to examine whether telecommunications investment was a stimulus or a consequence of economic growth in the former Soviet Union (FSU) and how such a relation impacts the new transition era.

With the early 1990s relaxation of COCOM export restrictions on telecommunications equipment[6] and the new market reforms, an examination of the development of the telecommunications infrastructure in the FSU provides a base to examine reform efforts. Historically, the political desire by the Communist Party of the Soviet Union (CPSU) to maintain information scarcity in the FSU led to the underdevelopment of the telecommunications system. The underdevelopment in turn led to high transaction costs with poorly developed markets, and ultimately undermined the very output growth the CPSU wanted.

While an examination of telecommunications in the FSU sheds light on the now historical decline in FSU economic growth, it is more than an exercise in economic history. If the underlying theory for the

current reform is to be other than the neoclassical paradigm of competitive-equilibrium and Pareto optimality, as some have recommended,[7] an understanding of the existing telecommunications network can assist in explaining imperfect information. The existence of imperfect information suggests the new informational economics[8] may provide an alternative vision for reforms that could be used by new administrations such as the Putin administration in Russia.[9]

Section II of this paper discusses the development of telecommunications in the FSU within the framework of international development. Section III provides a description of the telecommunications system in recent years. Section IV outlines the methodology. Section V discusses the results and section VI concludes with a discussion of the transition era.

II. THE DEVELOPMENT OF SOVIET TELECOMMUNICATIONS

The development of telecommunications in the FSU is perhaps best seen in the framework of worldwide development. At least three technologies are involved in telecom development: local loop, inter-exchange lines, and switches. The local loop initially was a narrowband (i.e., limited capacity) twisted pair of cooper wires that severely constrained phone use. The loop constraint has only recently begun to be eliminated in the FSU with the adoption of broadband fibre optic cables supplemented with cellular systems.

Inter-exchange lines also faced a copper wire constraint initially. Microwave transmission systems were introduced in the 1950s for high volume traffic over line-of-sight links in an attempt to the loosen the constraint. Both copper lines and microwave systems are now being replaced by fibre optic cables which increase the quality and the quantity of channels available.

Switches have progressed from operators (manual) to crossbar (electro-mechanical) to step-by-step to electronic (computer). Despite the presence of such foreign firms as MCI and Alcatel, the switching network in the FSU remains electro-mechanical. Though a fibre optic ring already exists in the most advanced Baltic republics, lines also lag world standards and are almost entirely copper.

The underdevelopment of the FSU telecommunications network reflects a neglect that began in the 1920s. Markets that flourished briefly in the New Economic Policy (NEP) period were in part eliminated by rising transaction costs. Telecommunications policy became on "transmission belt" to raise these costs. Instead of developing the telephone network, the network was excluded from the state budget and neglected.[10] The telephone apparatus itself became a symbol of power over transaction costs and has remained so to this day with the

most powerful managers and politicians having an array of phones on their office desks. The need to spread telephone availability beyond high priority managers was acknowledged by some Soviet specialists, but was never seen as a priority.[11]

In the Soviet era, telephone and associated equipment such as exchanges were either imported from plants in Eastern Europe such as the "Incoms" firm in Sofia or were produced in the "Eastern Electric" system.[12] Eastern Electric was a monopoly designed to provide standard equipment throughout the FSU. Eastern Electric was administered by the Ministry of Communications Equipment (Minpromsviaz) which existed as a separate bureaucracy until the late 1980s when it was merged with the Ministry of Communications (Minsviaz). Because of the strong links between Minpromsviaz and defense ministries, little was known about Minpromsviaz. Telephones were produced in Riga, Latvia, and Perm, Russia, with the Russian plant producing approximately 90% of all Russian-made phones. In general, the more advanced the technology of the equipment, the more likely the equipment was imported from Eastern Europe.[13] However, starting in the late 1980s some former Soviet defense plants converted to the production of civilian telecommunications equipment as links to Eastern Europe weakened. By the 1990s, imported phone equipment increased dramatically though a low-end market still exists for low quality domestically produced phones.

Compared with the rest of the world, the telecommunications network in the former Soviet republics had all the characteristics of a developing country. The low quality of service is well known to anyone who has tried to use the telephone network either for a simple call or for fax and data transmission. Most telephones are in urban areas with some rural areas having no phone service at all. Equipment us overused in two respects. First, there is not enough of it, requiring existing equipment to carry a heavy load. Second, "subscriber congestion" exists in the form of low quality equipment adding to the heavy load (e.g., the need to repeatedly redial to contact an operator). Cellular phone systems in large cities with at least one cellular phone company, Vympel, now listed on the New York Stock Exchange, have alleviated the problem of low service, but are generally limited to wealthy consumers and businesses.

III. STATISTICAL EVIDENCE OF FSU TELECOMMUNICATIONS DEVELOPMENT

Despite the importance of the telecommunications sector in any economy, there is a dearth of work on the FSU telecommunications system, particularly at any kind of regional level.[14] At the former

Soviet republic level, all of the 15 republics' telecommunications networks were subordinate to the all-Union monopoly run by the Ministry of Communications (MC) and Minpromsviaz. Though all republics had roughly the same share of investment funds devoted to communications overall (Table 1), the share devoted to telecommunications is unknown. Whatever the amount was, however, the low priority of communications suggests *a priori* that telecommunications investment was a consequence of and not a stimulus to economic growth. The significant drop after 1975 in the growth of both telephone availability (Table 2) and overall economic output[15] supports this hypothesis, though the 1990s saw an end to this relationship.

Telephone availability is frequently used as a proxy for telecommunications investment.[16] Though data on the total number of urban and rural phones exists in many FSU republic statistical handbooks, the series is incomplete.[17] However, the number of urban telephones per 100 urban inhabitants is available for a period (1959-87) comparable to a recent study of the United States.[18] From 1959-87, urban telephones per 100 inhabitants increased about 7 times with little variation in the cross republic figures (Table 3). The declining coefficient of variation for this index indicates that central planners succeeded in equalizing telephone availability over time. Regionally, the Baltic states and Armenia had substantially greater telephone availability than the rest of the USSR for all 28 years. The underdevelopment of telecommunications in Central Asia has no comparison with the West. One must go to Mongolia (2.4) or Cuba (4.0) to find similar figures.[19]

Telephone availability in the FSU was also underdeveloped relative to more developed countries. In 1980, the FSU (11.58) had almost eight times fewer telephones per 100 inhabitants than the US (83.7) though it could boast over 20 times more telephones per 100 inhabitants than mainland China (0.45).[20] Telephone availability was lower in Eastern European countries, with the exception of Poland (12.8).[21] With the recent rapid telecom growth in Turkey and Portugal, every OECD country has at least twice as many phones available per capita relative to the FSU.

Though the percentage of telephones that were residential steadily increased (Table 4), authorities never succeeded in fully satisfying the demand for a residential phone.[22] Limited published data on unmet demand for telephone installation revealed that unmet demand was highest in those republics with the highest number of phones available per capita (Table 5). Unmet demand for an urban telephone is lowest in the Central Asian republics, Azerbaijan, and Armenia.[23] Unmet demand remains a problem in the transition era with little prospect for rapid availability to many families. The lack of data for those who

simply gave up hope of obtaining a telephone also make comparisons approximate at best.

IV. METHODOLOGY

An examination of the benefits from telecommunications investment usually involves a comparison of various measures of macroeconomic activity and telecommunications availability.[24] Telecommunications investment has been found to be both a stimulus and a consequence of economic growth in many countries. Further, though diminishing returns to telecommunications investment (in the form of lower incremental increases in GDP) occurs in some of the most developed countries (including the US), there are still substantial benefits from telecommunications investment.[25] In examining the FSU, the inter-republic gross industrial output growth series is used as a proxy for GDP.[26] Because industrial development and urban development were closely linked in the Soviet system, this proxy is reasonable when using urban telephones and urban populations. Also, the agrarian and food-processing branches had low priority relative to industry, so the focus should be on telecommunications investment's contribution to industry in exploring the consequences for economic development in the FSU. Given such data limitations, causality tests can be used to determine whether telecommunications investment was a stimulus or a consequence of economic growth.

Causality is determined by time series predictability.[27] Two tests for causality are the Granger test and modified Sims test. Because each test is mathematically distinct, results for each provide a check on the results from the other test. However, both tests are only necessary and not sufficient tests for causality. Any acceptance of causality can only be suggestive at best. The tests are best seen as gathering evidence for a lack of causality.[28]

After first differencing the growth rates of both series the Granger test is performed by using the following equations:

$$1)\ x_t = x_{t-1} + u_t$$

$$2)\ x_t = x_{t-1} + y_{t-1} + u_t$$

The variable y "causes" x if the t-statistics on y_{t-1} is significant where both x and y take on the values of first differenced growth of output and phone availability.

The Sims test uses a future value to test causality using the following equations:

$$3)\ x_t = x_{t-1} + y_t + y_{t-1} + u_t$$

$$4)\ x_t = x_{t-1} + y_t + y_{t-1} + y_{t+1} + u_t$$

The variable y "causes" x if the t-statistic on y_{t+1} is significant. Following Hardy,[29] a one period lag structure is used. Both tests are run for each of the republics over the period 1959-87 and use variables that, after first differencing, were found to not exhibit autocorrelation.

V. RESULTS

The Granger test results are surprisingly uniform. All but the small republic of Moldavia appear to have one-way causality at the 10% level from output growth to telecommunications growth (Table 6). Eleven of the 15 republics have a lag term supporting one-way causality. The lack of an inverse relation between the two is also suggested by the low t-statistics in the second column of Table 6 for all but three of the republics. The Granger test supports the hypothesis that telecommunications investment was a consequence of economic growth and not a stimulus.

The modified Sims test results do not support the Granger results in that telecommunications investment and industrial growth appear to be unrelated (Table 7). Only three republics are found to have causality running from telecommunications investment toward output growth. Uzbekistan is the only republic which has a similar result with the Granger test. Moldavia again appears to be an outlier with output growth causing telecommunications investment growth using the Sims test, contrary to the Granger test result.

VI. CONCLUSION AND EPILOGUE

Telecommunications investment is shown to not have been a stimulus to economic growth in any of the former Soviet republics and a barrier to market reforms at the beginning of the transition era. Ten years in to the transition era, telecommunications remains a significant barrier though, unlike the Soviet era, availability has improved despite large declines in GDP. Some econometric evidence is found to support descriptive (Table 2) and anecdotal evidence suggesting that, conversely, telecommunications growth was a consequence of output growth in the FSU. The neglect of telecommunications suggests that the feedback of investment enhancing growth that can in turn create additional, new investment in telecommunications never existed in the FSU.[30] External funding to begin such a feedback process will have to be substantial and long term as previous World Bank experience

reveals that only 50% of new construction funds can be generated internally after initial foreign financing of telecom reconstruction.[31]

Previous neglect of telecommunications has consequences for the current transition period far beyond the telecommunications sector itself.[32] The technological backwardness of the existing telecom capital stock will continue to cause a misallocation of labor to both the telecom and the related telegraph sector. The lack of reform has actually allowed the workers in the existing telecom sector to retire or move on to e-commerce and other businesses with little threat of a sudden, large increase in unemployment. Because services and processing industries are now much more in demand than during the Soviet era, the earlier neglect of telecom investment in these sectors has pushed them into adapting telecom technologies beyond the Soviet monopoly system. Companies such as Vympel have created a good customer base and capitalization that needs to be replicated throughout the FSU. Such companies represent a future growth sector for all the 15 republics though which republic has a comparative advantage is not clear.

Two unforeseen consequences of the transition has been the continued decline in population growth in the former republics with some republics such as Russia in absolute decline plus the steep drop in GDP. Phone availability per 100 families has thus improved, with the city of Moscow actually exhibiting more than 100 phones per 100 families by 1995[33] while other regions of Russia have doubled availability in the past decade. When future transition era time series data become available, analysis will show that with telecom availability increasing despite a large drop in output, a transition to a time when telecoms will drive output growth may be coming.

Increasingly, telecom influence will be redefined as constrained by phone lines and not phones themselves as e-commerce penetrates even remote areas of the FSU with the use of PCs. The large Soros-funded project to link the backbone of the Russian university system to the World Wide Web is perhaps the best example of a telecom investment that seeks to reach out beyond wealthy customers and businesses only. The project has already transformed the availability of information to large numbers of future leaders who can break apart old hierarchical structures that limited both economic growth and democracy.

With rapid telecom reform unlikely, republics of the FSU will have difficulty in changing what Sah and Stiglitz[34] describe as the "architecture" of the economic system. Architecture is defined as "how the constituent decision-making units are arranged together in the system, how the decision-making authority and ability is distributed within a system, who gathers what information, and who communicates what with whom."[35] The FSU will continue to be characterized by a hierarchy (centralized, bureaucratic decision making) instead of a polyarchy

(decentralized, firm-level decision making) architecture as long as hierarchies can maintain high transaction costs and thereby control information. The continuation of a hierarchical architecture means some worthwhile investment projects and decisions in general will be incorrectly rejected (Type I error),[36] slowing the reform process. Recent attempts by groups within former Soviet bloc countries to block reform measures (e.g., discussion of new Russian laws on internet usage) can be interpreted as attempts by the hierarchy to prevent a polyarchy.[37] Future telecom investment, like any future economic reforms, must seek to impact a widespread group of people to overcome Soviet style hierarchies. As with telephones in an earlier era, WEB and e-commerce now offer the 15 republics an opportunity to leap over Western errors and technologies to develop modern PC-based production and infrastructure.

NOTES

1. Seth W. Norton, "Transaction Costs, Telecommunications, and the Microeconomics of Macroeconomic Growth," *Economic Development and Cultural Change* 41 (1992): 175-196.
2. Ronald Coase, "The Nature of the Firm," *Economica* 4 (1937): 386-405.
3. Norton, *op. cit.*
4. Nathaniel H. Leff, "Externalities, Information Costs, and Social Benefit-Cost Analysis for Economic Development: An Example from Telecommunications," *Economic Development and Cultural Change* 32 (1984): 255-276.
5. Andrew P. Hardy, "The Role of the Telephone in Economic Development," *Telecommunications Policy* 4 (1980): 278-286.
6. BISNIS Bulletin. July/August 1992. U.S. Dept. of Commerce, International Trade Administration.
7. Peter Murrell, "Can Neoclassical Economics Underpin the Reform of Centrally Planned Economies?" *Journal of Economic Perspectives* 5 (1991): 59-76 and Jan Adam, "Letter to the Editor," *Economics of Planning* 26 (1993): 183-184.
8. Joseph E. Stiglitz, *Whither Socialism? Perspectives from the Economics of Information* (Cambridge: MIT Press, 1991).
9. Murrell, *op. cit.*
10. Steven L. Solnick, "Revolution, Reform and the Soviet Telephone System, 1917-1927," *Soviet Studies* 43 (1991): 157-176.
11. G.G. Kudriavtzev and L.E. Varakin, "Economic Aspects of Telephone Network Development: The USSR Plan," *Telecommunications Policy* 14 (1990): 7-14.
12. Robert Campbell, "The Soviet Telecommunications System." Working Paper HI-4039/2-P, The Hudson Institute, Indianapolis, Indiana.
13. *Ibid.*, pp. 82-84.
14. *Ibid.* and Gregory J. Brock, "Technical and Allocative Efficiency in Soviet Communications." Unpublished Ph.D. dissertation, 1989, The Ohio State University, Columbus, Ohio.
15. Gertrude E. Schroeder, "The Slowdown in Soviet Industry, 1976-1982," *Soviet Economy* 1 (1985): 42-74.
16. Hardy, *op. cit.*

17. "Narkhoz" handbooks at the province (oblast') level also have some data on communications. However, these books were rarely published on an annual basis and then only in small quantities. "Transport and Communications" handbooks at the province level were also issued, but are even more difficult to find than the "Narkhoz." This is unfortunate, as handbooks of this type appear to have many of the telecommunications indices used here (e.g., Goskomstat RSFSR, *Transportation and Communications in Irkutsk Province*, Irkutsk: Irkutsk Statistical Administration, 1991).

18. A referee has noted that one weakness of a per capita phone index is that population growth may mask absolute phone growth. However, population is included because of the desire to proxy phone service and not simply phone existence. For another study with the same approach, see Francis J. Cronin, Edwin B. Parker, Elisabeth K. Colleran, and Mark A. Gold, "Telecommunications Infrastructure and Economic Growth: An Analysis of Causality," *Telecommunications Policy* 15 (1991): 529-535.

Also, with a goal of comparing long term telecom development and macroeconomic growth, the number of residential (apartment) phones cannot be considered because of lack of data for many republics and early years. The use of a given residential/non-residential phone ratio to interpolate missing data would assume that phone production and installation were constant and was not believed to be feasible. With the collapse of the FSU, MinSviaz archives containing such data may be available in Moscow and other cities, but such a project is beyond the scope of this paper.

19. Robert J. Saunders, Jeremy J. Warford, Bjorn Wellenius, *Telecommunications and Economic Development* (Baltimore: The Johns Hopkins University Press, 1983), ch. 4.

Even eliminating the rural areas with almost no telephone service does not improve the comparison. In 1980, the least developed republics of Azerbaijan (7.46) and Uzbekistan (7.24) had urban telephone availability similar to Mexico (7.5) and Fiji (7.3). The most developed Baltic republics of Estonia (17.08) and Latvia (22.23), on the other hand, had urban telephone availability similar to Ireland (18.7) though still less than 50% of most OECD countries.

20. Paul S.N. Lee, "Dualism of Communications in China," *Telecommunications Policy* 15 (1991): 536-544.

21. Goskomstat SSSR, *Transportation and Communications in the USSR* (Moscow: Finansi i Statistika, 1990).

22. A referee has pointed out that if data for the number of residential phones were available across republics over a long period, it would be difficult to separate household and industry telecommunication usage without detailed accounts of street phones (taksofoni). A phone on the street is often the primary phone for a family. Data on these phones is also rarely separated out in the republic handbooks.

23. The influence of the Russian cohort, however, is perhaps seen by a comparison of these predominantly Muslim republics with other Muslim countries. Unmet demand is much higher inside the FSU than the combined rural and urban unmet demand in countries such as Iran (1.84) and Algeria (0.83). Some Soviet client states, such as Syria in 1980, had an unmet demand (5.56) similar to some of the lesser developed Soviet republics, suggesting a Soviet development pattern there.

24. Saunders et al., *op. cit.*, ch. 4.

25. Using a more rigorous technique and better data than Hardy, Cronin et al. confirmed Hardy's finding for the US over a long period (1958-1988). See Hardy, *op. cit.* and Cronin et at., *op. cit.*

26. Narodnoe Khoziaistvo SSSR, various years.

27. The methodology and description here closely follows Cronin et al, *op. cit.*

28. Rodney L. Jacobs, Edward E. Leamer, and Michael P. Ward, "Difficulties with Testing for Causation," *Economic Inquiry* 17 (1979): 401-413.

29. Hardy, *op. cit.*

30. Cronin et al., *op. cit.*

31. Saunders et al., *op. cit.*, ch. 4.

Recent experience of foreign telecom firms in the FSU such as MCI, AT&T, and Alcatel have yielded mixed result. Despite a presence in the FSU for over three years, few electronic switches have been installed. Problems include transportation, technological incompatibility, and outright theft. Interviews with former USSR MinSviaz officials in 1992 also revealed a hostility to companies that seek to completely replace the existing telecom system.

32. Stiglitz notes that the structure of capital may be the fundamental problem in former socialist countries with the misallocation of labor a reflection of this problem See Stiglitz, *op. cit.*, p. 233.

33. *Socioeconomic Indicators of Russian Regions, 1985-1995* (Moscow: Russian Federation State Statistics Committee, 1997).

34. Raaj Kumar Sah and Joseph E. Stiglitz, "The Architecture of Economic Systems: Hierarchies and Polyarchies," *American Economic Review*, 76, No. 4 (1986): 716-727.

35. *Ibid.*

36. *Ibid.* Sah and Stiglitz call this Type-I error in reference to the statistical term.

37. A modern residential telephone network such as the project begun in Tatarstan will also garner support for difficult transition policies by reducing costs and increasing social welfare if they can be rolled out to a widespread customer base. See Jeff Cole, "Kazan Calling," *Wall Street Journal*, Aug. 21, 1992, p. A1.

TABLE 1
Investment in Communications as a Percentage of Total Investment, 1976-1988 (in %)

Region	1976-80	1981-85	1986-88
Russia	0.9	0.8	0.9
Ukraine	0.7	0.9	1.0
Belarus	1.1	1.3	1.5
Moldavia	1.0	1.1	1.4
Central Asia			
Uzbekistan	0.8	1.0	1.1
Kazakhstan	0.8	0.9	1.1
Kirgizia	1.2	1.5	1.5
Tadzhikistan	0.9	1.2	1.1
Turkmenia	0.7	0.9	1.2
Transcaucasia			
Georgia	1.1	1.1	1.4
Azerbaijan	1.1	1.0	1.3
Armenia	1.5	1.6	1.4
Baltics			
Lithuania	1.0	1.8	1.9
Latvia	0.9	0.9	1.3
Estonia	1.7	1.1	1.2
USSR	0.9	0.9	1.0

Sources: Narkhoz USSR 1988, p. 556 and Goskomstat SSSR, *Transportation and Communications in the USSR* (Moscow: Finansi i Statistika, 1990), p. 211.

TABLE 2
The Percentage Increase in Telephone Availability (Number of Telephones per 1000 Inhabitants), 1965-1985

Region	1965-75	1975-85
Russia	135.5	67.1
Ukraine	204.5	70.1
Belarus	215.0	87.3
Moldavia	269.2	83.3
Central Asia		
Uzbekistan	121.4	80.6
Kazakhstan	160.0	76.9
Kirgizia	112.5	79.4
Tadzhikistan	107.1	44.8
Turkmenia	100.0	55.3
Transcaucasia		
Georgia	132.1	60.0
Azerbaijan	60.7	66.7
Armenia	144.4	47.3
Baltics		
Lithuania	178.1	89.9
Latvia	159.0	44.9
Estonia	122.6	47.1
USSR	139.3	67.2

Source: Goskomstat SSSR, *Transportation and Communications in the USSR* (Moscow: Finansi i Statistika, 1990), p. 181.

TABLE 3
The Number of Urban Telephones per 100 Urban Inhabitants Across Republics

Republic	1960	1965	1970	1975	1980	1985
Russia	2.17	3.04	5.01	7.22	9.54	11.71
Ukraine	1.44	2.11	4.72	7.54	9.68	12.35
Belarus	1.95	2.88	5.37	8.39	10.43	13.51
Moldavia	2.26	2.94	5.57	9.76	12.42	14.30
Central Asia						
Uzbekistan	1.61	2.22	3.49	5.04	7.24	9.10
Kazakhstan	1.55	2.28	4.06	6.49	8.66	9.85
Kirgizia	1.69	2.61	3.89	5.99	8.75	9.90
Tadzhikistan	1.85	2.47	4.21	6.94	11.12	14.03
Turkmenia	2.13	2.62	3.84	6.77	7.72	10.29
Transcaucasia						
Georgia	2.49	3.82	6.26	9.04	11.31	13.00
Azerbaijan	2.63	3.90	4.73	5.80	7.46	10.96
Armenia	3.33	5.88	8.95	12.54	14.97	17.68
Baltics						
Lithuania	3.08	4.60	7.70	11.39	15.11	19.11
Latvia	4.84	6.71	12.02	19.03	22.23	25.04
Estonia	4.21	6.39	9.46	14.00	17.08	20.23
Overall Mean	2.48	3.63	5.95	9.06	11.58	14.07
Overall C.V.	40.20	43.00	41.89	41.76	36.12	32.38

Source: Republic level Narkhoz handbooks, various years.

TABLE 4
The Percentage of Telephones with Access to the Public Network that are Residential

Republic	1970	1980	1985	1986	1987	1988
Russia	33.5	47.4	52.9	54.2	58.0	59.7
Ukraine	36.5	49.6	54.8	56.1	60.9	61.5
Belarus	35.3	50.9	58.3	59.9	62.9	65.1
Moldavia	33.5	52.6	56.2	57.2	58.8	61.1
Central Asia						
Uzbekistan	29.3	49.9	56.3	58.5	62.0	62.9
Kazakhstan	30.1	47.5	52.6	54.4	59.4	62.0
Kirgizia	25.4	44.4	52.2	55.4	58.4	60.5
Tadzhikistan	37.4	48.5	50.7	52.5	55.8	58.7
Turkmenia	34.8	47.7	57.5	58.5	62.6	64.7
Transcaucasia						
Georgia	44.6	54.8	58.6	58.7	59.4	63.1
Azerbaijan	51.4	62.1	71.6	72.5	73.1	74.4
Armenia	58.7	69.1	74.4	74.7	77.3	73.5
Baltics						
Lithuania	39.1	58.1	62.6	64.0	65.0	66.3
Latvia	49.8	63.5	63.8	64.0	64.4	65.4
Estonia	34.9	51.3	52.7	53.6	54.5	56.4
USSR	35.2	49.5	54.7	56.1	59.4	61.2

Sources: Goskomstat SSSR, *Transportation and Communications in the USSR* (Moscow: Finansi i Statistika, 1990), pp. 181, 183; population data from Narkhoz USSR, various years.

TABLE 5
The Number of Unmet Applications for the Installation of an Urban Residential Telephone with access to the Public Network per 100 Urban Inhabitants*

Republic	1985	1986
Russia	7.15	7.21
Ukraine	7.42	7.75
Belarus	7.47	7.53
Moldavia	7.60	7.14
Central Asia		
Uzbekistan	4.12	4.15
Kazakhstan	6.00	6.16
Kirgizia	3.48	3.46
Tadzhikistan	5.99	5.18
Turkmenistan	4.12	419
Transcaucasia		
Georgia	10.48	10.02
Azerbaijan	4.45	4.13
Armenia	5.44	5.55
Baltics		
Lithuania	7.45	6.68
Latvia	7.55	7.25
Estonia	9.60	10.74
USSR	7.09	7.13

* No data before 1985 have been published. Data for 1987-90 are available, but only for both rural and urban telephones combined. Source: Narkhoz USSR 1990, pp. 85-86.
Note: Unmet demand per 100 inhabitants for telephones in other countries in 1980 (both urban and rural): Algeria: 0.83, Egypt: 0.95, Iran: 1.84, Syria: 5.56, Argentina: 3.26, Mexico: 0.57, Peru: 1.18. Source: Robert J. Saunders, Jeremy J. Warford, Bjorn Wellenius, *Telecommunications and Economic Development* (Baltimore: The Johns Hopkins University press, 1983), pp. 12-13.

TABLE 6
The Granger Relationships between Gross Industrial Output Growth and the Growth of the Number of Urban Telephones per 100 Urban Residents across Republics, 1960-1987

Republic	T. Statistic for Output Growth Causing Phone Growth[a]	T. Statistic for Phone Growth Causing Output Growth[b]
Russia	3.56	0.88
Ukraine	3.07	0.08
Belarus	3.79	-0.27
Moldavia	0.70	3.20
Central Asia		
Uzbekistan	5.27	1.82
Kazakhstan	3.93	0.60
Kirgizia	4.07	0.36
Tadzhikistan	2.00	0.45
Turkmenia	2.33	2.02
Transcaucasia		
Georgia	3.10	0.68
Azerbaijan	2.96	0.45
Armenia	2.85	1.05
Baltics		
Lithuania	3.74	0.99
Latvia	3.33	0.49
Estonia	2.46	0.05

[a] All coefficients are significant at the 10% level with the exception of Moldavia.
[b] All coefficients are insignificant at the 10% level with the exception of Moldavia, Turkmenia, and Uzbekistan.

TABLE 7
The Sims Relationships between Gross Industrial Output Growth and the Growth of the Number of Urban Telephones per 100 Urban Residents across Republics, 1960-1987

Republic	T. Statistic for Output Growth Causing Phone Growth[a]	T. Statistic for Phone Growth Causing Output Growth[b]
Russia	-0.31	1.34
Ukraine	0.71	1.23
Belarus	-0.58	1.88
Moldavia	1.94	-0.56
Central Asia		
Uzbekistan	0.56	3.49
Kazakhstan	-0.37	1.89
Kirgizia	-0.58	1.37
Tadzhikistan	0.24	-0.04
Turkmenia	-0.16	1.42
Transcaucasia		
Georgia	0.37	1.70
Azerbaijan	0.68	0.12
Armenia	0.58	0.41
Baltics		
Lithuania	0.32	1.62
Latvia	0.18	-0.21
Estonia	0.19	-0.10

[a] All coefficients are insignificant at the 10% level with the exception of Moldavia.
[b] All coefficients are insignificant at the 10% level with the exception of Armenia, Byelorussia, Kazakhstan, and Uzbekistan.