# International Mobility of Inventors and Innovation: Empirical Evidence from the Collapse of the Soviet Union

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**Abstract**

This paper assesses the extent to which the international migration of inventors affects innovation in the receiving country. Drawing on a novel database that maps the migratory patterns of inventors, we exploit the end of the Soviet Union and the consequent post-1992 influx of ex-Soviet inventors to the United States. Econometric analysis on a panel of U.S. cities and technological fields shows that the patenting activity of U.S. inventors increased significantly after the arrival of ex-Soviet Union inventors.

**JEL codes**: O31, O34, O51, J61

**Keywords**: geographic mobility, innovation, inventors, patents

# 1 Introduction

The international migration of skilled workers can cause profound economic and societal changes. These individuals often bring new ideas and complementary skills and augment workforce diversity, thereby enhancing innovation in the host country. However, initiatives aimed at attracting high-skilled workers elicit mixed responses. While proponents commend such measures as alleviating pressure on the labor market, opponents contend that skilled immigration poses a threat to native workers (Lee, 2015).

A handful of recent studies have endeavored to quantify the effect of high-skilled worker mobility on knowledge diffusion, utilizing supply shocks induced by historical events as a methodological approach. However, these investigations have yielded divergent conclusions (Moser et al., 2014; Borjas and Doran, 2012; Bahar et al., 2020; Yoon and Doran, 2020; Miguelez and Noumedem Temgoua, 2020)

Against this backdrop, the present paper seeks to bring novel evidence to this nascent literature. We empirically evaluate the extent to which foreign-born skilled workers' international mobility boosts the host country's innovative activity through knowledge spillovers. Following Borjas and Doran (2012) and Ganguli (2015), we draw on the massive influx of immigrant inventors into the United States in the aftermath of the Soviet Union's collapse.

Prior to this geopolitical shift, opportunities for Soviet researchers and scientists to engage with the 'Western world' were markedly constrained. As a consequence, scientists and engineers from the Soviet Union specialized in technological domains that diverged significantly from those pursued by U.S. inventors.

We exploit this historical shock, examining two pertinent dimensions through which the knowledge introduced by immigrant inventors might disseminate to incumbents: geographic location and the conceptual space of ideas. Estimation results indicate a substantial and positive impact of immigrant inventors on the level of innovation in the United States.

# 2 Data

We assemble an annual panel at the city/technological field level, identifying the number of inventors from the former Soviet Union arriving in the United States immediately subsequent to the USSR's collapse in late 1991. Concurrently, we calculate the corresponding number of patents granted to U.S. inventors by the United States Patent and Trademark Office (USPTO).

Information regarding the migration of Soviet Union inventors to the United States comes from the WIPO IPSTAT database. This database exploits information on inventors' nationality and country of residence gleaned from patent applications submitted under the Patent Cooperation Treaty (PCT). Such data enable the mapping of the migratory patterns of inventors (see Miguelez and Fink, 2013; Pellegrino et al., 2023).

We count the number of PCT applications filed in the United States (and subsequently granted) during the period 1992–2000, each featuring at least one inventor possessing the nationality of one of the 15 former Soviet Socialist Republics. Specifically, we retrieve information on the U.S. location (at the 5-digit ZIP code) where the foreign inventor was residing at the time the application was filed, as well as data pertaining to the 4-digit IPC codess assigned to the application.

Additionally, we extract from the USPTO database all patents granted within the United States from 1983 to 2000, each featuring at least one U.S. inventor. Analogous to the previous instance, we obtain information concerning the inventor's residence and the IPC codes assigned to each application.

# 3 Empirical strategy and results

## 3.1 Regression framework

We exploit variations across cities, technological fields, and time in the number of immigrant inventors arriving in the United States from the former Soviet Union. Following common practice in the field, we opt for the Metropolitan Statistical Area (MSA) as the administrative division for our analysis.

We estimate the following regression model:

$$y_{c,j,t} = \delta_c + \delta_j + \delta_t + (\delta_j \times \delta_t) + \beta_1 \text{Number of USSR patents}_{c,j} \times \text{Post}_t + \beta_2 \text{X}_{c,j,t} + \epsilon_{i,t}, \qquad (1)$$

where the dependent variable $y_{c,j,t}$ identifies the number of patents granted to U.S. inventors in city (MSA) $c$, technological field $j$, and year $t$.[1]

Concerning the covariates, $\delta_c$ represents a vector of MSA fixed effects, accounting for unobservable, time-invariant geographical specificities that might induce variation in patenting across cities. The term $\delta_j$ controls for technological specificities, while $\delta_t$ represents a vector of year fixed effects. Furthermore, we incorporate the interaction term $\delta_j \times \delta_t$ to control for technological shifts over time. This comprehensive set of fixed effects enables us to account for unobserved factors unrelated to the influx of ex-Soviet Union inventors that might correlate with the patenting activity of incumbent inventors.

The variable Number of USSR patents$_{c,j}$ quantifies the number of PCT patents with at least one inventor from the former Soviet Union residing in MSA $c$ and patenting within technological field $j$. Meanwhile, the indicator Post$_t$ takes the value 1 for 1992 and onwards, and 0 otherwise. The vector X$_{c,j,t}$ incorporates two additional controls: one measuring the number of patents by foreign-born inventors not affiliated with the ex-USSR, and another capturing the rate of invention progression throughout a technology's lifecycle.

The identification strategy exploits variations in the exposure of U.S. cities and technological fields to ex-Soviet Union inventors. We identify a group of 'treated' and 'control' cities/technological classes, contingent upon whether the variable Number of USSR patents$_{c,j}$ is greater than zero.

Expectedly, the control group comprising non-exposed cells outnumbers the treatment group. We matched control and treatment groups by applying Coarsened Exact Matching (CEM) to increase homogeneity between the two groups. We carried out CEM on two relevant characteristics prior to 1991: the MSA population in 1990 and the distribution of IPCs within an MSA. The final sample totals 38,933 control and 4,862 treated groups.

Figure 1 depicts the progression of U.S. patent numbers, differentiating between treated and non-treated samples. The trend suggests a noticeable augmentation in U.S. patents post-1992 in

[1] This variable excludes U.S. patents with at least one former Soviet Union inventor.

cities and technological fields classified as treated.

Nevertheless, an additional endogeneity concern persists, stemming from the non-random nature of immigrants' choice of destination. If unobserved factors influence both the selection of destination by immigrants and the level of innovation at the city level, the coefficient $\beta_1$ will be biased.

We address this concern by employing a supply-push instrument *à la* Card (2001). We instrument the variable of interest, Number of USSR patents$_{c,j}$, with the number of all USSR-born immigrants prior to 1990. This instrument exploits the fact that existing and historical immigrant communities play a significant role in determining the location preferences of new immigrants, but do not influence the level and quality of innovation at the city/technological field level (see also Ganguli, 2015).

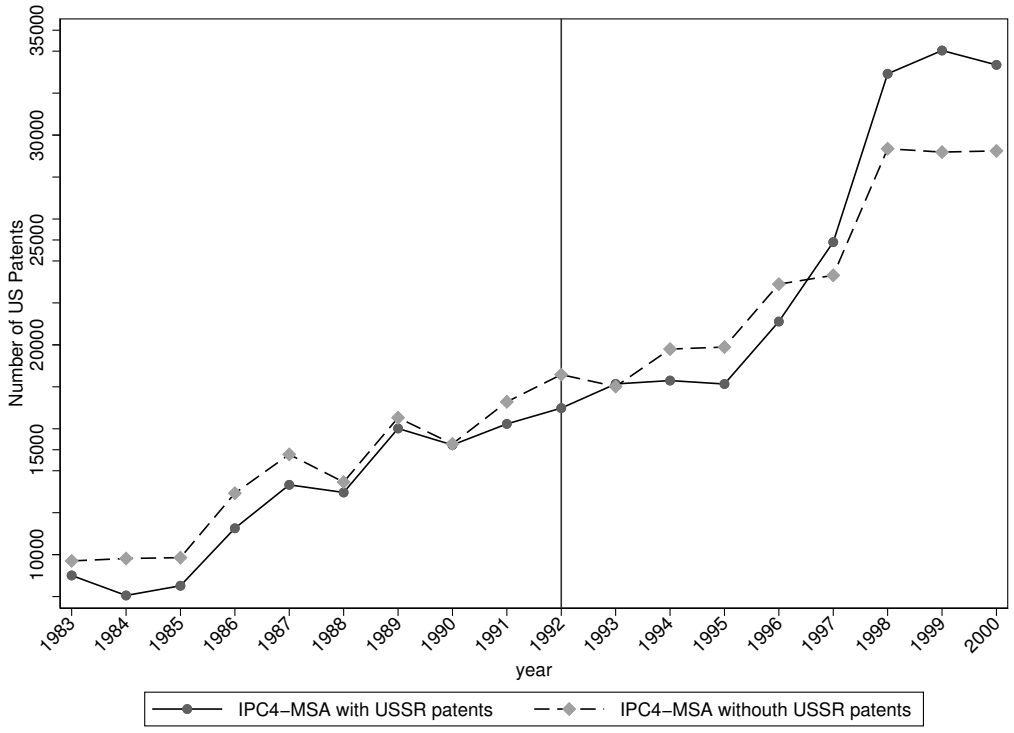


Figure 1: Yearly number of U.S. patents by domestic inventors for treatment and control groups

To construct the instrument, we extract data from the 1990 Public Use Microdata Sample-PUMS (State 5% sample), focusing on individuals aged 15–65 years who reported being born in the former Soviet Union and were residing in a specific MSA in 1990.[2] We then construct a weighted measure of the inflow of USSR inventors across U.S. cities, using the pre-shock distribution of Soviet-born immigrants as follows:

$$\frac{\text{Tot.USSR Migrants}_{c1990}}{\text{Tot.USSR Migrants}_{1990}} * \text{Migrant Inventors}_{jt},$$

where the ratio represents the proportion of all Soviet-born immigrants recorded in the 1990 census in city $c$, and Migrant Inventors$_{jt}$ is the aggregate number of ex-Soviet Union inventors holding a

[2]Participants are instructed to provide information regarding their place of residence five years prior.

patent in field $j$ in year $t$.

### 3.2 Econometric results

Columns (1–4) of Table 1 present the estimates derived from the first-stage regression. These estimates affirm the relevance of the selected instrument, elucidating that the historical enclaves of USSR immigrants significantly correlate with the locational choices of inventors from the former Soviet Union. The coefficients observed in the reduced form, represented in columns (5–8), are positive and exhibit high statistical significance. The full model displayed in column (8) incorporates a quadratic age sub-class, the number of foreign non-USSR patents, and year × class fixed effects. The point estimate implies that an additional granted patent from an ex-Soviet Union inventor in city $c$, field $j$, and year $t$ yields around 38 additional domestic patents annually.

Table 1: First Stage and Reduced Form

| | First Stage | | | | Reduced form | | | |
|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| USSR migrants 1990 | 1.089*** | 1.085*** | 0.722*** | 0.722*** | | | | |
| | (0.165) | (0.164) | (0.187) | (0.187) | | | | |
| *Number of USSR patents × Post* | | | | | 47.105*** | 46.554*** | 38.183*** | 38.219*** |
| | | | | | (7.178) | (7.120) | (12.331) | (12.317) |
| Quadratic age sub-class | No | No | No | Yes | No | No | No | Yes |
| Number of foreign patents | No | No | Yes | Yes | No | No | Yes | Yes |
| Year × Class fixed effects | No | Yes | Yes | Yes | No | Yes | Yes | Yes |
| Year fixed effects | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Class fixed effect | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| MSA fixed effect | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Number of observations | 43,795 | 43,795 | 43,795 | 43,795 | 43,795 | 43,795 | 43,795 | 43,795 |
| Number of clusters | 6,302 | 6,302 | 6,302 | 6,302 | 6,302 | 6,302 | 6,302 | 6,302 |
| $R^2$ | 0.30 | 0.30 | 0.39 | 0.39 | 0.04 | 0.04 | 0.13 | 0.13 |
| F-Statistics | 43.78 | 43.87 | 14.97 | 14.98 | | | | |

*Notes:* The dependent variable in the reduced-form regressions (columns 5–8) is the number of U.S. patents awarded to U.S. inventors per MSA, IPC sub-class, and year, excluding patents attributed to ex-Soviet Union inventors. The dummy variable *Post* takes 1 for years post-1991 and 0 otherwise. Standard errors are clustered at the level of MSA and IPC code.
***, **, and * signify significance at the 1%, 5%, and 10% level, respectively.

We check the robustness of our results to the exclusion of some of the most prominent historical enclaves of Soviet-born immigrants. Specifically, we recompute all models by excluding New York MSAs. Furthermore, we perform a series of robustness checks by formulating various dependent variables based on weighted measures of patent applications. These additional results do not alter the quantitative or qualitative nature of our findings.

## 4 Conclusions

This study has evaluated the degree to which foreign-born inventors augment innovation in the host country through the dissemination of new ideas and knowledge. Leveraging the natural experiment presented by the collapse of the Soviet Union, we provide new empirical evidence regarding the influence exerted by foreign-born inventors in enhancing U.S. innovation.

Instrumental variable estimates on a panel of U.S. patents at the city, technological class, and year level suggest a positive and significant impact of ex-Soviet Union immigrant inventors on the patenting activity of native inventors.

These findings bear significant policy implications. They indicate that the immigration of highly skilled workers, especially inventors, proves advantageous for the host country's economy, attributable to the positive spillover effects on native inventors.

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