

Preliminary, Not for Citation, Comments Welcome

Where Did All the Soviet Innovation Go?
Evidence from Soviet and Russian Patents,
1963 to 2007

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ABSTRACT

Developing countries will need to incur significant new costs to address legal obligations associated with enhanced intellectual property rights (TRIPs). In many countries, it is too early to predict whether increased patent protection increases innovative activity. Recent economic history may provide a useful laboratory for understanding the effects of patent reform on innovative activity. A unique new data set allows examination of patenting behavior by citizens of the Soviet Union (1971-1991) and of Russia (1992-2007). I find that Soviet inventors obtained tens of thousands of patents abroad, despite prohibitions on ownership of private property in the U.S.S.R. Further, outsourcing patent protection appears to promote innovative activity in the short run but not in the long run. An important implication of these findings is that emerging markets and developing countries may increasingly need to invest in their own institutions of intellectual property protection over time rather than outsourcing them.

Despite steadily rising investment in research and development since 1992, the selection of Russia over other countries for basic scientific research by U.S. firms, and a rapidly expanding information technology sector, economists and economic policymakers have observed that Russia's information technology sector remains smaller than investment and employment in science and engineering fields would predict. In 2007, IT represented only 0.15 percent of GDP in contrast to 8.5 percent in the U.S. in 2002.¹ Such underdevelopment has also been noted in closely related sectors and patent-intensive industries. Some have identified institutional instability and underdevelopment as a potential source of these outcomes. This explanation may be insufficient, given evidence of greater institutional stability and protection of intellectual property in Russia. Economic history may provide some insight on this and other theories.

A chief feature of socialism, as practiced in the Soviet Union, was the official prohibition of private property. Absent private property and the arms race notwithstanding, what was the incentive to add to the stock of knowledge? Founded in 1924, the State Committee for Inventions and Discoveries was one of the first institutions established by Lenin. Further, there was patenting in the U.S.S.R and outside the U.S.S.R. by Soviet citizens, and these records were public in both places. How do we reconcile this puzzle – a traditional disincentive to invent with significant inventive activity?

With a unique new data set of patents obtained during the Soviet period outside the Soviet Union and data recently available through the Russian Patent Office (Rospatent), I attempt to shed light on this conundrum. The preliminary evidence suggests four

¹ U.S. Census Bureau (2002).

important reasons for Soviet authorities allowing the public act of acquisition of private property by private citizens abroad. First, while many inventions, e.g., pharmaceuticals and chemical processes, were not patentable in the Soviet Union, they were elsewhere and could earn the Soviet government royalties and payments. Second, disclosure in patent offices abroad could offer important international recognition for having been the first to develop or to patent a given idea. Apart from the arms race, there were few public outlets for demonstrating comparable or higher returns to investment in science and technology. Third, patenting abroad may have been an admission that certain ideas needed protection and that Soviet institutions were too weak or too politically sensitive to provide this protection. Finally, as a tool of external validation of the novelty, usefulness, and non-triviality of a given idea, inventors and their managers could capture more resources from the state. Whatever the motive, initial results are suggestive that commercialization opportunities were underdeveloped domestically and abroad during the Soviet period and that only with the protection of intellectual property rights at home did commercial opportunities begin to develop significantly abroad. Patent assignment rates abroad increased appreciably after passage of patent reform laws in post-Soviet Russia in 1992. This implies that protection of intellectual property at home and protection abroad are not substitutes but complements. Further, the conventional wisdom among many students of the former Soviet Union that intellectual property was not valued during socialist and non-socialist periods may require some revision. It appears to have been valued, just not within the borders of the Soviet Union. More generally, “missing institutions” can only be temporarily missing and not permanently missing as countries seek development by committing to higher living standards through new additions to the stock of knowledge.

This paper is in four parts. The first part presents a brief history of private property and inventive activity during the Soviet period. The second part describes the data, and the third part outlines the empirical strategy and discusses initial results for U.S. data. The fourth part concludes and describes the remainder of the research agenda.

I. Private Property, Intellectual Property, and (or in Spite of) the Soviet Union

Gerschekron (1962) first suggested that, due to Russia's relative economic backwardness, the government might substitute for "missing institutions." Alternatively, Russia could "borrow" institutions or institutional-development ideas from the experiences of more advanced countries. During Russia's period of rapid economic development, for example, substitutes for missing institutions were found and sought in England in the financial sector.² Recently, economic historians, such as Douglass North (1981, 1990, 2005), Tom Bethell (1999), and David Landes (1969, 1999), have demonstrated the important link between the institution of private property and economic development. One view of economists and other researchers studying productivity and innovation, e.g., Merges (1992), is that stronger patent protection provides an enhanced incentive to create new knowledge. Murray and Stern (2005) find modest empirical support of the "anti-commons" hypothesis, i.e., that stronger intellectual property rights may hinder the growth of new additions to the stock of knowledge. Whether strong patent laws help stimulate technological change or not remains an open research question. This author in

² See Cook (1997).

Cook (2007) has extended this line of research to include the relation between all property rights and patenting outcomes, which has been found to be nontrivial.

A series of decrees in 1918 and afterwards eliminated private ownership of land and most physical property.³ Two important exceptions were “personal” property, including utensils, household furniture, and other items for personal and family use, and private plots of land in the countryside. Several researchers have offered evidence of the magnitude and significance of ownership of plots of private gardens, especially in smoothing consumption during periods of official food shortages and over the business cycle. Among others, another exception in practice was private ownership of agricultural land for large-scale production in the Caucasus region, e.g., the Georgian Republic. This area supplied much of the Soviet Union with citrus fruit, which was produced and sold on market principles.

In 1919, the Decree on Inventions was signed. After this time pre-revolutionary patents, which were not considered property by Soviets, lost legal force. Patents were replaced by “inventors’ certificates,” which offered recognition of the inventor without control rights over the invention. Patent rights were assigned to the Soviet government, and the technology was available to any state-owned enterprise or entity wishing to use it. Patents were re-introduced in 1931 with the “Statute on Inventions and Technical Improvements” and were regulated like other sanctioned forms of private property. In principle, inventors were given the option of applying for an inventor’s certificate or a patent, but the second option was rarely exercised or granted. Between 1965 and 1968,

³ See Kucherov (1962) for a rich discussion of the series of legal actions associated with the nationalization of private property in the USSR.

of the 80,000 rights granted inventors, only three were in the form of patents.⁴ Van Caenegem attributes the low relative number of patents to “socialist morality” and limitations on patentability of certain inventions, including chemicals, pharmaceuticals, and ideas produced while inventors were employed by a state enterprise or agency.⁵ Enterprise managers’ names often appeared on patents in an effort to elicit more funds for an idea, firm, institute, or agency. Inventors were to be compensated for their inventions, but they were typically not compensated more than a few hundred dollars.

Stalin’s death precipitated a reconsideration of incentives associated with innovation. One upshot was that greater scientific exchange with the West, including through technology transfer, was increasingly supported and encouraged. In 1965 and 1978, the USSR signed the Paris Convention for the Protection of Industrial Property and the Patent Cooperation Treaty. Soviet participation in these agreements implied that Soviet inventions would be protected abroad, as Western inventions circulating within the Soviet Union would be.

In 1985, Gorbachev initiated patent reform, which he considered, along with increased investment in R&D, a central feature of *perestroika*, or fundamental restructuring of the economy. Beginning in 1989, inventors were granted exclusive rights to their inventions for 20 years, compensation to inventors was augmented, development funding external to the enterprise system was created, and incentives were offered for foreign use of inventions. Through a trade agreement signed between George H.W. Bush and Gorbachev in 1990, most-favored-nation status was accorded the Soviet Union in

⁴ Van Caenegem (1993) contains a detailed account of the evolution of intellectual property during the Soviet and early post-Soviet periods. The discussion in this paper relies heavily on this work.

⁵ Van Caenegem (1993) reports that 80 percent of inventions in 1985 were produced by state employees.

exchange for greater protection of patents within its borders. This series of reforms culminated in the passage of a patent reform law in 1992, which established the Russian Patent Office and is currently in effect.

While studies have addressed private property and inventive activity in the Soviet Union, to the author's knowledge there exists no systematic data or analysis of inventive activity of Soviet citizens outside the U.S.S.R. The sections below describe how this gap in the literature is being filled.

II. Data

A unique data set has been constructed using data from the U.S. Patent and Trademark Office (USPTO), the European Patent Office, the German Patent Office (GPO), and the Russian Patent Office.⁶ The U.S. data are for all types of patents – utility, design, and plant – with at least one inventor residing in the U.S.S.R. or Russia between 1971 and 2007.⁷ Data are collected for patents having at least one inventor residing in the Soviet Union (1924 to 1991) or one inventor residing in Russia (1992-2007). Using the EPO search engine, one may collect data on patent applications and grants from all European and four non-European (Australia, Canada, Israel, and Japan) patent offices. EPO and GPO patent data are also for all types granted between 1924 and 2007. Unlike the USPTO's, most foreign search engines do not allow searches by country. Therefore, a

⁶ To date, patents granted to Soviet citizens abroad have been identified in Austria, Canada, Denmark, England, Finland, France, Germany, Greece, Switzerland, and the U.S. The data-collection effort is initially focused on those countries granting the majority of patents: England, Germany, and the U.S.

⁷ Most patents granted in the U.S. are utility patents. A patent is granted if an invention is found to be novel, useful, and non-trivial, and patent rights are granted for 20 years from the date of application.

mechanism was devised to match common Soviet and Russian names with an identifiably unique structure to patents in non-U.S. databases. The Russian Patent Office (RPO) began reporting to the EPO in early 2008, although Soviet and Russian patents obtained in Russia are not yet readily available. Each patent record contains full names of the Soviet or Russian patentee (s); names of co-inventors; patent number; location of the inventor; application date; grant date; forward and backward citations; patent classification; assignment status; assignee, including location; and a brief description or title of the patent. Data availability varies across sources. For example, data on forward citations is only available for U.S. patents. Adjustments are being made to the data set for this reason. Data on firm status and technological class from Hall, Jaffee, and Trajtenberg (2001) have been matched to patents. The data file is operational for patents obtained in the U.S. between 1971 and 2007.

Currently, there are 9,338 patents in the data set. Figure 1 shows the evolution of patenting activity by Soviet citizens in the U.S. between 1971 and 2007. For the most part, patenting follows Soviet and Russian investment in R&D (Figure 2), which is what we would expect. It also increases with patent reform in 1992. One difference from the conventional analysis is that these are data external rather than internal to the country. Figures 3 and 4 report patenting data pre- and post-patent reform, i.e., 1971 to 1991 and 1992 to 2007. It is interesting that inventive activity is pro-cyclical with respect to the Soviet Union prior to 1992 and is pro-cyclical with respect to the U.S. after 1992. In general, patenting in the U.S. has been pro-cyclical over time. I return to this point below.

Figures 5, 6, and 7 compare patenting activity by Soviet and Russian inventors to Soviet and Russian economic activity or demand. Patenting abroad and Soviet/Russian GDP did not obviously covary in the mid-1970's and early 1980's but did beginning in the late 1980's. In contrast, patent activity in the USSR and Russia covaries with the level of Soviet and Russian economic activity throughout the period.

Figure 8 presents data on patents granted by technological class by decade, and Figure 9 reports the same data pre- and post-reform. These data imply that areas of technological change are shifting over time, which is true for many countries, including the U.S. One likely reason is that areas in which patenting was legally prohibited, i.e., chemicals and pharmaceuticals, were now opened to patenting in Russia and elsewhere. Another is that R&D activities were increased in these previously under-researched areas, and increased patenting in these areas would be one indicator of new knowledge creation in these areas. Is there anything we can learn about the economic value of Soviet citizens' patents? Yes. A crude measure would be assignment of patents at issue. By this measure, ideas of greater value were patented after 1992 relative to before 1992. Figure 10 gives the assignment status of patents prior to and following ostensible patent reform, and Figure 11 gives the composition of assigned patents over the period.

In sum, if we accept U.S. demand as a proxy for world demand, from the preliminary evidence we may infer that decisions by Soviet inventors seeking protection of ideas abroad were determined by non-market factors for the twenty years preceding patent reform in and collapse of the Soviet Union. In stark contrast, since 1992, patenting by Russian residents has been consistent with market demand and with patenting patterns

among inventors patenting in the U.S. Results from graphical analysis in this section are subjected to more formal tests in the next section.

III. Initial Results

What are the determinants of patenting abroad for Soviet citizens? Are ideas treated equally in their protection in the U.S.S.R. and in the U.S.? Has increased patent protection influenced technical change in Russia? These are the questions whose responses are sought in this section.

A. Correlations

The correlation coefficients in Table 1 reveal no relation between the data series between 1971 and 2006. Consistent with the data in Figures 3 and 4, Russian and other U.S. patents are negatively and significantly correlated prior to 1992. After 1992, this pattern is reversed, and these series are positively and significantly correlated. Just as there is heterogeneity in covariation over time, there is heterogeneity in covariation across technological groups, as can be seen in Table 2. Chemical, computer and communications, and drugs and medical patents positively and significantly covary, and mechanical and other patents negatively and significantly covary over the period. The correlation between Russian and all electrical patents is negative but not significant. Correlations in Table 3 combine the analysis by time period and by technological class.

Correlations between drug-related and medical inventions are the only ones that are consistent across time periods. This finding provides some evidence that patenting pharmaceutical inventions in the U.S. was a substitute for patenting such inventions in the U.S.S.R. Among computer and communications and electrical patents, there is a complete reversal of direction of covariation, from negative to positive, between the two periods. After 1992, Russian and total U.S. patents are positively and significantly correlated across fields. As in the graphical analysis, patenting decisions by Soviet citizens do not appear driven by demand considerations, while among Russian citizens they are.

To be sure, these initial findings raise more questions than they answer. While the motive to patent in the drugs and medical field is clearer than for other fields, the motive for Soviet inventors to seek protection of their ideas abroad is less clear. How did patenting patterns differ inside and outside the Soviet Union? Did patenting patterns differ across countries where Soviet citizens obtained patents? Would international patenting activity reflect differential protection and commercial opportunities, or would it represent strategic behavior by the Soviet government or by independent Soviet inventors? If the former is true, was patenting abroad an innocuous means by which managers could receive external validation of their units' ideas and, as a result, garner more resources within the Soviet budgeting process? Or was disclosure another strategy of cold-war competition, that is, demonstrating the magnitude, depth, and scope of Soviet scientific discovery or potential for such? If the latter is true, were Soviet officials indifferent to the protection of new knowledge outside the military-industrial complex? Or were Soviet inventors treating patents like commercial opportunities arising from

garden plots or other market-based transactions to which Soviet authorities turned a blind eye? Finally, if patents are one measure of productivity, in which countries and in which fields did Soviet authorities receive the highest return to investment in basic research, in which the U.S.S.R. had significant capacity relative to the rest of the world?

B. Initial Regression Results

The empirical strategy is designed to test and eliminate the aforementioned hypotheses related to Soviet and Russian inventors' patenting behavior abroad. In the first stage, it is possible to examine the basic covariates of foreign innovative activity using USPTO data on patenting by Soviet and Russian citizens and EPO data on patenting within the USSR and in Russia. I expect a pattern similar to that observed in the graphs and correlations above: little comovement between patenting at home and abroad in the earlier period and more in the later period. In the second stage, this model would be extended in a differences-in-differences framework.⁸ Estimation in the first-stage is described and executed below.

A preliminary inspection of the data suggests that structural breaks are more pronounced in 1981 and in 1997 rather than in 1991, and this is taken into account in estimation. Specifically, I estimate the following OLS time-series model:

$$\text{uspat}_t = \alpha + \beta_1 \text{ruspat}_t + \beta_2 \text{usgdp}_t + \beta_3 \text{rusgdp}_t + \beta_4 d1981_t + \beta_5 d1997_t + \beta_6 d1982-1997_t + \beta_7 d1998-2006_t + \beta_8 t + \varepsilon_t,$$

⁸ Estimation in the second stage would also exploit panel features of the data and incorporate data to minimize the problem of unobserved heterogeneity.

where $uspat_t$ is log of US patents granted Soviet or Russian inventors in year t , $ruspat_t$ is log of Soviet or Russian patents granted Soviet or Russian inventors in year t , $usgdp_t$ is log of US GDP in year t , $rusgdp_t$ is log of Soviet or Russian GDP in year t , $d1981_t$ is a dummy for the year 1981, $d1997_t$ is a dummy for the year 1997, $d1982-1997_t$ is a dummy for the years 1982 to 1997, $\beta_7 d1998-2006_t$ is a dummy for the years 1998 to 2006, and t is a time trend. There is evidence of a unit root in the $uspat$ series, and this series and the first three regressors are first-differenced prior to estimation. The coefficient of interest is β_1 . Columns 1 to 4 in Table 5 report the results of this regression.

The estimated coefficients on $ruspat$ are consistently negative and significant across models. This implies that patenting in the U.S. and in the U.S.S.R. or Russia are substitutes rather than complements between 1971 and 2006. This finding is suggestive that weak property rights at home were being exchanged for stronger property rights abroad. While the last round of patent reform begins in 1992 in Russia, its effects are likely observed with a lag. The coefficient on the period 1998 to 2006 is ambiguous, and it would be difficult to link this result to patent reform. To examine the effects of greater patent protection, more data on timing of various elements of changes in the patent system will be used in the second stage of estimation.

Further, it is interesting to note that patenting abroad is uncorrelated with either demand in the U.S. or in the Soviet Union/Russia.

IV. Conclusion and Future Research

Patents are one measure of additions to the stock of knowledge that increase living standards. What happens to countries in which intellectual property rights are not seriously protected (most countries in the world)? The laboratory of patenting behavior of citizens of the Soviet Union and Russia provides a unique lens for understanding the process of innovation in much of the modern world. An important implication of these findings is that emerging markets and developing countries may need to increasingly invest in their own institutions over time rather than outsourcing them. Upon Gerschenkron's advice, governments may need to intervene to encourage development of these institutions.

This is clearly the beginning of this research agenda. Future work will focus on examining post-Soviet research networks and returns to investment in Soviet and Russian scientific endeavors using citation and network analysis. This will be feasible with the addition of patent data from other countries, particularly from the RPO for the entire Soviet and post-Soviet period.

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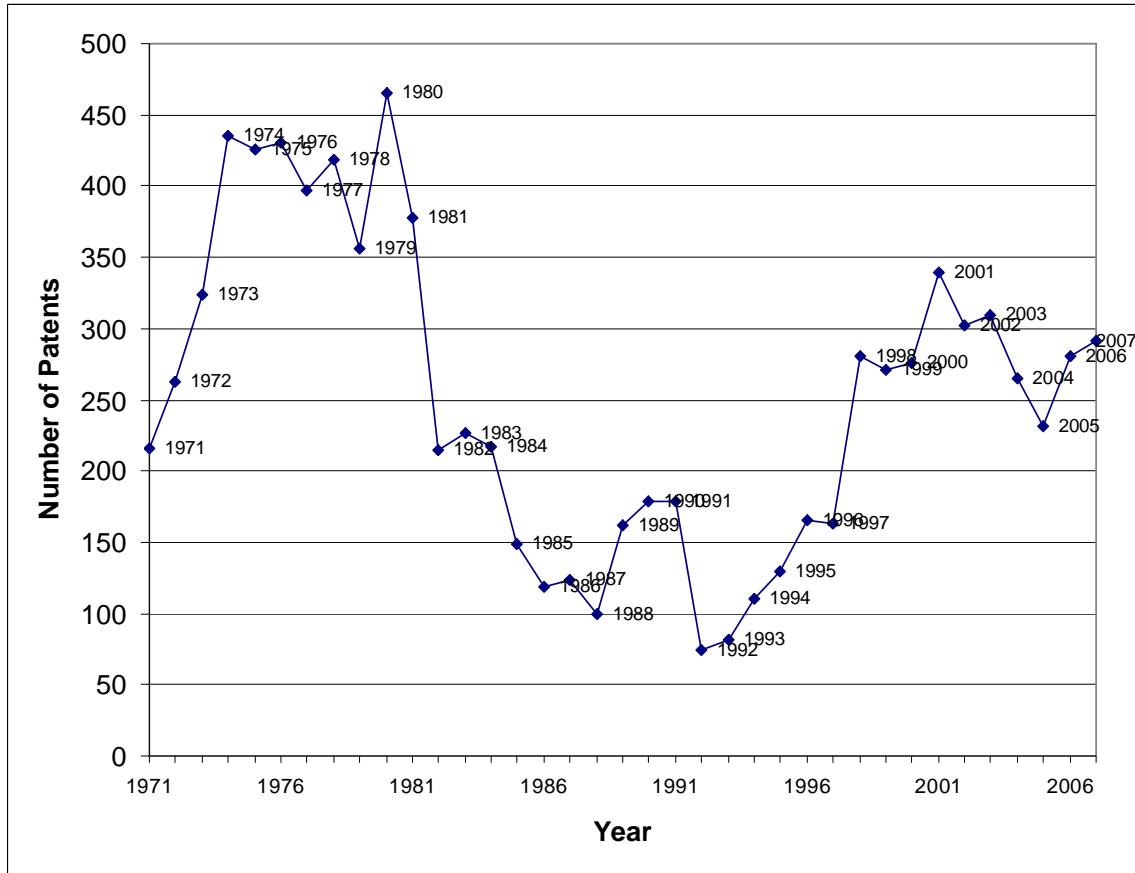
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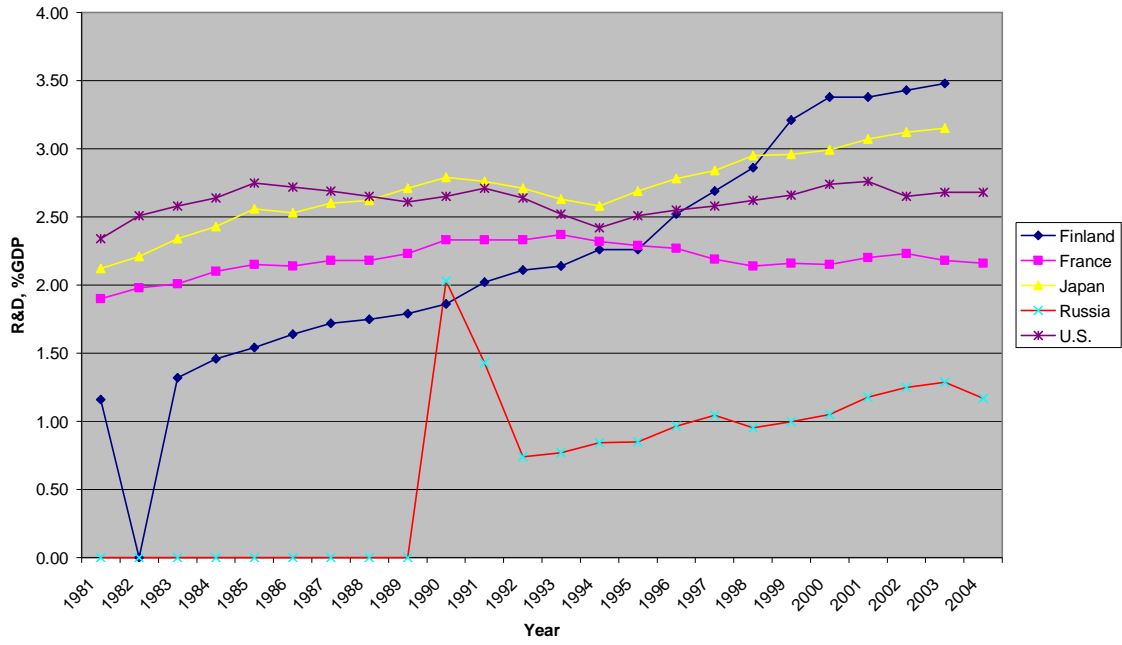
Figure 1: Number of Patents Granted by USPTO to Soviet and Russian Inventors*, 1971-2007 (by Grant Year)



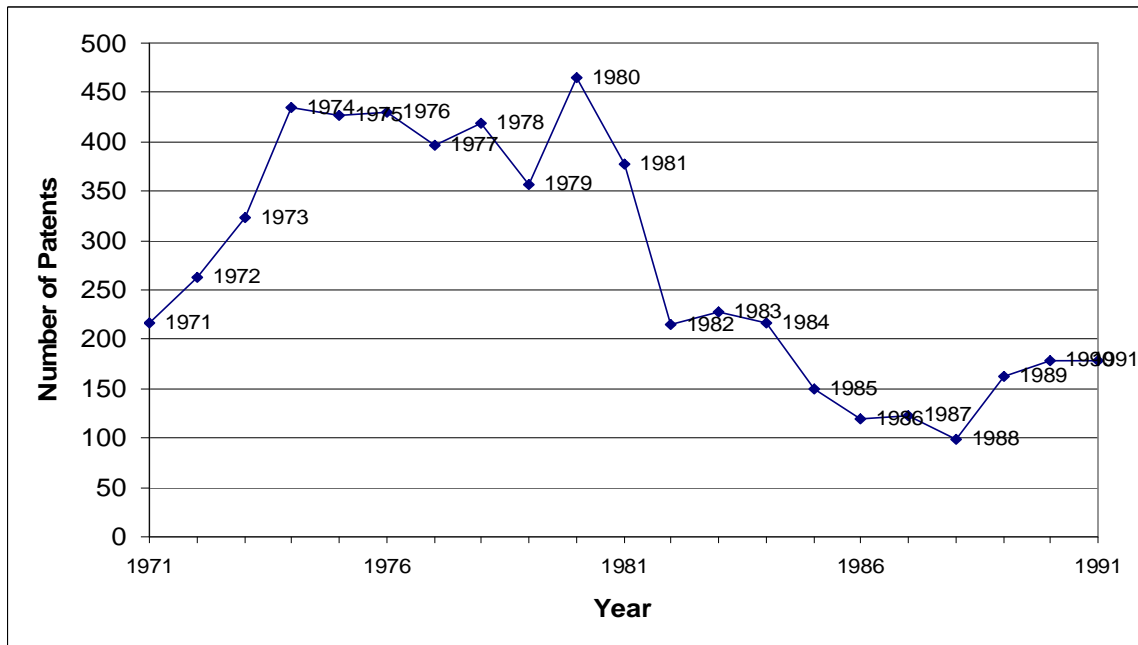
Source: Author's calculation from USPTO database which is retrieved by <http://www.pattools.com>
 Note: *one or more investors are residing in Russia or U.S.S.R.

Figure 2.

R&D Expenditure, Selected Countries, 1981-2004
Source: OECD (2006)

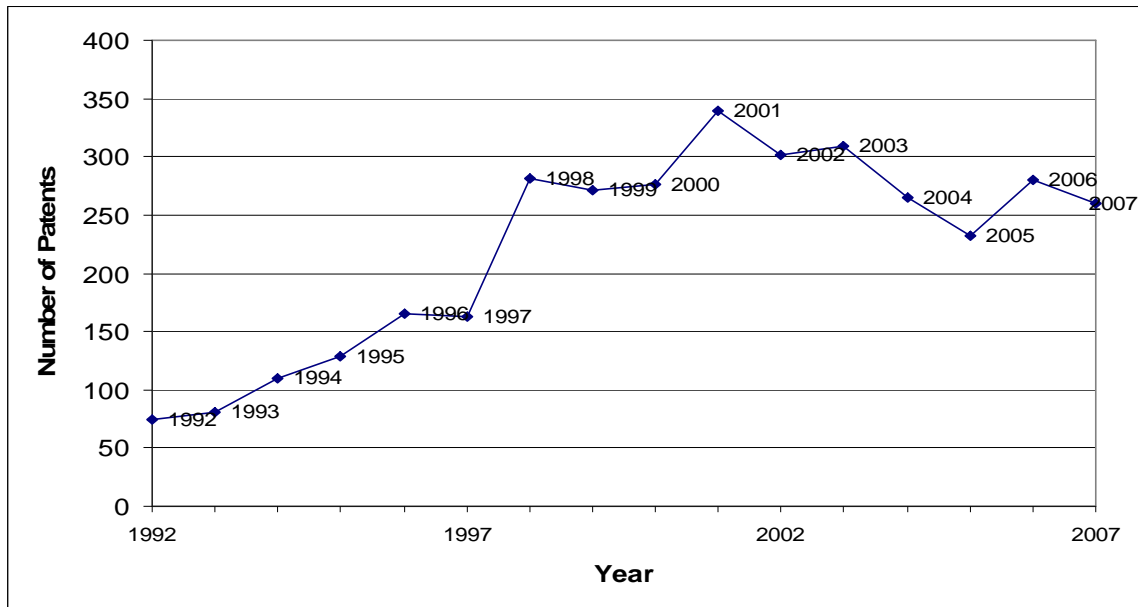


**Figure 3: Number of Patents Granted by USPTO to Soviet Inventors*
(by Grant Year) : 1971-1991**



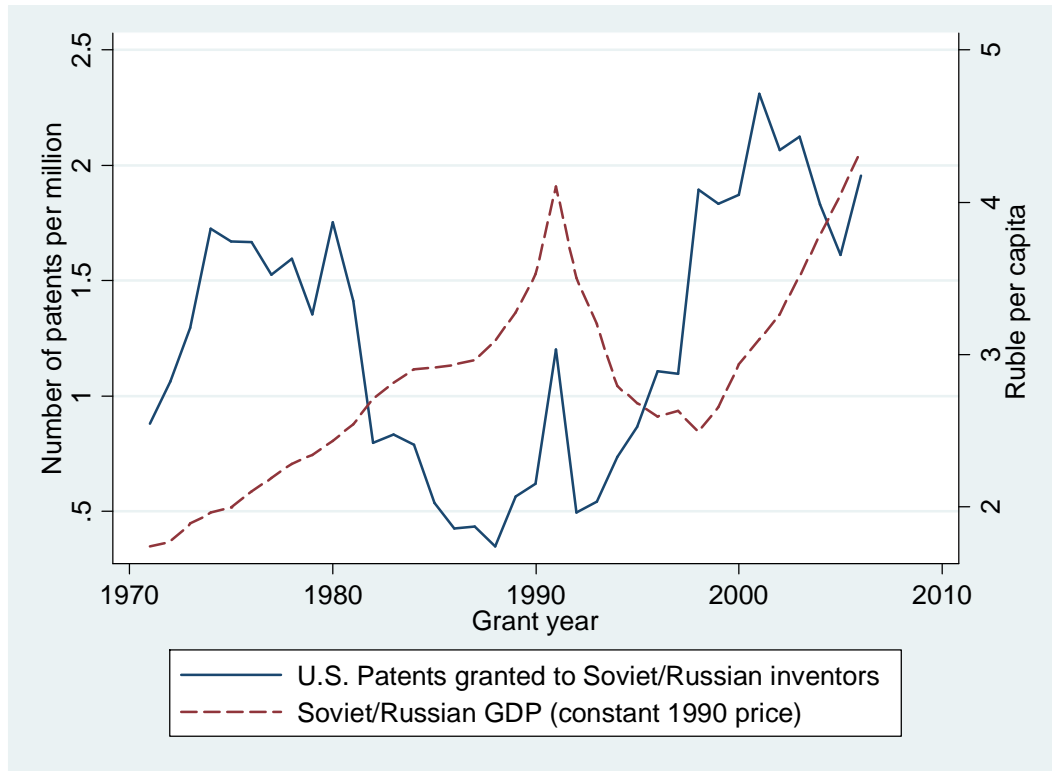
Source: Author's calculation from USPTO database which is retrieved by <http://www.pattools.com>
 Note: *one or more investors are residing in Russia or U.S.S.R.

**Figure 4: Number of Patents Granted by USPTO to Russian Inventors*
(by Grant Year) : 1992-2007**



Source: Author's calculation from USPTO database which is retrieved by <http://www.pattools.com>
 Note: *one or more investors are residing in Russia or U.S.S.R.

Figure 5: Gross Domestic Product of Soviet Union and Russian Federation and U.S. Patents Granted to Soviet/Russian Residents, 1971 - 2006

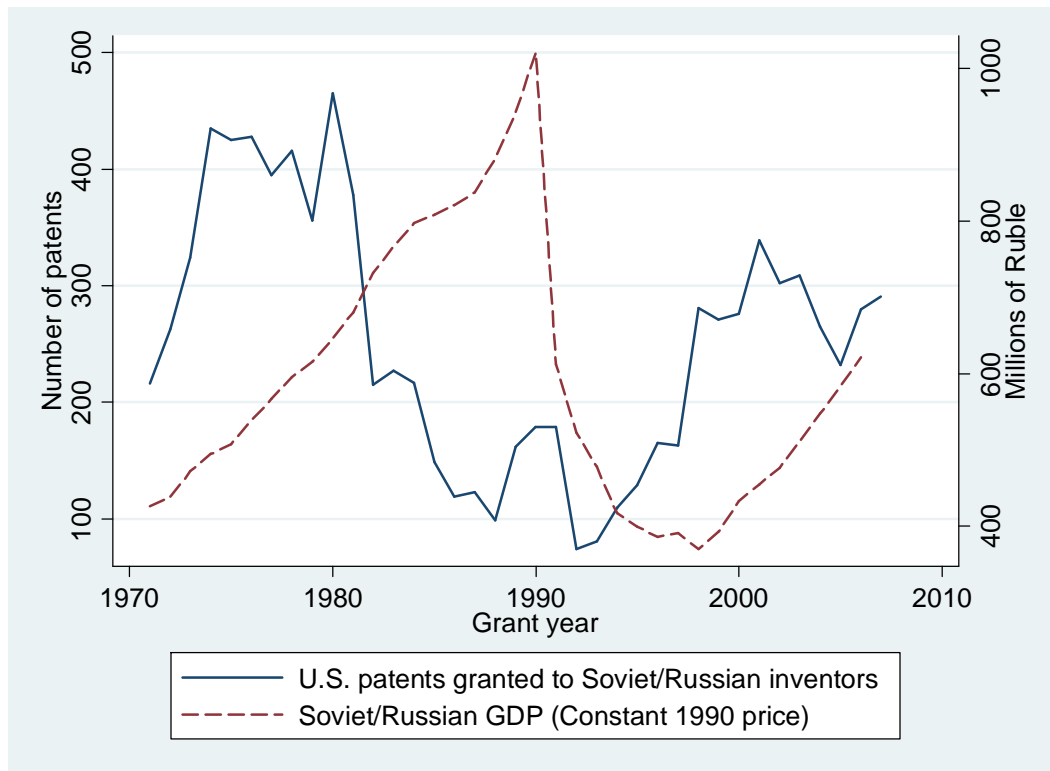


Source:[GDP] United Nations Statistics Division available at <http://unstats.un.org/unsd/snaama/selectionbasicFast.asp>
 [Population] UN Population Division, World Population Prospects, 2006.
 [US patents granted to Soviet/Russian inventors] Author's calculation from USPTO database.

Note: GDP data between 1971 and 1990 are for GDP of Former Soviet Union and are converted to New Rubles by dividing by 1000.(in constant 1990 prices, in millions of New Rubles). GDP data between 1991 and 2006 are for GDP of Russian Federation (in constant 1990 prices, in millions of New Rubles).

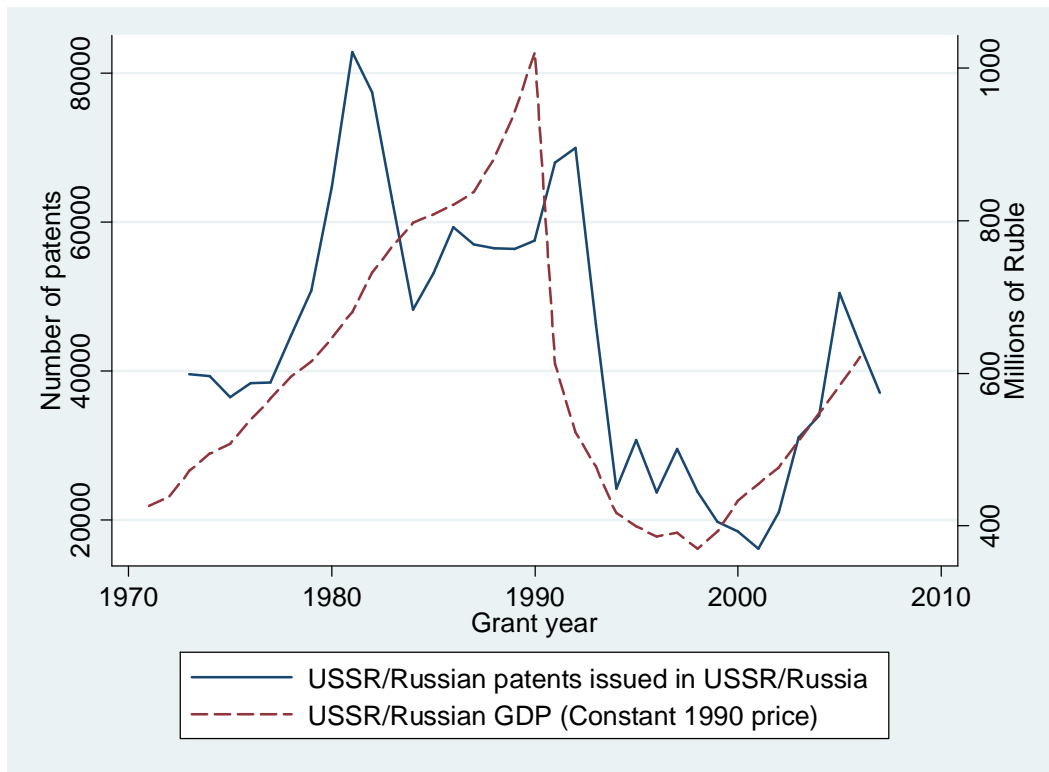
Population data between 1971 and 1990 are for population of Former Soviet Union, and population data between 1991 and 2006 are for population of Russian Federation.

Figure 6: Gross Domestic Product of Soviet Union and Russian Federation and U.S. Patents Granted to Soviet/Russian Residents, 1971 - 2006



Source and Note: See above.

Figure 7: Gross Domestic Product of Soviet Union and Russian Federation and USSR/Russian Patents issued in USSR/Russian Federation, 1971 - 2006



Source:[GDP] United Nations Statistics Division available at <http://unstats.un.org/unsd/snaama/selectionbasicFast.asp>

[USSR/Russian patents] Worldwide database in <http://ep.espacenet.com> (European Patent Office).

Note: (1) GDP data between 1971 and 1990 are for GDP of Former Soviet Union and are converted to New Rubles by dividing by 1000.(in constant 1990 prices, in millions of New Rubles. GDP data between 1991 and 2006 are for GDP of Russian Federation (in constant 1990 prices, in millions of New Rubles).

Figure 8: Share of Patents Types Granted by USPTO to Soviet and Russian Inventors, 1971-1991 and 1992-2007

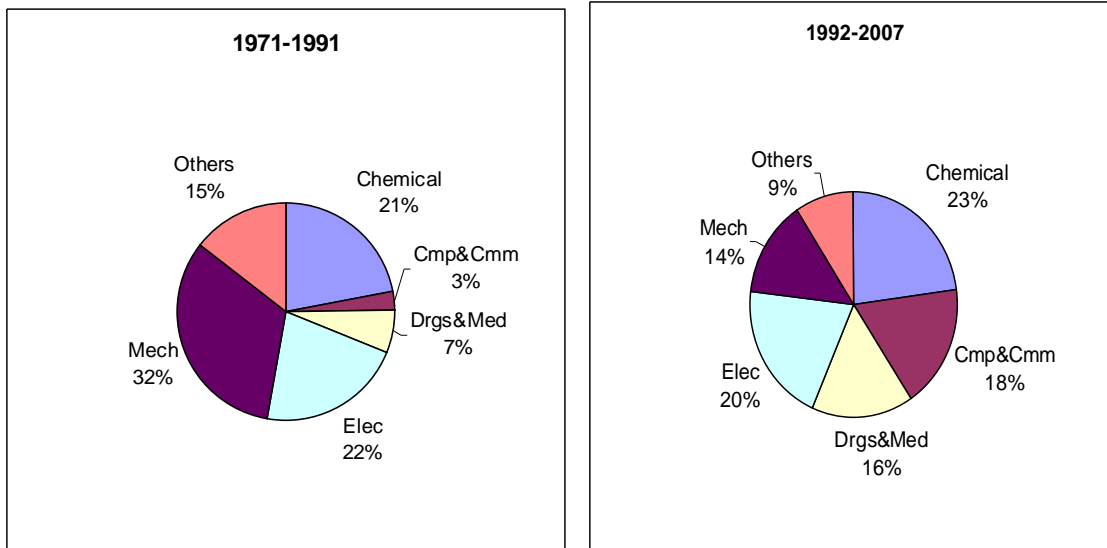
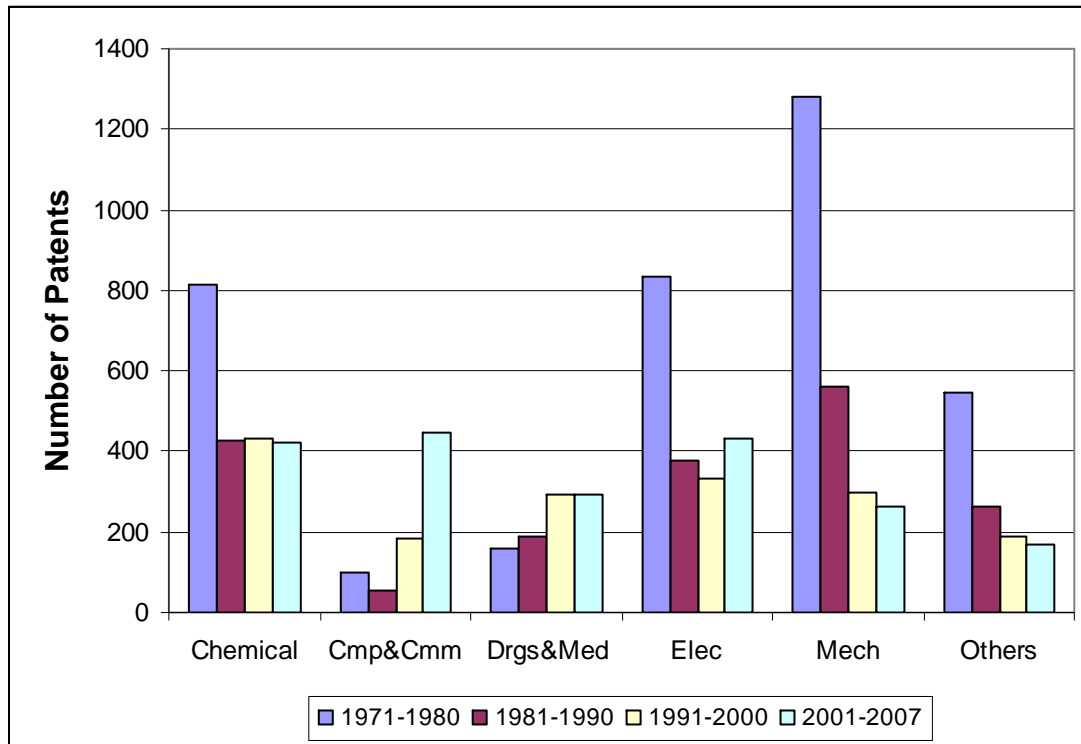
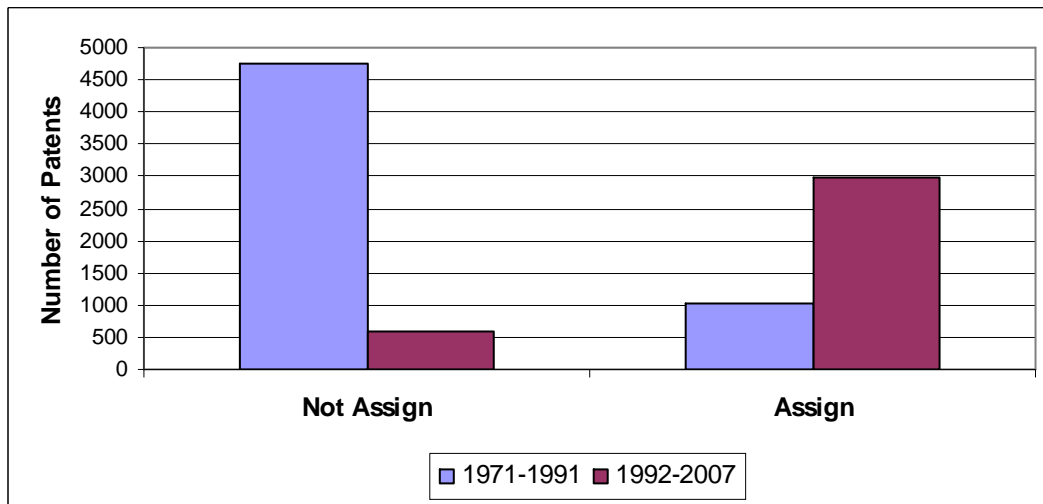


Figure 9: Share of Patents Types Granted by USPTO to Soviet and Russian Inventors, 1971-2007, By Decade



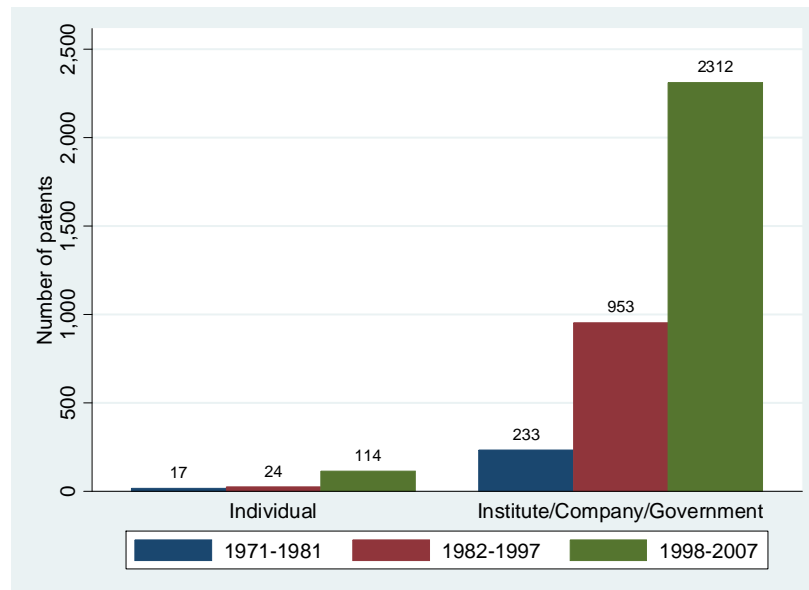
Source and Note: Author's calculation; USPTO database, Hall, et al. (2002)

Figure 10: Assignment Status of Soviet/Russian Inventors' Patents Obtained in the U.S., 1971-1991 and 1992-2007



Source: Author's calculation from USPTO database

Figure 11: Assignment by Type, Soviet and Russian Inventors' Patents Obtained in the U.S., 1971-1981, 1982-1997 and 1998-2007



Source: Author's calculation from USPTO database

Table 1: Correlations, Patents to Soviet and Russian Citizens and All U.S. Patents, 1971-2006

1971-2006	1971-1991	1992-2006
-0.061	-0.452	0.963
(0.724)	(0.040)	(0.000)
<i>36</i>	<i>21</i>	<i>15</i>

Source: U.S. data (1971-2002) are calculated from Hall et al. (2001) database; U.S. data (2003-2006), http://www.uspto.gov/go/taf/us_stat.htm.

Russian data are collected by author from <http://www.uspto.gov>.

Note: Standard deviations appear in parentheses. Number of observations appear in italics.

Utility patents only.

Table 2: Correlations, Patents to Soviet and Russian Citizens and All U.S. Patents, 1971-2002

<i>Russian Patents</i>	<i>All Patents</i>					
	Chemical	Comp&Comm	Drgs&Med	Electrical	Mechanical	Other
Chemical	0.675 (0.000) <i>32</i>	0.828 (0.000) <i>32</i>	0.777 (0.000) <i>32</i>	0.776 (0.000) <i>32</i>	0.648 (0.000) <i>32</i>	0.716 (0.000) <i>32</i>
Comp&Comm	0.675 (0.000) <i>32</i>	0.828 (0.000) <i>32</i>	0.777 (0.000) <i>32</i>	0.776 (0.000) <i>32</i>	0.648 (0.000) <i>32</i>	0.716 (0.000) <i>32</i>
Drgs&Med	0.612 (0.000) <i>32</i>	0.820 (0.000) <i>32</i>	0.803 (0.000) <i>32</i>	0.775 (0.000) <i>32</i>	0.630 (0.000) <i>32</i>	0.722 (0.000) <i>32</i>
Electrical	0.004 (0.983) <i>32</i>	-0.110 (0.549) <i>32</i>	-0.209 (0.250) <i>32</i>	-0.121 (0.510) <i>32</i>	-0.115 (0.530) <i>32</i>	-0.151 (0.408) <i>32</i>
Mechanical	-0.301 (0.095) <i>32</i>	-0.542 (0.001) <i>32</i>	-0.619 (0.000) <i>32</i>	-0.535 (0.002) <i>32</i>	-0.399 (0.024) <i>32</i>	-0.491 (0.004) <i>32</i>
Other	-0.161 (0.379) <i>32</i>	-0.424 (0.016) <i>32</i>	-0.508 (0.003) <i>32</i>	-0.410 (0.020) <i>32</i>	-0.287 (0.111) <i>32</i>	-0.382 (0.031) <i>32</i>

Source: U.S. data are calculated from Hall et al.(2001) updated database.

Russian data are collected by author from <http://www.uspto.gov> .

Note: Standard deviations appear in parentheses. Number of observations appear in italics.

Utility patents only. NBER technological classification from Hall, et al. (2001)

Table 3: Correlations, Patents to Soviet and Russian Citizens and All U.S. Patents, 1971-1991 and 1992-2002

<i>Russian Patents</i>	1971-1991						1992-2002					
	<i>All Patents</i>						<i>All Patents</i>					
	Chemical	Comp&C omm	Drgs&Med	Electrical	Mechanical	Other	Chemical	Comp& Comm	Drgs&Med	Electrical	Mechanical	Other
Chemical	0.058 (0.802) <i>21</i>	-0.454 (0.039) <i>21</i>	-0.326 (0.150) <i>21</i>	-0.497 (0.022) <i>21</i>	-0.372 (0.097) <i>21</i>	-0.336 (0.137) <i>21</i>	0.904 (0.000) <i>11</i>	0.924 (0.000) <i>11</i>	0.941 (0.000) <i>11</i>	0.858 (0.001) <i>11</i>	0.891 (0.000) <i>11</i>	0.919 (0.000) <i>11</i>
Comp&Comm	0.058 (0.802) <i>21</i>	-0.454 (0.039) <i>21</i>	-0.326 (0.150) <i>21</i>	-0.497 (0.022) <i>21</i>	-0.372 (0.097) <i>21</i>	-0.336 (0.137) <i>21</i>	0.904 (0.000) <i>11</i>	0.924 (0.000) <i>11</i>	0.941 (0.000) <i>11</i>	0.858 (0.001) <i>11</i>	0.891 (0.000) <i>11</i>	0.919 (0.000) <i>11</i>
Drgs&Med	-0.006 (0.979) <i>21</i>	0.287 (0.207) <i>21</i>	0.514 (0.017) <i>21</i>	0.085 (0.714) <i>21</i>	-0.134 (0.562) <i>21</i>	0.042 (0.857) <i>21</i>	0.811 (0.003) <i>11</i>	0.904 (0.000) <i>11</i>	0.895 (0.000) <i>11</i>	0.844 (0.001) <i>11</i>	0.875 (0.000) <i>11</i>	0.905 (0.000) <i>11</i>
Electrical	0.206 (0.371) <i>21</i>	-0.701 (0.000) <i>21</i>	-0.638 (0.002) <i>21</i>	-0.577 (0.006) <i>21</i>	-0.214 (0.351) <i>21</i>	-0.322 (0.154) <i>21</i>	0.818 (0.002) <i>11</i>	0.954 (0.000) <i>11</i>	0.924 (0.000) <i>11</i>	0.937 (0.000) <i>11</i>	0.879 (0.000) <i>11</i>	0.884 (0.000) <i>11</i>
Mechanical	0.317 (0.162) <i>21</i>	-0.652 (0.001) <i>21</i>	-0.628 (0.002) <i>21</i>	-0.507 (0.019) <i>21</i>	-0.050 (0.830) <i>21</i>	-0.219 (0.340) <i>21</i>	0.629 (0.038) <i>11</i>	0.763 (0.006) <i>11</i>	0.694 (0.018) <i>11</i>	0.717 (0.013) <i>11</i>	0.691 (0.019) <i>11</i>	0.713 (0.014) <i>11</i>
Other	0.408 (0.066) <i>21</i>	-0.584 (0.005) <i>21</i>	-0.567 (0.007) <i>21</i>	-0.456 (0.038) <i>21</i>	-0.012 (0.959) <i>21</i>	-0.186 (0.420) <i>21</i>	0.663 (0.026) <i>11</i>	0.823 (0.002) <i>11</i>	0.733 (0.010) <i>11</i>	0.876 (0.000) <i>11</i>	0.781 (0.005) <i>11</i>	0.787 (0.004) <i>11</i>

Source: U.S. data are calculated from Hall et al.(2001) updated database.

Russian data are collected by author from <http://www.uspto.gov> .

Note: Standard deviations appear in parentheses. Number of observations appear in italics.

Utility patents only. NBER technological classification from Hall, et al. (2001)

Table 4: Correlations, Patents to Soviet and Russian Citizens and All U.S. Patents
1971-1991 and 1992-2002, By Assignment Status

	1971-1991		1992-2002	
	<i>All patents</i>		<i>All patents</i>	
<i>Russian Patents</i>	Assignee (yes)	Assignee (no)	Assignee (yes)	Assignee (no)
Assignee (yes)	0.161 (0.486) <i>21</i>		0.969 (0.000) <i>11</i>	
Assignee (no)		-0.001 (0.996) <i>21</i>		0.683 (0.021) <i>11</i>

Source: U.S. data are calculated from Hall et al.(2001) updated database.

Russian data are collected by author from <http://www.uspto.gov> .

Note: Standard deviations appear in parentheses. Number of observations appear in italics.

Utility patents only. Assignment is assignment at time of issue of patent to a firm, government entity, or other organization that is not an individual.

Table 5. OLS Regressions

<i>Dependent variable: Log of US patents obtained by USSR/Russian inventors</i>	(1)	(2)	(3)	(4)
Log of USSR/Russian patents	-0.378* (0.228)	-0.454** (0.231)	-0.389* (0.232)	-0.504** (0.249)
Log of USSR/Russian GDP	0.225 (0.463)	-0.041 (0.493)	0.082 (0.529)	0.138 (0.533)
Log of US GDP	-0.739 (2.709)	-0.252 (2.687)	-0.458 (2.784)	-0.688 (2.780)
Time trend	0.004 (0.005)	0.003 (0.005)	-0.001 (0.009)	0.019 (0.016)
Year = 1981				-0.248 (0.309)
Year = 1997				0.047 (0.328)
Year = 1982-1997		-0.152 (0.109)		-0.398* (0.225)
Year = 1998-2006			0.116 (0.200)	-0.479 (0.417)
Constant	-0.058 (0.131)	0.017 (0.140)	-0.010 (0.157)	-0.035 (0.169)
R^2	0.104	0.164	0.115	0.226
N	33	33	33	33

Note: 0.01 - ***; 0.05 - **; 0.1 - *;

All equations are (first) differenced prior to estimation.

USSR=1971-1991, Russia=1992-2006

USSR/Russian patents are obtained by Soviet and Russian citizens in the USSR or Russia.