Measuring Soviet Performance in Industrial Innovation: The Implementation of New Inventions

Martens, John A.

Erstveröffentlichung / Primary Publication
Konferenzbeitrag / conference paper

Measuring Soviet Performance in Industrial Innovation: The Implementation of New Inventions

Prepared For:
Technology and Transition in the USSR
A NATO Science Policy Workshop
University of Birmingham
17-20 September, 1991

By:
John A. Martens

Summary and Conclusions

The Soviet economy's use of new technologies was measured through a study of two random samples of data on inventions used for the first time by Soviet organizations. The first sample covered the late 1960s; the second, the late 1970s. The sample information was extremely detailed and permitted an analysis according to: the speed of implementation [lead time], economic savings, and the technical areas, industrial sectors, and geographical locations of the organizations that originated and used the inventions.

The major findings relating to the speed of using new technologies were as follows:

- The average lead time for the Soviet sample [3.5 years] from the late 1970s showed only a slight improvement over the first sample's [3.7 years] and both remained significantly slower than the lead times established in two earlier studies of the United States and the Federal Republic of Germany. The U.S. and F.R.G. implemented over 50 percent of their inventions in little more than one year. The U.S.S.R. needed well over two years to achieve this proportion.

- Average lead times by implementing industrial sector differed at most by little more than a year for both Soviet samples. The difference among the averages for the first sample was significant at the .07 level; for the second, at the .13 level.

- The average lead time for the Soviet defense industrial sector showed almost no change. Whereas lead times of the defense industrial and civilian machinebuilding sectors differed significantly in the late 1960s, they were not significantly different in the 1970s.

- Lead times for inventions that were originated and used in the same facility [in-house inventions] differed significantly, averaging about one-third less in both samples, from those inventions that crossed organizational boundaries.

- Lead times for in-house inventions differed significantly according to the type of originating facility. Inventions coming from a research facility required an average of about one year longer to implement than an invention from a production facility. No such significant difference existed for out-of-house inventions.

The findings relating to the changing composition of the samples were as follows:

- The overall change in the shares of the technical areas in the total sample was not significantly different.

- The overall shares of each industrial sector in the total sample showed little change. The defense industrial sector's share, which excluded all inventions from

two of the major defense industrial ministries, was by far the largest in both samples.

- Inventions used by the defense industrial sector exhibited a significantly different mix of technical areas from those used by the civilian machinebuilding sector for the 1960s. Changes in the civilian sector's mix of technologies erased this difference in the 1970s.

- Academic facilities replaced civilian machinebuilding facilities as the most important source of outside inventions for the defense industrial sector. The technical areas for the inventions coming from academic facilities also evolved to parallel more closely those of importance to the defense industrial sector.

- Universities and polytechnical institutes provided a minor share [about 3 percent] of inventions used in production facilities in both samples.

- Interregional exchanges of inventions appeared to decrease between the two samples, totaling about 55 percent of the identified exchanges in the 1960s and about 40 percent in the 1970s.

- The RSFSR was the only republic recording a positive balance in the exchange of inventions with other republics. It accounted for almost 60 percent of all inventions crossing republic boundaries.

Measuring Soviet Performance in Industrial Innovation: The Implementation of New Inventions

Industrial modernization and the rapid use of new technologies were always central goals of Soviet economic planners. In the 1930s they coined slogans such as *"Catch Up With and Overtake the West!"* and *"Technology Decides Everything!"* in launching state campaigns to modernize the USSR's industrial base. Yet, while news about significant individual technological achievements grabbed headlines, officials after World War II worried about the continued technological backwardness of most Soviet industry. Competition with the West, especially military competition, pushed them to seek solutions. They legislated new institutions

and reformed existing ones. They allocated resources generously and even established special programs, both legal and clandestine, to acquire Western technologies. Rapid technical innovation, however, remained an elusive goal for the centrally-planned Soviet economy.

Western researchers have described well many of the institutional and managerial obstacles to technical innovation within the Soviet economy. [1] The Soviet state's strict control over information has, however, limited research to case studies and a careful collecting of anecdotal material and press accounts.

This study examines an important aspect of technical innovation, the use of new inventions in Soviet industry. It builds on methods developed in an earlier study and is based on two random samples of data taken from the Soviet journal *Vnedrennye izobreteniya* (Introduced Inventions).[2] The detail available in these data permits a broad quantitative analysis of Soviet innovation performance over time according to a number of different aspects, such as industrial sector, facility type, technology and geographical location.

The Data

The journal used for this study, *Vnedrennye izobreteniya*, publishes notifications of the first usage of Soviet inventions. The notifications usually contain information on the name and location of the developing organization, the technical area of the invention, the name and

[1] Joseph S. Berliner, *The Innovation Decision in Soviet Industry* (Cambridge: The MIT Press, 1976); Ronald Amann, Julian Cooper and R.W. Davies (ed.), *The Technological Level of Soviet Industry* (New Haven: Yale University Press, 1977); and Ronald Amann and Julian Cooper (ed.) *Industrial Innovation in the Soviet Union* (New Haven: Yale University Press, 1982).

[2] John A. Martens and John P. Young, "Soviet Implementation of Domestic Inventions: First Results," in *Soviet Economy in a Time of Change*, Vol. 1, Joint Economic Committee, Congress of the United States, October 10, 1979, pp. 472-509.

location of the using organization, the date of application, the date of first usage, and occasionally the economic savings resulting from using the invention. The published information is sometimes incomplete, especially in the case of facilities related to defense production. Moreover, no information is given on the use of classified inventions, nor on any inventions used by facilities subordinated to the Ministries of General or Medium Machinebuilding.

Soviet censorship and changes in the journal's reporting practices created some missing-data problems. First, in the late 1960s a law was passed that strictly limited references to defense industrial facilities as originators of inventions. This censorship probably explains why many of the organizations originating the inventions in the two samples remain unidentified [50 percent in the 1973-74 sample and 44 per cent in the 1981 sample]. Second, more inventions in the second sample [84 missing dates] than in the first sample [13 missing dates] had no use dates. [3] Otherwise, the data remained remarkably complete.

Using the Data: A Measure of Lead Time

Two data elements are of central importance to this study: the application date and the date of first usage. The application date is that on which the Soviet patent office [State Committee for Inventions and Discoveries] received the papers disclosing the invention. This date likely corresponds to the time when an invention was developed enough to be workable. The date on which a Soviet organization certified that it had first put an invention into serial production is the use date. Lead time is defined as the time elapsed between the application and use dates. [4]

[3] Missing use dates were reported for inventions in each of the industrial sectors.

[4] For more information on using Soviet invention data and on the Soviet standards for inventions see Martens and Young, *op.cit.*, pp. 473-483.

The Samples

Two samples were made, each randomly selecting one out of ten entries listed in the journal *Vnedrennye izobreteniya*. The first, from the 1973-74 journal issues, totaled 1600 inventions; the second, from the 1981 issues, totaled 1323 inventions. The distribution of the application dates for the sampled inventions [*see Table 1*] indicates that the innovation process being investigated probably began during the late 1960s for the first sample, and during the late 1970s for the second.

Analysis of the Samples

The average lead times for the total sample shortened by about 5 percent, from 3.68 in 1973-74 to 3.46 years in 1981 [*see Table 3*]. This difference was significant at the .01 level. The following sections analyze lead times and structural changes in the two samples according to technical areas, industrial sectors, geographical location, and facility type.

Table 1
Distribution of Application Dates
(Number of inventions)

Year of Application Date	1973-1974 Sample	1981 Sample
Pre 1965	121	6
1965	52	11
1966	81	9
1967	174	14
1968	218	16
1969	322	25
1970	415	30
1971	176	51
1972	41	59
1973		55
1974		101
1975		126
1976		199
1977		306
1978		273
1979		41

Source: Author's samples from the Soviet journal *Vnedrennye izobreteniya*.

1. Technologies

Each Soviet invention identifies the examining department in the State Committee for Inventions and Discoveries responsible for its technical evaluation, and bears an International Patent Classification category. On this basis, the sampled inventions were assigned technical areas. Most of the sampled inventions also contained information on the using facilities and were accordingly assigned to a specific Soviet industrial sector. Table 2 summarizes this information.

Table 2
Industrial Implementation of Sampled Soviet Inventions by Technical Area

1973-74				Const	Elec	Food	Inst		Metl-	Metl-	Min &	Power	Radio	Sci		
Using Sector	Agric	Chem	Comp	&Mats	Eng	& Med	MtTst	Light	lurgy	wrkg	Drlg	Gen	elec	Inst	Trans	Total
Defense Industrial	2	20	44	23	21	14	32	8	37	86	0	8	101	38	18	452
Civilian Machbldg.	11	15	7	24	23	10	14	8	27	112	2	19	12	13	24	321
Other Civ. Heavy	0	54	10	21	12	7	3	4	40	35	41	5	13	13	13	271
Light & Food	13	10	1	30	1	29	1	34	0	5	0	6	0	3	10	143
Construction	2	5	0	64	2	1	0	3	3	10	1	1	1	0	8	101
Transportation	1	3	7	7	5	1	8	5	5	20	1	1	3	4	16	87
Other	0	6	1	6	0	18	0	3	0	4	2	0	9	5	1	55
Power Gen & Trans	0	2	5	8	12	0	3	1	0	4	1	10	3	1	2	52
Closed Oth.Civ.Heavy	0	16	4	1	0	0	1	1	4	1	5	2	3	1	2	41
Closed Civ. Machbldg.	0	2	0	2	11	0	1	1	2	8	0	0	2	3	1	33
Educ. & Scientific	2	0	2	1	1	0	1	0	0	4	0	2	6	4	0	23
Unknown	0	1	1	1	1	1	0	1	0	7	0	3	1	2	2	21
Total	31	134	82	188	89	81	64	69	118	296	53	57	154	87	97	1600

1981				Const	Elec	Food	Inst		Metl-	Metl-	Min &	Power	Radio	Sci		
Using Sector	Agric	Chem	Comp	&Mats	Eng	& Med	MtTst	Light	lurgy	wrkg	Drlg	Gen	elec	Inst	Trans	Total
Defense Industrial	2	20	34	18	23	5	18	6	16	67	3	6	84	37	12	351
Civilian Machbldg.	8	13	14	27	12	6	11	8	21	82	5	15	16	10	14	262
Other Civ. Heavy	1	52	6	17	8	5	2	3	16	17	23	4	8	8	4	174
Educ. & Scientific	3	12	18	7	4	1	3	3	5	6	3	4	28	13	0	110
Other	4	8	1	6	0	52	2	0	0	0	2	0	18	5	0	98
Light & Food	8	5	3	14	1	25	2	18	1	5	1	2	1	2	2	90
Transportation	1	5	2	16	10	0	4	3	2	10	0	2	6	0	13	74
Construction	2	2	1	30	3	0	0	0	0	5	2	2	2	1	2	52
Closed OthCiv.Heavy	0	14	4	2	1	0	0	1	9	6	1	0	6	0	0	44
Closed CivMachbldg.	0	4	3	2	11	1	4	1	3	3	1	2	2	1	1	39
Power Gen. & Trans.	0	0	0	7	6	0	0	0	0	1	0	3	1	1	1	20
Unknown	0	0	1	0	1	0	1	0	0	2	0	1	0	1	1	8
Total	29	135	87	146	80	95	47	43	73	205	41	41	172	79	50	1323

Technical Area Abbreviations: Agric=Agriculture; Chem=Chemistry; Comp=Computers and related equipment; Const & Mats= Construction and materials (glass and ceramics; paper and pulp; timber and woodworking); Elec Eng= Electrical engineering and machinery; Food & Med= Food processing and handling, medical equipment and preparations; Inst MtTst= Instrumentation (material testing; measurement and control); Light= Domestic goods, textiles and publishing; Metllurgy= Ferrous and Nonferrous metallurgy; Metlwrkg= Metalworking; Min & Drlg= Mining and drilling; Power Gen= Power generation and transmission; Radioelec= Radioelectronics; SciInst= Scientific instruments (physical and chemical property evaluation); Trans= Transportation.

Source: Author's samples from Soviet journal *Vnedrennye izobreteniya*.

A. Sample Contents

The technical areas in the two samples largely corresponded to their relevant industrial sector. Metalworking was concentrated mainly in the defense industrial [5] and civilian machinebuilding sectors, radioelectronics in the defense industrial sector, and food and medical in the light and food sector. In the two closed civilian sectors, the high number of chemical and electrical engineering technologies largely reflected the predominance of facilities from the Ministries of the Chemical and Electrical Equipment Industries.

The overall composition of the technical areas for the sampled inventions changed little from 1973-74 to 1981. The sample share for some technical areas that were developing rapidly in the West -- such as computers, radioelectronics and scientific instrumentation -- grew slightly, while smoke stack technologies -- metalworking, metallurgy and transportation -- showed small declines. The overall change in the shares of the technical areas in the total sample was not significant statistically. [6]

If the composition of the technical areas for the samples of used inventions reflects the structure of industry's technological base, this result suggests that the relative technological structure of Soviet industry changed little between the sample periods.

The composition of the technical areas for the sampled inventions used in the defense industrial

[5] As noted above, the journal *Vnedrennye izobreteniya* contained no information on inventions used in organizations subordinate to the Ministries of Medium and General Machine Building. Consequently, the defense industrial sector in this study is limited to organizations subordinate to the Ministries of the Aviation Industry, Defense Industry, Machine Building, Radio Industry, Communications Equipment Industry, Electronics, and the Shipbuilding Industry.

[6] $\chi^2 = 13.327$, d.f.=14, and .7 < P .5.

sector of Soviet industry also showed no statistically significant change between the two samples. The same was true for the civilian machinebuilding sector. The technical areas showing the most growth in the civilian machinebuilding sector were principally those areas -- computers and related equipment and radioelectronics -- previously concentrated in the defense industrial sector. This growth was sufficient to make the composition of the 1981 civilian machinebuilding sector's technical areas no longer significantly different from that of the defense industrial sector.[7] They had differed in the 1973-74 sample.

The composition of technical areas for the educational & scientific sector evolved strikingly between the two samples. In 1981 it now paralleled the most important areas of the defense industrial sector, with radioelectronics, computers and related equipment, and scientific instrumentation having the largest shares. This change attests, perhaps, to the success of the state's programs designed to involve Soviet academic establishments more in research relevant to the defense industries.

B. Lead Times

A number of different factors can influence lead times among technologies. Inventions may be simple or complex, the requirements for outside technical support may vary, projects may be assigned different priorities, and managerial efficiency may vary widely.

Table 3 presents the average lead time by technical area for the two samples. F-tests on the sample means were not highly significant. In addition, the lack information on the above factors makes interpretating the relative lead times in this chart difficult. Some rankings correspond with generally held views -- radioelectronics and computers and related equipment exhibited

[7] In comparing the composition of the technical areas of the defense industrial and civilian machinebuilding sectors for 1973-74, yields $\chi^2 = 32.638$ which at 14 degrees of freedom results in $.005 < P < .001$. For 1981, yields $\chi^2 = 23.153$ which at 14 degrees of freedom results in $.1 < P < .05$.

relatively short lead times and chemistry rather long ones in both samples. Other technical areas, such as scientific instrumentation and light industry, varied more widely.

Table 3
Estimates of Lead Time by Technical Area

	1973-74 Sample				1981 Sample			
Technical Area	No.	Mean Lead Time (yrs.)	Within Class Std. Dev.	Rank	No.	Mean Lead Time (yrs.)	Within Class Std. Dev.	Rank
Computers & RltdEqpmt	82	3.27	2.51	1	71	2.83	2.30	1
Construction and Mat.	182	3.53	2.27	3	129	3.12	2.32	2
Food and Medicine	76	3.59	2.46	7	76	3.13	2.75	3
Scientific Instr.	84	3.76	2.39	10	67	3.26	2.80	4
Light Industry	65	4.01	2.81	13	36	3.32	2.90	5
Radioelectronics	150	3.54	2.56	4	152	3.36	2.65	6
Metalworking	277	3.58	2.54	6	183	3.38	2.62	7
Mining and Drilling	51	4.78	2.84	15	37	3.43	2.65	8
Electrical Eng.	85	3.67	2.25	9	74	3.51	2.76	9
Metallurgy	110	3.48	2.72	2	62	3.56	3.36	10
Instr. (Mat. Testing)	61	3.80	2.65	11	41	3.65	3.01	11
Power Generation	56	3.82	1.99	12	37	3.93	2.63	12
Agriculture	31	3.66	2.18	8	24	4.01	3.04	13
Chemistry	125	4.05	3.15	14	116	4.15	3.73	14
Transportation	94	3.56	2.25	5	46	4.26	3.41	15
Total	1529	3.68			1151	3.46		
		$F^{14}_{1514} = 1.32$ Pr > F .19				$F^{14}_{1136} = 1.42$ Pr > F .14		

Source: Author's samples from the Soviet journal *Vnedrennye izobreteniya*

2. Sectors

A. Sample Contents

Using the information available on an invention's originator and user, each invention was assigned to an industrial sector. Each sector's relative share of total inventions used varied little between the samples [*see Figure 1.*] Only the educational and scientific sector recorded a major increase, from a 1 percent share of the inventions used in the 1973-74 sample to 8 percent of the 1981 sample. This sector possesses some production facilities, most notably for instrumentation,

and has frequent contractual ties to Soviet industry. Yet, its total share of total Soviet industrial output is probably quite small. The increased activity in the use of inventions may reflect greater efforts by the sector's managers to have their inventions declared *"used"* to reap greater institutional benefits and prestige.

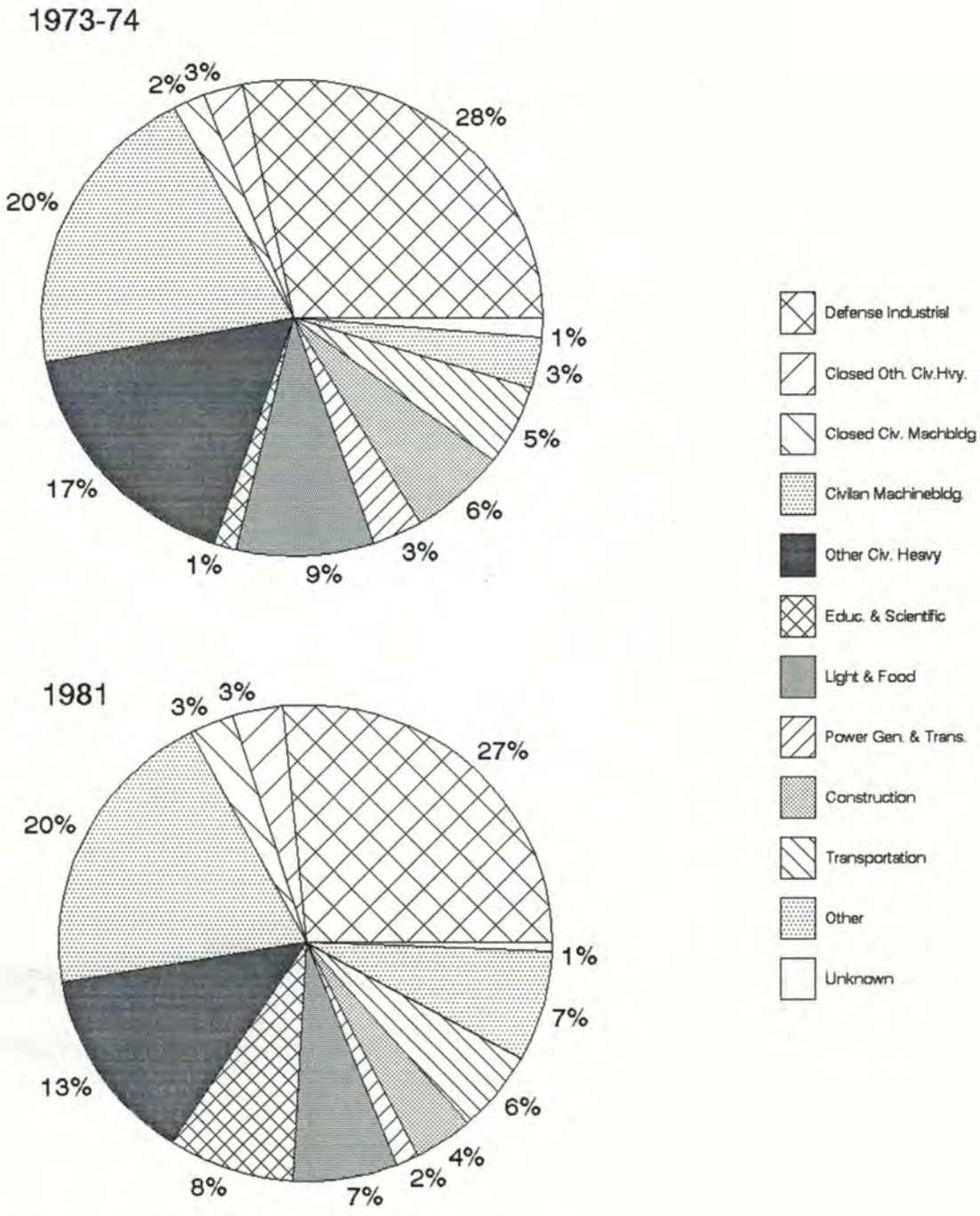
The defense industrial sector's share of total used inventions is considerably understated. First, the samples contain no classified inventions, which have been estimated to comprise slightly over 10 percent of total Soviet inventions. Adjusting the totals for classified inventions would raise the defense industrial sector's share to about 35 percent of the total, approximately equal to the combined shares of the civilian machinebuilding and other civilan heavy industry sectors. Second, inventions used by organizations of the Ministries for Medium and General Machine Building are also not included. This sector's large share of total inventions used probably corresponds to its considerable command over Soviet economic resources.

The large number of unknown originating facilities prevents the development of a complete view of the intersectoral movement of Soviet inventions [*see Table 4.*] Of the inventions that identified both originating and using facilities, most remained within their sector of origin [58 percent for the 1973-74 sample and 61 percent for the 1981 sample.]

Soviet officials put pressure on the academic establishment to become more involved in problems related to defense and civilian industrial production. The 1981 sample shows an increase in the defense industrial sector's use of inventions from the educational and scientific sector in comparison with the 1973-74 sample. Both samples show a clear orientation of the academic organizations away from the light and consumer goods industries and toward the producers' goods industries.

Figure 1

Soviet Inventions Used for the First Time
According to Industrial Sector



Source: Author's sample from Vnedrennye Izobreteniya.

Table 4
Intersectoral Movement of Soviet Inventions
(Number of inventions)

1973-74 **Using Sector**

Originating Sector	Civ Mach	Clsd Civ Mach	Clsd Oth Hvy	Cons	Def Ind	Lt & Food	Othr	Oth Civ Hvy	Pwr	Trns	Unkn	Educ &Sci	Total
Civilian Machinebldg.	142	10	1	4	32	18	4	24	5	10	2	0	252
Other Civilian Heavy	6	4	14	3	5	2	0	94	1	6	1	0	136
Educ. & Scientific	19	2	2	3	19	7	1	29	6	3	0	19	110
Light & Food Industry	5	0	0	5	3	65	1	1	0	3	0	1	84
Construction	4	1	0	43	0	6	1	10	0	1	2	0	68
Defense Industrial	5	0	0	0	38	0	0	0	1	1	1	0	46
Other	5	1	0	0	3	5	21	4	0	1	1	0	41
Power Gen. & Transmiss.	3	2	0	4	0	0	0	1	27	0	0	0	37
Transportation	0	0	0	2	2	1	1	4	0	15	0	0	25
Closed Civ. Machbldg.	0	1	0	0	0	0	0	0	0	0	0	0	1
Unknown	132	12	24	37	350	39	26	104	12	47	14	3	800
Total	321	33	41	101	452	143	55	271	52	87	21	23	1600

1981 **Using Sector**

Originating Sector	Civ Mach	Clsd Civ Mach	Clsd Oth Hvy	Def Ind	Educ &Sci	Lt & Food	Othr	Oth Civ Hvy	Pwr	Trns	Cons	Unkn	Total
Civilian Machinebldg.	130	7	3	12	1	17	1	12	1	6	0	0	190
Educ. & Scientific	15	1	5	24	98	3	12	18	3	6	4	0	189
Other Civilian Heavy	7	0	8	8	1	2	0	70	2	2	1	0	101
Light & Food Industry	5	1	1	6	1	54	0	1	0	2	3	0	74
Other	2	1	1	2	0	4	53	2	0	2	0	0	67
Construction	3	0	1	4	1	1	0	8	2	2	28	0	50
Power Gen. & Transmiss.	4	1	0	1	0	1	0	0	8	4	2	0	21
Transportation	1	0	0	0	0	0	0	3	0	14	1	0	19
Defense Industrial	2	0	0	7	1	0	0	1	0	1	0	0	12
Unknown	93	28	26	287	7	8	32	59	4	35	13	7	599
Total	262	39	45	351	110	90	98	174	20	74	52	7	1322

Source: Author's sample from the journal *Vnedrennye izobreteniya*.

B. Lead Times

Table 5 presents the average lead time by using sector. An F-test on the sampled means for the first sample was significant at the .1 level. It was not for the second sample.

Table 5
Lead Time by Implementing Sector

	1973-1974 Sample				1981 Sample			
Using Sector	Rank	No.	Mean Lead Time (yrs.)	Within Class Std. Dev.	Rank	No.	Mean Lead Time (yrs.)	Within Class Std. Dev.
Educational & Scientific	1	22	2.91	1.42	1	90	3.07	3.15
Construction	6	98	3.79	2.68	2	41	3.17	2.07
Closed Other Civ. Heavy	5	37	3.79	2.70	3	39	3.28	3.02
Civilian Machinebldg.	7	296	3.84	2.66	4	227	3.28	2.62
Defense Industrial	2	434	3.31	2.19	5	305	3.30	3.03
Closed Civ. Machinebldg.	10	33	4.12	3.21	6	35	3.41	3.17
Other Civilian Heavy	3	264	3.71	2.29	7	157	3.75	2.99
Light & Food Industry	4	138	3.72	2.41	8	85	3.86	3.03
Power Generation & Trans.	8	51	3.86	2.84	9	18	3.88	2.74
Transportation	9	86	3.97	2.66	10	71	4.30	2.38
Total		1459	3.64			1068	3.46	
			$F^{9}_{1449} = 1.77$				$F^{9}_{1058} = 1.54$	
			Pr > F .07				Pr > F .13	

Source: Author's sample from the journal *Vnedrennye izobreteniya*.

Strikingly, the lead time for the defense industrial sector scarcely changed between the two samples, and the small difference was not statistically significant. The civilian machinebuilding sector, however, showed a reduction in lead time of over 10 percent. That difference was statistically significant. Moreover, while there was a statistically significant difference between the defense industrial and civilian machinebuilding lead times in the 1973-74 sample, there was no statistically significant difference for the means in 1981. As noted above, the civilian machinebuilding sector had begun using a greater share of "faster" technologies, which may well have contributed to its improved performance. Nonetheless, the failure of the defense industrial sector to show any improvement in its lead times possibly accounts for the tone of urgency heard during this period in official pronouncements on increasing the use of science in the economy.

The educational and scientific sector's relatively short lead times almost certainly reflect its greater tendency to use its own inventions [*see Table 4 and discussion below on Facility Types.*] Almost 90 percent of innovations used by this sector also originated there.

3. Location

A. Sample Data

Many of the inventions included in the two samples indicated the location of the originating and using facilities. Soviet censorship practices severely restricted geographical information for defense industrial organizations. Consequently, the summary tables [*see Tables 6 and 7*] relate principally to organizations in the civilian economy.

The Soviet state has developed a vast network of organizations dedicated to the dissemination of scientific and technical information, including information on inventions. Tables 6 and 7 show

that many of the sampled inventions crossed regional boundaries. Yet, interregional exchanges of inventions appeared to decrease between the two samples. The share of "outside" inventions used dropped between the two samples, from about 55 percent to slightly under 40 percent. An investigation of this changes relation to lead times could, perhaps, partially explain the observed improvement in the total average lead times.

The relative importance of Moscow and Leningrad as major academic research centers and as the headquarters for many central USSR research establishments is reflected in the relative large shares of inventions from the Central and Northwest regions.

Aggregating the same data at the republic level exhibits the RSFSR's major importance as the source of much of the USSR's new domestic technology. Only the RSFSR had a large positive outflow of inventions for the two samples [*see Table 8*] and accounted for almost 60 percent of all inventions that crossed republic boundaries. Evidently the RSFSR, in addition to possessing superior raw material resources, also possesses a number of scientific and technological resources that are important to the industrial infrastructures of the other republics.

4. Facility Type

The Soviet press has frequently criticized academic research establishments for being disinterested in production problems. It has also criticized industrial research establishments for sluggishness in developing and implementing truly novel technologies. Numerous press articles have asserted that the "not-invented-here" syndrome is especially strong within the research and production establishments of the industrial ministries.

A. Sample Data

The sample invention information frequently identified the type of facility that developed and used the inventions. [This information was largely lacking for inventions created by or used at defense industrial facilities.] Of all the 1973-74 inventions implemented at production facilities, 270 were identified as originated by a research, design or educational facility and 155 by a production facility [*see Table 9*]. For the 1981 sample, the totals were 227 and 95 respectively. In both samples, the universities accounted for only one invention used at a production facility, reflecting their largely educational orientation in the USSR.

To improve industrial innovation, Soviet officials created a new type of industrial facility, the Scientific-Production Association, or NPO. This reform generally designated a research institute as a production association's lead organization. Mirroring the implementation of this reform, the number of inventions used by NPOs increased from the 1973-74 to the 1981 sample, [3 in 1973-74 to 21 in 1981.] The average lead time for NPO inventions was 3.1 years, or slightly shorter than that of the sample as a whole.

Table 6
Interregional Movement of Soviet Inventions: 1973-74

Originating Region \ Using Region	Be	C	CA	CCh	DD	ES	FE	Ka	Mo	N	NC	NW	Pri	S	SW	TC	Ur	V	VV	WS	U	Total
Belorussian	15	0	0	1	1	0	0	0	0	1	0	0	2	2	1	0	0	1	0	1	6	31
Central	12	82	0	4	22	7	1	4	1	1	5	6	12	0	3	2	11	11	0	4	58	246
Central Asia	0	0	4	1	0	0	0	0	0	0	0	0	1	0	2	0	0	0	0	0	4	12
Central Chernozem	0	1	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	9
Donetsk-Dnepr	1	4	0	3	36	0	0	1	1	2	2	0	1	1	0	0	3	1	1	0	7	64
East Siberia	0	0	0	0	0	6	0	0	0	0	0	0	1	0	0	0	0	0	0	0	2	9
Far East	0	0	0	0	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	3
Foreign	0	0	0	0	0	0	0	2	0	0	0	1	1	0	0	0	0	0	0	0	0	4
Kazakh	0	0	0	0	0	0	0	7	0	0	0	1	1	0	0	0	0	0	0	0	1	10
Moldavia	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	1	0	0	2	7
Northern	0	0	0	0	1	0	0	0	0	9	1	1	2	0	0	0	0	0	0	0	1	15
Northern Caucasus	1	2	0	1	1	0	0	0	0	0	20	0	1	1	0	0	0	2	2	0	2	33
Northwest	1	6	0	1	6	2	0	0	0	3	2	17	4	0	0	1	4	3	1	0	15	66
Pribaltics	1	1	0	0	0	0	0	0	0	0	2	0	37	0	1	1	0	0	1	0	8	52
Southern	0	0	0	0	2	0	0	0	0	0	0	0	1	5	0	3	0	0	0	1	1	13
Southwest	0	1	0	0	5	2	0	0	0	0	0	0	1	0	13	0	1	0	1	0	12	36
Transcaucasus	0	0	0	0	0	0	0	1	0	0	2	0	0	0	0	7	1	1	0	0	2	14
Urals	0	0	0	0	2	0	0	2	0	0	1	0	1	0	1	0	26	2	0	2	17	54
Volga	0	1	0	1	2	0	0	2	0	0	1	0	0	0	0	1	3	20	0	2	4	37
Volga-Vyatsk	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	1	0	10	1	4	19
West Siberia	0	1	0	2	1	0	0	0	0	0	0	1	1	0	0	0	0	1	0	14	4	25
Unknown	14	82	2	16	74	7	8	7	1	3	10	17	47	5	11	6	59	41	18	19	394	841
Total	45	181	6	38	155	25	10	26	7	20	46	44	114	14	32	21	109	84	34	45	544	1600

Source: Author's sample from Soviet journal **Vnedrennye izobreteniya**.

Table 7
Interregional Movement of Soviet Inventions: 1981

Originating Region \ Using Region	Be	C	CA	CCh	DD	ES	FE	Ka	Mo	N	NC	NW	Pri	S	SW	TC	Ur	V	VV	WS	U	Total
Belorussian	16	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	22
Central	4	103	3	1	9	1	0	1	0	3	4	5	10	0	9	2	6	5	2	2	19	189
Central Asia	0	1	10	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	13
Central Chernozem	0	0	0	4	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	1	7
Donetsk-Dnepr	2	2	0	0	35	0	0	1	0	0	2	2	2	0	2	2	1	0	1	0	7	59
East Siberia	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4
Far East	0	1	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	1	6
Foreign	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Kazakh	0	0	1	0	0	0	0	12	0	0	0	1	0	0	0	0	0	1	0	0	5	20
Moldavia	0	0	0	0	2	0	0	0	3	0	0	0	0	0	1	0	0	0	0	0	0	6
Northern	0	0	0	0	0	0	0	0	0	6	1	0	0	0	0	0	0	0	0	0	0	7
Northern Caucasus	0	0	0	0	3	0	0	1	0	0	25	1	1	0	2	0	0	0	0	0	6	39
Northwest	0	1	0	0	5	0	0	0	1	1	1	43	1	0	1	0	1	1	3	0	10	69
Pribaltics	1	0	0	0	0	0	0	0	0	0	0	0	38	0	0	0	0	1	0	0	3	43
Southern	0	2	0	0	0	0	1	0	0	0	0	0	1	14	0	0	0	1	0	0	3	22
Southwest	0	2	1	1	0	1	0	0	0	0	1	0	2	1	37	0	1	2	0	1	11	61
Transcaucasus	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	9	0	0	0	0	3	13
Urals	1	2	1	0	3	2	0	0	1	2	1	0	0	0	0	0	25	1	0	0	8	47
Volga	0	2	0	1	0	0	0	1	0	1	2	0	0	1	1	0	1	13	0	1	2	26
Volga-Vyatsk	0	1	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	13	0	2	18
West Siberia	0	0	0	0	2	1	1	0	0	0	0	1	0	0	0	1	0	0	0	11	4	21
Unknown	3	65	1	11	44	5	1	5	4	2	9	26	17	8	21	6	26	15	13	6	341	629
Total	27	183	17	18	106	13	8	22	9	15	47	79	72	24	77	20	61	40	32	21	432	1323

Source: Author's sample from Soviet journal **Vnedrennye izobreteniya**.

Table 8

The Interrepublic Exchange of Inventions
(Number of inventions)

	1973-74				1981			
Republic	Out-flow	In-flow	Of which from RSFSR	Bal-ance	Out-flow	In-flow	Of which from RSFSR	Bal-ance
RSFSR	95	38	...	57	67	30	...	37
Moldavia	1	3	2	-2	3	2	2	1
Tadzhik	1	0	0	1	0	0	0	0
Azerbaydzhan	3	2	2	1	0	1	1	-1
Kirgiz	0	0	0	0	0	1	1	-1
Georgia	2	3	1	-1	1	2	1	-1
Turkmen	0	1	1	-1	0	1	1	-1
Uzbek	4	0	0	4	2	4	2	-2
Armenia	0	3	1	-3	0	2	1	-2
Latvia	6	12	6	-6	0	3	2	-3
Kazakh	2	12	8	-10	3	6	3	-3
Estonia	1	10	9	-9	0	4	3	-4
Belorussia	10	16	14	-6	2	8	5	-6
Lithuania	2	12	8	-10	2	8	6	-6
Ukraine	32	51	44	-19	35	45	39	-10
Total	159	163	96		115	117	67	
RSFSR Outflow as Percent of Total Inflow			59%				57%	

Source: Author's samples from the soviet journal *Vnedrennye izobreteniya*.

Table 9
Interfacility Movement of Soviet Inventions

1973-74

Originator	**User**										
	Scientific			PDBs	Prod	Educ			Other	Unkwn.	Total
		SRI	PKTI				Univ	Polt			
Scientific	77	76	1	1	168	0	0	0	65	83	394
of which *SRI*	72	71	1	1	128	0	0	0	49	71	321
PKTI	5	5	0	0	40	0	0	0	16	12	73
Proj. & Design Bureaus [PDBs]	1	1	0	6	86	0	0	0	24	18	135
Production Facilities	1	1	0	0	155	0	0	0	8	41	205
Educational	1	1	0	0	17	3	0	3	5	8	34
of which *University*	0	0	0	0	1	0	0	0	1	0	2
Politechnical	1	1	0	0	16	3	0	3	4	8	32
Other	0	0	0	0	4	0	0	0	13	6	23
Unknown	12	12	0	1	322	1	0	1	91	382	809
Total	92	91	1	8	752	4	0	4	206	538	1600

1981

Originator	**User**										
	Scientific			PDBs	Prod	Educ			Other	Unkwn.	Total
		SRI	PKTI				Univ	Polt			
Scientific	153	140	13	7	167	3	2	1	50	59	439
of which *SRI*	137	135	2	5	109	3	2	1	36	46	336
PKTI	16	5	11	2	58	0	0	0	14	13	103
Proj. & Design Bureaus [PDBs]	0	0	0	14	58	0	0	0	12	10	94
Production Facilities	3	1	2	0	95	0	0	0	7	14	119
Educational	2	2	0	0	12	23	2	21	6	12	55
of which *University*	1	1	0	0	1	2	2	0	0	0	4
Politechnical	1	1	0	0	11	21	0	21	6	12	51
Other	0	0	0	0	3	0	0	0	9	6	18
Unknown	30	28	2	7	173	3	2	1	41	344	598
Total	188	171	17	28	508	29	6	23	125	445	1323

Source: Author's samples from journal *Vnedrennye izobretenniya*.

B. Lead Times

The two samples showed considerably longer mean lead times for “out-of-house” inventions, i.e., those inventions originated and used in different facilities [see table 10]. These longer “out-of-house” lead times were unaffected by the facility type [see table 11], suggesting that an "outside" origin had a greater impact on lead times than did the type of facility creating the invention.

Table 10
Average Lead Times for In-House and Out-of-House Inventions

1973-74	No.	Average (Years)	Within Class Std. Deviation (Years)
In-House	236	2.60	1.64
Out-of-House	447	3.78	1.76
1981			
In-House	268	2.63	2.04
Out-of-House	337	4.42	3.09

Source: Author's sample from the Soviet journal *Vnedrennye izobreteniya*.

Table 11 summarizes the average lead times for inventions moving between research and production facilities. In addition, these lead times are adjusted to reflect whether an invention originated and was used in the same facility. Such in-house implementation can be expected to have a considerable impact on lead-time -- problems in imparting know-how are minimized, organizational barriers are almost certainly fewer, and the existing capabilities of production better understood.

Table 11
Lead Time in the Movement of Inventions Between Research and Production

1973-74

	In-House			Out-of-House		
	No.	Avg.	Within Class Std. Dev.	No.	Avg.	Within Class Std. Dev.
Production to Production	113	2.29	1.45	32	3.65	1.64
Research to Production	29	3.15	1.75	230	3.85	1.80
Research to Research	79	2.85	1.82	6	5.28	3.95
			$F^2_{218} = 4.66$			$F^2_{265} = 1.99$

1981

	In-House			Out-of-House		
	No.	Avg.	Within Class Std. Dev.	No.	Avg.	Within Class Std. Dev.
Production to Production	63	2.02	1.36	18	4.20	3.32
Research to Production	53	3.10	2.27	164	4.25	3.17
Research to Research	140	2.75	2.14	15	4.97	4.03
			$F^2_{254} = 4.56$			$F^2_{194} = 0.342$

Source: Author's sample from the Soviet journal *Vnedrennye izobreteniya*.

The type of facility did have an impact for the in-house inventions in both samples, with the mean lead times significantly different at the .01 level. In this case, the lead times for inventions moving from research to production averaged almost one year longer than those originating directly at production facilities. Such a difference might, of course, be due to other factors

beyond the scope of the current data. For example, separate research facilities may develop more complex inventions than those developed at production facilities. Nevertheless, the difference in lead times does parallel the Soviet press' frequent criticisms of lethargy in many research organizations.

This significant difference in lead times for in-house and out-of-house inventions may well explain the educational and scientific sector's relatively short average lead times. The share of in-house inventions used by this sector is far greater than for any other sector [*see Table 4.*]

5. Economic Savings

Soviet facilities are required to calculate the economic effectiveness or savings realized from using each invention. This calculation in turn determines the size of bonuses given to the employees responsible for an invention's implementation, and is used by central officials as a measure of an organization's innovative accomplishments. As with many such economic indicators, state bodies have issued lengthy decrees and developed extremely complex formulae on the topic. The Soviet press, in its turn, has frequently exposed how few organizations follow the regulations.

Table 12
Economic Savings
(Rubles)

	1973-74	1981
No. in Sample	370	176
Mean	27,014	82,278
Median	5,600	71,009
Min	10	1,000
Max	857,700	1,960,000

Source: Author's sample from the Soviet journal *Vnedrennye izobreteniya*.

A. Sample Data

Only a small proportion of the inventions in both samples indicated economic savings, 23 percent for 1973-74 and 13 percent for 1981. Given these small shares and our lack of confidence in the significance of these calculations, no effort was made to relate these data to lead times.

Table 12 summarizes the data on economic savings and shows a clear increase in the size of the savings between the two samples. Because economic savings directly influence the size of employee rewards, the larger 1981 savings probably reflect the success of the state's campaign to increase the size of incentive payments. [The drop in the share of inventions reporting savings may also indicate the organizational backlash to this pressure.]

6. A Comparison of Soviet and Western Lead Time

A definition of lead time that uses features of patent law common to many countries presents an unusual opportunity to compare innovation performance among countries. [8]

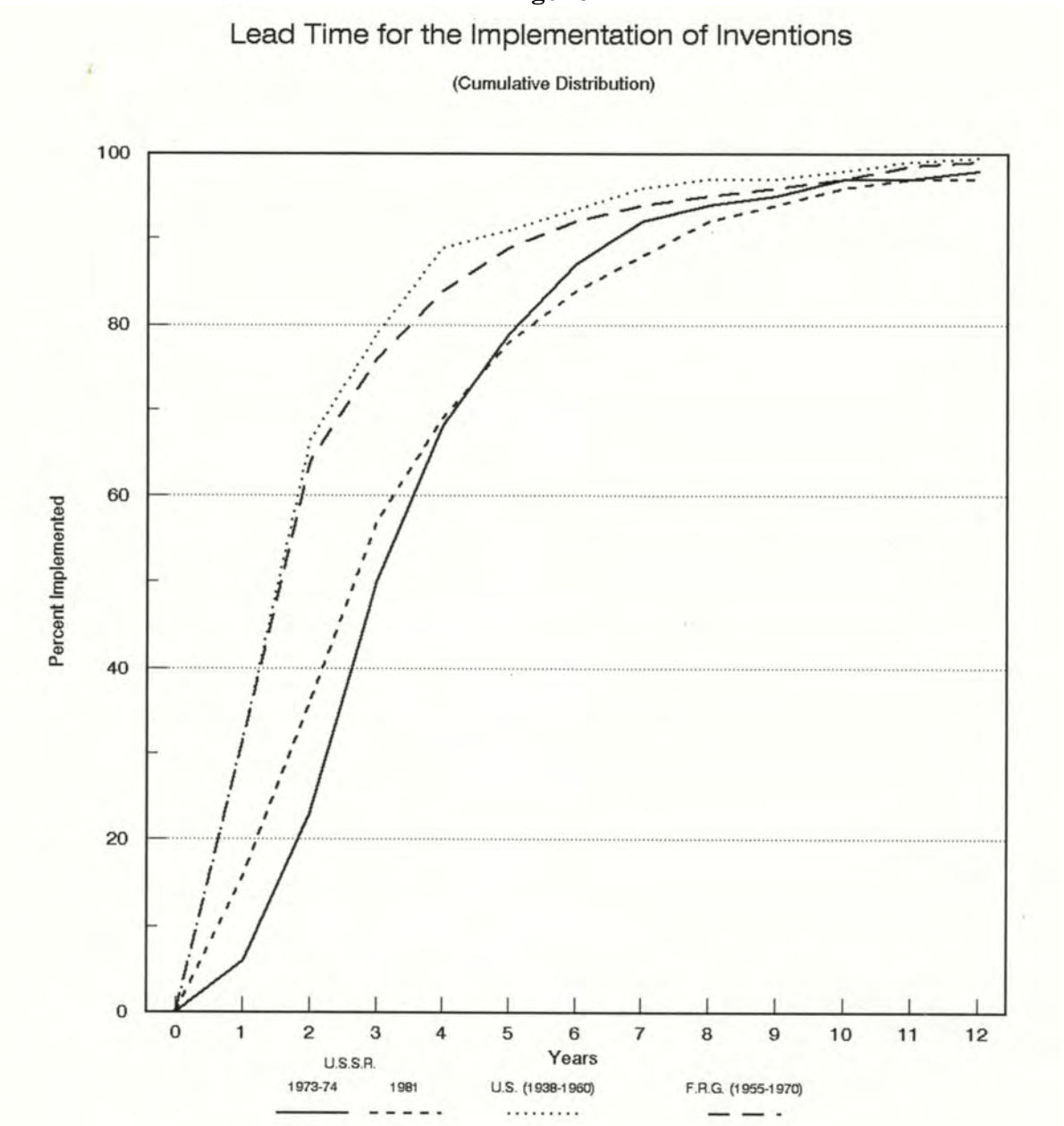
Figure 3 presents cumulative distributions for the implementation of inventions in the Soviet Union (the 1973-74 and 1981 samples), the Federal Republic of Germany and the United States. The curves indicate the proportion of inventions implemented (y-axis) in any number of given years (x-axis.)

The studies compared in Figure 3 differ in several important ways. First, the FRG lead times were calculated from the time of invention, not from the time of filing for the patent. Although the German study noted that filing quickly followed invention, the German distribution would still almost certainly shift slightly to the left if it were to be comparable with the other samples. Second, the time periods of the studies differed. If new or older technologies differ inherently in their required lead times, or if R&D management practices changed significantly over time, the comparisons are, to that extent, misleading.

No significant difference existed between the U.S. and F.R.G. performance. Both differed significantly from the 1973-74 and 1981 Soviet samples. The United States and the Federal Republic implemented over 50 percent of their inventions in little more than one year, whereas the Soviets needed well over two years to achieve this proportion of implementation.

[8] For more detail on the basis of comparison and the Western data see Martens and Young, *op. cit.*, pp. 504-506.

Figure 2



Source: U.S. data from Barkev V. Sanders, "Speedy Entry of Patented Inventions into Commercial Use," The Patent, Trademark and Copyright Journal of Research and Education, Vol.6 (1962), No. 1, p.95; German data from Klaus Greferman, et. al. Patentwesen und Technischer Fortschritt, Teil I, Die Wirkung des Patentwesens im Innovationsprozess, (Goettingen: Verlag Otto Schwarz, 1974); and USSR data from author's samples of inventions in Vnedrennye izobreteniya.

Additional Information on Data from the Journal *Vnedrennye izobreteniya*

All data on an invention's first usage are linked to the original inventor's certificate publication, which provides the names of the inventors, the application date, the patent examination department and a full international patent classification (IPC). Today, most of these data are available in online patent resources.

From 1968 to 1982 the journal *Vnedrennye izobreteniya* gradually reduced details on the facilities that developed and used new inventions, reflecting a policy of growing censorship.

When a used invention belonged to one of the defense-industrial ministries (i.e., Aviation Industry, Electronics Industry, Radio Industry, Industrial Means of Communication, Machinebuilding, Defense Industry, and Shipbuilding), the originating facility information was gradually reduced. First, the using facility's name was dropped. Later, the name of the originating facility was dropped, and finally, the using ministry's name and the date of first usage were omitted. The journal itself was withdrawn from open publication in 1983.

The Ministries of Medium Machinebuilding and General Machinebuilding were key defense organizations, but information from them was not published in the journal. Neither was information from the Committee for State Security and from any of the Ministry of Defense Special Units.

The data from most civilian facilities are quite complete, giving the name of the facility, its location and the date of first usage. However, those civilian industrial ministries with defense connections were formatted similarly to the defense-industrial ministries, i.e., no specific facility is identified. The paper refers to them as "closed" civilian facilities (see figure 1 and tables 4 and 5). Ironically, only this difference in formatting makes certain their linking to the defense sector.

All of the inventions in the study were unclassified, i.e., none of them originated in the Ministry of Defense's Invention Department. (For the method to identify previously classified inventions, see table 4.2 in John Martens, *Secret Patenting in the U.S.S.R. and Russia*, 2010, Deep North Press.) Furthermore, none of them were listed as Not Subject to Publication in the official Bulletin of the State Committee for Inventions and Discoveries.

The technological areas in the paper follow the information given in the official Bulletin of the State Committee for Inventions and Discoveries for the technical examination departments. (See Appendix 3, Martens, *ibid*.)

(Added March 2021)