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Labor Markets in Transition: Science and Migration after the Collapse of the Soviet Union: Dissertation Summary

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In this dissertation, I draw upon the collapse of the Soviet Union to shed light on the behavior of workers and the human capital they embody. The questions I address in each of the three essays have general economic importance and public policy implications: What is the impact of grants on occupational choice and productivity? What is the relationship between location and productivity? How do incentives in the wage structure impact migration decisions? The changes that accompanied the end of the USSR, the increased availability of microlevel data in recent years in the form of publication and census data, and quasi-experimental methods allow me to provide new causal evidence on these topics.

The first two essays concern the behavior of scientists, members of the labor force with high levels of human capital and who play an important role in knowledge production and economic growth. In the first essay, I ask how research grants impact scientific output and scientists' decisions in a setting with a large scientific labor force but limited funding opportunities. Using information from the earliest large-scale grant program for Soviet scientists, I employ a regression discontinuity design to obtain causal estimates of the impact of grants. I construct a unique panel data set of scientists and their publications and show that the grants more than doubled researcher publications and induced scientists to remain in the science sector.

In the second essay, I study the unprecedented exodus westward of scientists after the end of the USSR and examine both the selection of emigrants and the impact of emigration on their subsequent productivity. Using a unique panel data set of Russian scientists and a difference-in-differences approach, I show that scientists who emigrated after the end of the USSR were more productive after they left Russia compared to scientists who did not emigrate. Exploiting the increase in international collaboration among scientists who did not emigrate, I also show that international collaboration is associated with an increase in researcher productivity, but less than for emigration.

In the third essay, I analyze immigrant selection before and after the USSR within a Roy Model framework. With microlevel data from Russia, Ukraine, and Bulgaria, along with data for immigrants in the United States, Spain, and Greece, I compare immigrants' predicted wages in the source country with the predicted wages of their native counterparts. I also reweight the source country wage distributions by the characteristics of immigrants in host countries. These approaches allow me to see what part of the source country distribution immigrants would fall in had they not emigrated. I find evidence of positive selection for the United States, and negative selection for Greece and Spain after the fall of the Soviet Union. During communism, selection among Soviet men in the United States was intermediate and selection among women was positive.

While a shock on the scale of the Soviet collapse is unlikely to recur, the evidence I provide about the behavior of workers from the Soviet experience can help inform policymakers in the areas of labor, science, and immigration policy. As in most crisis situations, the end of the Soviet Union was unexpected. Recent experiences regarding the magnitude and unexpectedness of the financial crisis and natural disasters show the fragility of government resources and institutions. The evidence in this dissertation suggests that after sharp economic changes, workers make important occupation and location decisions. Targeted policies can impact the size and productivity of the labor force during these times of transition, which can have lasting impacts on innovation, economic growth, and well-being.

Chapter 1

Saving Soviet Science: The Impact of Grants When Government R&D Funding Disappears

Governments fund science in order to support the production of basic scientific knowledge, a key input for innovation, and ultimately, economic growth (Brooks 1994; Romer 1990). How can policymakers most effectively support scientists in the advancement of scientific knowledge? The answer to this question is still not well understood, especially considering the extent of government resources devoted to this pursuit. Existing research has almost exclusively focused on developed country settings, where levels of government R&D funding are high and financing opportunities abound. Therefore, estimates of the impact of any specific R&D funding program are typically underwhelming due to the wide availability of alternate funding opportunities (e.g., Jacob and Lefgren 2007) or a potentially inelastic supply of scientists (Goolsbee 1998).

In this essay, I estimate the impact of one type of R&D funding—research grants for basic scientists—on scientific output and scientists' decisions in a setting with very limited public sector funding for science. Drawing upon the earliest large-scale "emergency" grant program for Soviet scientists, funded by financier George Soros under the auspices of the International Science Foundation (ISF), I estimate the impact of grants when there is a large scientific labor force but limited funding opportunities for scientists. This "experiment," the dramatic drop in government R&D funding, and the ISF grant program provide an opportunity to estimate the marginal impact of funding for science when there are few

funding opportunities and the supply of scientists is presumably very elastic.

The ISF grant program had two components: an individual and a team-based grant. The first component was an individual cash grant of $500, which represented approximately one year's salary at the time, and was awarded to over 26,000 basic scientists actively publishing in top Soviet/Russian and international journals. The second component was aimed at supporting the research team of the top scientists. An additional $1,000 was given to the "best" scientists among all those who received the individual cash grant, which they were to divide among members of their research team.

There are still few studies providing evidence on the causal impact of grants on scientific output due to the associated empirical challenges. Because grant receipt is likely to be correlated with ability or other unobserved factors, simple estimates of the impact of grant receipt would tend to be biased upward due to selection issues (see Jaffe [2002] for a discussion). Grants are rarely randomly assigned, and instead are usually awarded after extensive review processes, the deliberations of which are often confidential. Apart from Jacob and Lefgren (2007), who exploit discontinuities in National Institute of Health priority scores and grant receipt, few studies have been able to examine grant programs that provide conditions in which to avoid selection problems.

In this case, I was able to employ quasi-experimental methods to obtain causal estimates of the impact of the grants. The ISF grants were called "emergency" grants because Soros desired that the funds be dispersed to scientists as quickly as possible considering the dire situation. Therefore, simple eligibility criteria had to be used: to receive the grant, an individual had to have at least three publications between 1988 and the time of the grant program announcement in 1993. Moreover, the recipients of the team grant would be the scientists who had the highest impact factor scores among all those who applied, based on each scientist's top three publications, so no additional application process was used.

The suddenness of the program and the simple, nonlinear structure of the eligibility rules allow me to avoid typical selection issues and utilize exogenous variation in grant receipt. I estimate the causal impact of the grants by comparing scientists who just missed the eligibility cutoffs with those who just made them using regression discontinuity and difference-in-differences approaches. The reasoning is that scientists who just missed the cutoffs are a good counterfactual group for those who just made the cutoff—they are likely to be very similar in observable and unobservable ways, and only differ in their receipt of the grant.

Theoretical work in this area suggests that differing incentive schemes can play a role in the production of scientific knowledge, and thus the structure of grants and the incentives they provide likely matter for scientists' outcomes (e.g., Manso 2009). The two types of grants in this case provide an opportunity to estimate the impact of funding when it is awarded to an individual scientist, and in line with the recent evidence on the increasing importance of collaboration and teams in scientific research, when it is awarded to a scientist's research team (e.g., Azoulay, Zivin, and Wang 2010; Wuchty, Jones, and Uzzi 2007).[1]

Scientific grants can have an impact on both the extensive margin (size of the science sector) and the intensive margin (output of researchers in the science sector). Both margins are likely to be salient in the post-Soviet setting. A key concern during this time was that scientists would exit the science sector because salaries had dropped too low and there were alternative career options in the private sector. Another concern was "brain drain"—that scientists would emigrate to western countries, or might be recruited by rogue nations or terrorist organizations for their knowledge related to weapons. Thus, in addition to the intensive margin, I examine the impact of grants on the extensive margin and on emigration rates.

The expected impact of the grants on these outcomes is not clear-cut from a theoretical standpoint. First, it is not clear how a one-time pecuniary shock would affect participation in the science sector or productivity, especially considering that challenges in enforcement may have essentially made the individual grant "no strings-attached." Second, the expected impact on migration rates is ambiguous. The individual grant may have decreased migration costs by reducing credit constraints, thereby increasing migration probabilities; or it may have provided temporary means of subsistence to scientists that deterred migration in the short run. I provide a conceptual framework in which to think about the possible impacts the grants may have had on outcomes based on models of occupational choice and the migration decision. I also consider the role of incentives embedded in the structure of the two types of grants: the team grant, which would be expected to facilitate research but not migration; and the individual grant, which could do either.

To test these hypotheses, I create a panel data set of grantees and nongrantees and match them to their publications and locations using the Thomson Reuters ISI Web of Science database.[2] My analysis provides evidence that both grants had a positive impact on researcher publications. The individual cash grant prevented scientists from exiting science, particularly in the poorer, non-Moscow areas, and doubled researcher publications on the margin. With higher wages, more outside career options, and alternative funding options in Moscow, this suggests that the individual grant had more "bite" outside of Moscow, which is consistent with theoretical predictions. The individual grant appears to have prevented emigration among scientists, but only in Moscow, where the costs of migration were lower. The increase in publications attributed to the individual grant suggests that Soros and the ISF spent about $100 per publication. The

team grant also increased the team leader's publications on the margin, suggesting that there are complementaries in the team production of research. The team grant, meanwhile, seems to have facilitated migration, likely by sustaining researcher productivity in the short run that kept the door open for subsequent emigration possibilities.

Chapter 2

Location and Scientific Productivity: Evidence from the Soviet "Brain Drain"

Policymakers in both the developed and developing world are concerned about the location decisions of the world's scientists and engineers and how these decisions impact their productivity. While many scientists and engineers today are born or trained in the developing world, few stay there. In fact, many of the top, "highly cited" scientists in the world were born in developing countries, but very few remain there to do their research (Hunter, Oswald, and Charlton 2009; Weinberg 2010). Given the important role of scientists in knowledge production and economic growth (Romer 1990), countries that produce scientists but have their "brains drained" are concerned about stemming this outflow, while countries like the United States are benefitting from this increasing "globalization" of science.[3]

While simple comparisons of the research output of scientists in the developing and developed world suggest large disadvantages to being located in a low-income country (see Kahn and MacGarvie [2008]), the factors driving these differentials are not obvious. It is likely that there are observed or unobserved differences between the individuals who choose to emigrate and those who do not in terms of their preferences or their ability, which may be correlated with research productivity. Therefore, without accounting for these differences, estimates of the impact of being located in a developed country would be biased upward. Recent research on the mobility of scientists between countries has focused on understanding which scientists emigrate, i.e., the measurable selection of scientists, and has made steps toward understanding the causal impact of emigrating on the productivity of the individual and their peers. This evidence suggests that scientists doing research in developing countries appear to be at a disadvantage when compared to otherwise similar scientists located in developed countries (Kahn and MacGarvie 2008).

The productivity differentials between the developed and developing world may be driven by a number of factors, which can be considered inputs in the researcher production function, such as differences in research funding and infrastructure, or knowledge inputs that depend on the peer group. That is, in addition to more tangible differences, there may be barriers to knowledge transfer in developing countries due to the geographic distance from other scientists in the field (peers), which implies fewer knowledge spillovers (Jaffe, Trajtenberg, and Henderson 1993), or from other nonphysical barriers to accessing knowledge (Agrawal, Kapur, and McHale 2008). Other factors tied to a location, such as the location of journal editorial boards or the culture surrounding publication, can also matter for productivity.

To address concerns about endogeneity, previous studies have attempted to use individual fixed effects models that account for unobserved factors that may be correlated with research productivity, or instrumental variables approaches that provide exogenous variation in the location decisions of scientists. However, the data requirements of these approaches are significant. Because of the difficulty in tracking the location of scientists, much of the existing research on the mobility and selection of scientists has used samples of several hundred scientists who have moved between countries, or are comprised of individuals in one field of science. The empirical challenge is that it is typically difficult to observe scientists' outcomes before and after they make the decision to emigrate, and to find comparable control scientists who did not emigrate.

In this essay, I draw upon the unprecedented exodus westward of highly skilled scientists after the end of the USSR to examine both the selection of emigrants and to estimate the impact of emigration on their subsequent productivity. The USSR was a country that had a large scientific community but was relatively "closed" to contact with researchers outside of the Eastern bloc. When the Soviet Union collapsed, there were almost suddenly opportunities to meet western scientists, to travel, and to emigrate. Many scientists chose to move abroad to the United States, Israel, or Europe to continue their careers, and opportunities for collaboration between former Soviet and western scientists increased greatly. Anecdotes about the large "brain drain" abound, or the darker allusions to the recruitment of scientists by rogue nations for weapon building.

For my analysis, I create a large unique panel data set of over 15,000 Russian scientists across many fields of science who were publishing in the top Soviet journals just before the end of the USSR. I match them to their publications and affiliations using the Thomson Reuters ISI Web of Science before and after the fall of the USSR. The panel nature of the data allows me to observe the productivity of the top scientists both during Soviet times and after the Soviet collapse, when there was increased mobility. In terms of selection, I show that on a number of observable characteristics, emigrants look very different from those who stay at home. The emigrants tend to be selected from the upper part of the productivity distribution, and tend to be younger.

Using a difference-in-differences strategy, I then show that scientists who emigrated were more productive after they left Russia compared to scientists who did not emigrate. However, I find heterogeneity in this effect. All else equal, the most productive scientists during the 10 years before

the end of the USSR who later emigrated were no more productive after leaving Russia. I also find that the effect of emigrating is lower if a scientist was from Moscow. For robustness, I also use matching methods to compare individuals who emigrated to those who look similar on their observable characteristics but did not emigrate, as well as an instrumental variables approach using distance to Moscow as an instrument for the decision to emigrate.

The end of the USSR and the "opening" of its borders not only gave scientists greater freedom of mobility, but also allowed them greater opportunity to interact with foreign scientists. This increase in access to scientific communities abroad after the end of the USSR reflects an aspect of the globalization of science that continues to be salient. The relatively recent advances in communication through the Internet and greater ease of travel are allowing scientists better access to knowledge and increased communication/collaboration with scientists abroad from distant locations. This "openness" should improve knowledge transfer by increasing nongeographic proximity to knowledge and thus reducing the productivity differentials between scientists in the developed and developing world. However, theory and evidence suggest that face-to-face interactions continue to be important (see, e.g., Gaspar and Glaeser [1998] for a discussion).

In addition to examining the selection of emigrants and the productivity differential attributed to emigrating, I also exploit the increase in international collaboration among scientists who did not emigrate after the end of the USSR. This allows me to ask how important these phenomena are for the productivity of scientists: international collaboration, which increases access to knowledge and resources through nongeographic proximity, and emigration, which increases geographic proximity. In the spirit of recent research on the potential substitutes for geographic proximity (Agrawal, Kapur, and McHale 2008), I ask whether we can view international collaboration as a substitute for emigration and whether from a policy perspective, it is one way to prevent "brain drain" from developing countries. My results show that both emigrants and those who internationally collaborated are positively selected in terms of publications, but emigrants were the "best of the best." Then, with a difference-in-differences estimation approach using individual fixed effects, I show that while both emigration and international collaboration are associated with an increase in researcher productivity, by emigrating, scientists gain an additional 0.23 publications per year on average compared to those who stay but internationally collaborate. This difference can be considered a measure of the impact of location on scientific productivity minus the benefits of gaining access to knowledge and resources through nongeographic proximity.

Chapter 3

Immigrant Selection Before and After Communism

The fall of the Soviet Union brought about many changes in the formerly communist countries. Almost suddenly, the regime changes led to greater mobility and choice in employment and residence decisions as emigration restrictions were lifted, and levels of internal and international migration dramatically increased. Another dramatic change that characterized the transition to market economies was an increase in wage inequality, which resulted from changes in the structure of wages as the labor markets moved away from communist wage grid systems, and from changes in the composition of the labor force (see, e.g., Brainerd [2000]; Hunt [2002]). In this essay, I study how these changes altered incentives to emigrate and the subsequent impact on immigrant selection.

As the European Union (EU) enlarged in recent years, there was considerable interest and concern about the consequences of immigration from its neighbors to the East—the formerly communist countries of Central and Eastern Europe, South Eastern Europe, and the former Soviet Union. For the EU host countries, the concern was mainly about what kinds of workers would immigrate and what increased immigration would mean for native labor markets. Meanwhile, the concern in the source countries was about what kinds of workers would emigrate and what impact an exodus of workers westward would have on home labor markets and national demographics.

Much of the literature on these issues to date deals with the former aspect of immigration in the EU, that is, the impact on natives (e.g., Angrist and Kugler [2003], who look at the impact of European labor market institutions on the relationship between immigration on native employment; and Friedberg [2001], who looks at the impact of Soviet immigration on native outcomes in Israel). Yet, there is still little empirical evidence on immigrant selection and the impacts of emigration from Central and Eastern Europe, South Eastern Europe, and the former Soviet Union on source country labor markets. Recent research in the U.S.-Mexico immigration literature is grounded in the Borjas (1987) negative selection hypothesis based on the Roy Model framework, which suggests that it is the low-skilled workers from more unequal countries with higher returns to human capital who choose to emigrate to the United States. Since much of the concern in EU countries is that precisely the low-wage workers will flood the EU gates, where wages are higher and less dispersed, my motivation for this essay was to test the immigrant selection hypotheses for immigrants from a selection of postcommunist countries and to see how emigration decisions changed after the end of communism.[4]

The fall of the Soviet Union provides a unique opportunity to test the selection hypotheses among relatively highly educated source country populations, as it dramatically, almost suddenly, changed the wage structure and dispersion of earnings in the formerly communist countries. Following the approaches in the recent immigrant selection literature (Chiquiar and Hanson 2005; Moraga 2011), in this essay I test the immigrant selection hypotheses using microlevel data from three host countries (United States, Spain, and Greece) and three postcommunist source countries (Russia, Ukraine, and Bulgaria). I also use retrospective data from Ukraine from 1986 and the United States in 1990 to see whether the nature of selection has changed since the communist period. The choice of host countries and time periods is based on differing levels of wage dispersion—the United States has greater wage inequality than Europe, and the USSR had less wage inequality than the postcommunist countries today. This should differentially impact immigrant selection and immigration decisions during these periods and to these countries.

To test the hypotheses, I first estimate Mincerian-style wage regressions and compare the returns to observable characteristics among residents in source countries and immigrants in host countries. Based on these results, I make predictions concerning the nature of selection. I then compare immigrants' predicted wages in the source country with the wages of their native counterparts for both the communist and postcommunist periods. Next, I use the DiNardo, Fortin, and Lemieux (1996) reweighting method to create counterfactual densities of the wages that immigrants would obtain if they were paid according to the prices of skills in the source countries. The difference between the actual and counterfactual densities is immigrant selection in terms of potential earnings. Despite limitations of small immigrant sample sizes, the results suggests that there is positive selection for immigrants from all three countries in the United States, while there is intermediate to negative selection for Spain and Greece. However, since these results are likely to be biased upward due to undercounting of immigrants and the sorting of immigrants on unobserved ability, it is likely that there is even greater negative selection for Spain and Greece. For the communist period, I find that among Soviet-born men in the United States, there was intermediate selection, while among women, there was positive selection.

Notes

1. However, I cannot compare the relative importance of the two grants, because as described in the empirical section of the essay, the estimates are local treatment effects based on different samples of scientists who are on the margin of receiving each grant.
2. Web of Science ® prepared by THOMSON REUTERS ®, Inc. (Thomson ®), Philadelphia, Pennsylvania, USA: © Copyright THOMSON REUTERS ® 2010. All rights reserved.
3. There is evidence, however, that countries can gain from return migration or from greater access to knowledge from abroad (Agrawal et al. 2011).
4. For example, the United Kingdom initially announced it would prevent all but "a few highly skilled or agricultural workers from taking jobs in Britain" from the new accession countries; Spain imposed a two-year restriction on Romanians and Bulgarians looking to work in the country when the two countries acceded in January 2007 ("Join the queue, says Spain" 2006).

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