It is interesting how prominent this process is in mathematics, see Figure 4 right: universities produce a bigger share of publications, they are hiring new faculty or stimulating publication activity of existing faculty more aggressively.

To sum up, we see the following picture based on our numerical study: Russian mathematics has lost its best representatives; nevertheless, it still stands very high at the international level. The decline has come to an end but no significant progress is currently visible. We should stress, though, that metric values give only a very rough picture, oftentimes distorted by various database peculiarities not directly related to the discipline itself. A comparison of particular universities or even particular countries should not be based on such values exclusively.

References

[1] The MCQ is calculated by counting the total number of citations into the journal that have been indexed by Mathematical Reviews over a five-year period, and dividing this total by the total number of papers published by the journal during that five-year period.

[2] George J. Borjas, Kirk B. Doran, THE COLLAPSE OF THE SOVIET UNION AND THE PRODUCTIVITY OF AMERICAN MATHEMATICIANS, The Quarterly Journal of Economics (2012), 1143–1203. doi:10.1093/qje/qjs015

[3] 15 universities initially selected by the RF government for the 5-100 project plus Moscow State University and Saint-Petersburg State University

5-100: Russian academic excellence project, http://5top100.ru/

Math Graduates' Career Prospects in Modern Russia

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"A mathematician will do it better"
Hugo Steinhaus

What can mathematicians do in applied science or other disciplines? First of all, mathematicians teach students of other fields math. Second, they prove theorems. Sooner or later, unexpectedly many of these theorems find some kind of application.

Yet, there is also another obvious answer, which is probably even more important in terms of technological development; it also helps create much more jobs for people with a degree in math. I'm talking about the fact that science and technology in general are becoming more and more mathematized.

We will briefly talk about the mathematization of science in the Soviet and post-Soviet periods and discuss the job prospects mathematicians have in modern Russia.

1. Historical Background

The mathematization of knowledge is one of the major processes going on in culture and science. The level of mathematization of a given discipline is a sign of its academic maturity and applicability.

However, this is a fundamental truth that was forgotten for nearly 1500 years after the end of the Antiquity, when pythagoreanism flourished. In the Middle Ages and during the Renaissance, mathematics was solely viewed as a skill, only required by merchants or engineers. It was taught at professional schools (e.g., "abacus schools" in Italy) but not at universities. Mathematics continued to develop and to slowly penetrate other spheres of knowledge only with the help of some random autodidacts, be it university professors or military engineers.

In the Early Modern Period, the situation changed dramatically. It turned out that math was necessary in order to process the empirical achievements of the Renaissance. One can quote Carl Friedrich Gauss, who said, paraphrasing Newton, "Mathematicians stand on each other's shoulders." When new means of communication became widely accessible to scientists all across Europe, they finally managed to "stand on each other's shoulders" in math. The traditionally low level of mathematical literacy common among professionals was no longer sufficient as it didn't measure up to the challenges of capitalism, gunpowder, and the Age of Discovery.

By the beginning of the XVII century, a new attitude had developed: universities needed pure mathematics, and mathematics graduates could find professional employment in applied spheres. The Age of Reason was starting. Universities were, one after another, opening new chairs of mathematics, the first among them being the Lucasian Chair of Mathematics and the Savilian Chair of Geometry. Some countries joined the process too late, and their universities would later regret their conservatism as they had to give way to schools of applied sciences (e.g., engineering schools in France), which had "sheltered" pure physicists and mathematicians.

Since those times, higher education institutions offer degree programs in mathematics. Some graduates of these programs become pure mathematicians, while others pursue different careers expanding the influence of mathematics on external fields of knowledge that are mature enough for such a connection. The list of such fields is growing constantly and might look surprising now. For example, two centuries ago economics was clearly considered to be part of humanities, and it was hard to find a research article that would contain a complicated equation. Nowadays, however, nearly half of all Nobel Prize winners in economics have a BA in math or physics.

It is not just the mathematization of knowledge that pushes demand for math graduates on the labor market; there are other reasons too. To put the popular theory of job-market signalling (developed by an economics Nobel Prize winner with a background in math) simple, an employer sees a potential employee's diploma as a sign of the latter's motivation, ambition and skill rather than a document that certifies the fact that a job candidate has obtained some specific knowledge. From such a perspective, having a degree in math is a huge advantage on the labor market: "The value of mathematics is the fact that it's hard" (A.D. Aleksandrov). This is why employers often hire mathematicians to do creative, abstract work even if it has nothing to do with math per se.

2. The Role of Math Graduates in the USSR and in Russia

The first thing many readers would think of once they've seen the subtitle is nuclear weapons. Yet, we believe that Soviet mathematicians' contribution to arms industry wasn't unique and shouldn't even be considered as their main service to the country.

The rate of mathematization in physics and other sciences increased drastically in the 1920s. For the following three decades, the USSR was an extremely isolated country. Academics were prohibited from maintaining contacts with their foreign colleagues, and such cutting-edge disciplines as cybernetics and genetics, where math could be applied, were simply banned. It took the Soviet Union another 30 years before it allowed certain branches of economics, actuarial mathematics, quantitative finance, biostatistics and other disciplines that were simply irrelevant for the Soviet economic and political system into the country.

As a result, it was the same sad story in many fields: Russia was lagging behind Western countries, which had had time enough to develop these areas in a way that they were already very abstract or math-rich. It turned out, however, that it's easier for mathematicians with zero knowledge of the subject to overcome such a methodological gap than it actually is for specialists in the field who have no mathematical background.

The history of economics in post-1991 Russia provides a perfect example. Many of the economists and financial experts trained in the Soviet union were inadequately prepared for the new economic system. Leonid Kantorovich, a Soviet Noble Prize winner and a prominent theoretical mathematician, was one of the pioneers who applied mathematical methods in economics. Yet, by 1991 there were few specialists in the USSR who could teach and develop modern economics according to international standards. At the time, most of them were fellows at the Central Economic Mathematical Institute of the Russian Academy of Sciences, and most of them had a background in mathematics; some of them are world-famous mathematicians (e.g., Fyodor Zak, Dmitry Piontkovsky).

CEMI director Valery Makarov (who also happens to be one of L. Kantorovich's most prominent disciples) succeeded in using his employees' knowledge and international networks in order to create the New Economic School — the country's first world-class master's program in economics. In the first years of the program, most of the students were graduates with diplomas in exact science; they would later become the first Russians to pursue post-graduate degrees in economics at the world's best PhD programs. Many of them came back and took leading positions both in Russian higher education (in particular, in the New Economic School and Higher School of Economics) and in Russian economy & finance.

The branches of economics and finance that were not covered by the New Economic School were largely revived by people with a background in exact sciences too. Before the Revolution of 1917, for example, Russia used to be one of the world's leaders in actuarial science; the World Actuarial Congress was scheduled to take place in St. Petersburg in 1915 (but never did due to the outbreak of World War I). After the revolution, this discipline was rendered irrelevant, so most of its aspects (except life insurance, for example) had to be "reinvented" in 1991. This was a long process that culminated in 2008 when the Russian Guild of Actuaries became accredited as a full member of the International Actuarial Association. Most of the 150 best Russian actuaries, who have achieved Fully Qualified Actuary status, graduated in physics or math rather than economics or finance.

The situation in programming and computer science in the Soviet Union was relatively better: in 1948, the ban on everything that had to do with cybernetics was finally lifted for the purposes of developing the arms industry. Physicists and mathematicians were actively involved in creating new institutes and university departments dedicated to computer science. One can name Yuri Neimark, who created the first ever Department of Computational Mathematics and Cybernetics in the country (in Gorky State University, nowadays known as Nizhny Novgorod State University), and Mark Ayzerman, the pioneer of intellectual data analysis at the Institute of Control Sciences of the Russian Academy of Sciences. Both of them were among the disciples of physicist Alexander Andronov. The Institute of Control Sciences gave the world such people as Vladimir Vapnik, Alexey Chervonenkis, and Ilya Muchnik. In 2007, the latter became research supervisor of the

School of Data Analysis. Its role in the development of computer science and programming in Russia is similar to that of the role of the New Economic School played in terms of economics and finance.

Credit for the fact that the country is no more lagging behind the West in many sciences, like it did in the times of the Iron Curtain, should be given to Russian physicists and mathematicians.

3. Prospects

Nowadays there are at least three other areas where demand for mathematicians is high.

First of all, Russia needs to develop new innovational disciplines that emerged earlier in the West. As mentioned before, it has managed to overcome the gap in the sphere of economics and computer science but there's a whole range of areas (e.g., in natural sciences and engineering) where the process hasn't even started yet due to lack of resource base. In some fields it is already being accumulated but it is also necessary to form an initial pool of specialists who would first get an appropriate education themselves and then start training future generations. Experience shows that in the end, such stories help create new labor market opportunities for physicists and mathematicians.

Secondly, new disciplines are emerging all the time. Their scope and professional & educational requirements often are still vague even in the most progressive countries. Such areas include mathematical methods for drug design or quantum computers and communications. This is where new international labor markets for physicists and mathematicians are developing too. If Russia timely invests sufficient funds in the development of such areas, it will likely become one of the world's innovations leaders.

Thirdly, Russia is finally able to offer internationally competitive employment opportunities to academic mathematicians. Holders of foreign PhD-diplomas in math are now coming back to Russia to take up new jobs. The introduction of postdoc-equivalent positions at some of the Russian universities and research centers gives talented young mathematicians a chance to build a successful academic career within the country.

Math in Moscow: Conveying Traditions of Russian Mathematical School

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Math in Moscow (MiM) is the name of a short-term (1-2 semesters) study abroad program offered in English jointly by the Independent University of Moscow (IUM), National Research University Higher School of Economics (HSE), and Moscow Center for Continuous Mathematical Education (MCCME). It was first launched in spring 2001 by IUM. Along with courses in mathematics and computer science, students can study Russian language, Russian literature, history of mathematics and science, and history of Russia. All MiM courses are credited to the students at their home institutions.

The main goals of the program are to:

- intensify the interaction between Western and Russian (not only mathematical) cultures;
- make Russian traditions of teaching mathematics available to international students;
- provide an international learning environment to IUM students;
- provide an international teaching experience to IUM instructors;
- broaden foreign students' understanding of contemporary Russia.

The biggest difficulty encountered by MiM in pursuing these goals is not program-specific; it rather applies to all internationalization efforts in Russia. Potential students have certain stereotypes about life in Moscow and Russian people that are hard to break. Thus, MiM's efforts to overcome these stereotypes may have cultural significance, not bounded to mathematics only.

The MiM program aims at combining the best traditions of Russian and Western systems in teaching mathematics. We have adopted the North American custom of giving significant homework assignments. Grading follows Western