Research Proposal: Immigration and Global Innovation

Rui Xu
Stanford University

January 2, 2014

1 Introduction

International immigration, especially high-skilled immigration, has been increasing rapidly in the past two decades. As documented by Kerr and Lincoln (2010), immigrants represent a quarter of the US science and engineering (SE) workforce and nearly half of the SE workforce with doctorates. There is no doubt that high skilled immigrants play an important role in the innovation process of the US economy, yet the net effect of those immigrants on productivity and wages of domestic workers is still under debate. Many empirical studies, such as Peri and Sparber (2010) and Peri, Shih and Sparber (2013), found significant positive contributions of STEM immigrants to total productivity growth in the US and no negative correlation between inflow of foreign-born STEM workers and wages of native workers (college-educated or not). Whereas other studies, such as Borjas (2006) and Borjas (2007), identified negative impact of foreign graduate students on domestic graduate students' enrollment and after-graduation wages. Even more ambiguous is the effect of high-skilled migration on the source countries, which suffer from "brain drain" as talents emigrate but in the same time benefit from faster technology transfers facilitated by migrated talents (Kerr (2008)).

The objective of this project is to quantify the aggregate effects of high-skilled migration on both the source and the destination country by studying a general equilibrium model with heterogenous agents and endogenous research effort. The distinct contributions of this paper will be three-fold. First, by setting up a general equilibrium model with high-skilled migration from a less developed country to a more developed country, we are able to quantify the aggregate impact of migration on both economies in a unified framework. The GE model is preferred because research intensity in both economies are endogenous to migration and knowledge diffusion. Second, heterogeneity of research talent is introduced into the GE model, so that the results will provide important implications about crowding-out effects of immigrants on domestic research talents. Last but not the least, it is very difficult, if not impossible, to quantify the long-run aggregate impact of high-skilled immigration using micro studies. My model could fill the gap in the literature by giving a plausible quantification of the impact on both the source and the destination countries, as well as providing policy implications about high-skilled immigration in destination countries like the U.S.

2 Baseline Model Summary

Similar to Acemoglu, Aghion and Zilibotti (2002), Kerr (2008) and many others, my model has a leader economy l and a follower economy f, where the leader has higher research efficiency and higher initial technology level. Economic growth is driven by expanding varieties of machines resulting from research activities as in Romer (1990). Each economy chooses to either innovate new technology *(innovation)* or adopt existing technology *(imitation)*, and the stock of varieties A_i evolves according to the following law of motions:

$$\begin{aligned} Innovation: \quad \dot{A}_l(t) = &\quad \eta_l A_l(t) H_l(t) \\ Imitation: \quad \dot{A}_f(t) = &\quad \eta_f A_f(t) H_f(t) \left(\frac{A_l(t)}{A_f(t)}\right)^{\omega} \qquad (where\, \eta_f < \eta_l) \end{aligned}$$

where η_i, $i \in \{l, f\}$ is (innovative/imitative) research efficiency, H_i is the total human capital devoted to research and $\left(\frac{A_l(t)}{A_f(t)}\right)^{\omega}$ represents knowledge diffusion. Human capital is essential to both innovation and imitation, as argued by Nelson and Phelps (1966), Benhabib and Spiegel (1994) and Stokey (2012). In the steady state, we can prove that the leader economy only innovates and the follower economy imitates. Both economies grow at the same rate and the global technology growth will be determined by the innovator, i.e. the leader economy. To endogenize researcher quality and research intensity in each economy, I introduce heterogeneity in agents' talent of doing research. Each agent is assumed to be born with the same ability of doing manual work, but with idiosyncratic research talent ϵ drawn from a Pareto distribution $\epsilon \sim pareto(\underline{\epsilon}, \theta)$. In equilibrium, only agents with research talent above some endogenous threshold will become researchers. Denote the talent cutoffs for the leader and the follower economy as ϵ_l^* and ϵ_f^*, respectively. The share of researchers in the labor force would be given by $\int_{\epsilon^*}^{\infty} f(\epsilon)d\epsilon$ and total human capital devoted to research is $H(t) = \int_{\epsilon^*}^{\infty} \epsilon f(\epsilon)d\epsilon \cdot L(t)$, where $L(t)$ is population of the economy.

Next I introduce high-skilled immigration by allowing agents with talent level $\epsilon \geq \frac{\eta_l}{\eta_f}\epsilon_l^*$ from the follower economy (so that the immigrant researchers are at least as efficient as the marginal domestic researcher) to migrate to the leader economy with an exogenous probability p, which will be determined by the migration data. The leader economy chooses an optimal talent cutoff ϵ_l^* given p and the follower chooses ϵ_f^* given ϵ_l^* and p. For simplicity, I solve for the allocations of utilitarian national planners, but the model can be easily adapted to a decentralized economy with taxes and research subsidies. With proper calibration of the model (discussed in ***Section 3***), we could evaluate the effect of high-skilled migration on the steady state productivity growth and levels, the welfare of each country, and the global welfare.

3 Example Calibration: US vs. China (See Appendix)

4 Model Extension

In the baseline model, I assumed for simplicity that researchers' efficiency η_i only depends on their origin $i \in \{f, l\}$. So a person from the follower economy would always be less productive as a researcher than someone with the same intrinsic talent from the leader economy. The simple model would not be able to explain the increasing share of international students in the US since 1980s, especially at the doctoral level, where 51% of PhD recipients in science and engineering fields were foreign-born in 2003 (Bound, Turner and Walsh (2009)). Much of the growth has come from rapidly growing countries, particularly South Korea, India, Taiwan and most recently China (Black and Stephan (2010)). To reflect this empirical trend and to evaluate the impact of larger inflows of international students, I revise the model by letting research efficiency be determined by the quality of higher education received by the researcher. Then admitting international students for higher education on top of high-skilled immigration should further improve the global pool of researchers and benefit both the leader and the follower economy. With the extra layer of student migration, the calibration would be slightly more complicated, but the model could potentially match the real world more closely and provide more accurate welfare implications.

5 Future Plans

This project about high-skilled immigration and its effect on global innovation will become my job market paper in 2015. I will present findings of the project at Stanford and in later stages at external conferences to obtain valuable feedbacks. The research grant would be very helpful to support my research in the summer of 2014 and during 2014-2015 academic year when I am on the market.

References

Acemoglu, Daron, Philippe Aghion and Fabrizio Zilibotti. 2002. "Distance to Frontier, Selection, and Economic Growth." *Journal of the European Economic Association* 4(1):37–74.

Benhabib, Jess and Mark M. Spiegel. 1994. "The role of human capital in economic development: Evidence from aggregate cross-country data." *Journal of Monetary Economics* 34:143–173.

Black, Grant and Paula Stephan. 2010. *American Universities in a Global Market*. NBER.

Borjas, George J. 2006. "Immigration in High-Skill Labor Markets." *NBER working paper* .

Borjas, George J. 2007. *Do Foreign Students Crowd Out Native Students from Graduate Programs?* University of Wisconsin Press.

Bound, John, Sarah Turner and Patrick Walsh. 2009. *Science and Engineering Careers in the United States*. University of Chicago Press.

Kerr, William R. 2008. "Ethnic Scientific Communities and International Technology Diffusion." *The Review of Economics and Statistics* 90(3):518–537.

Kerr, William R. and William F. Lincoln. 2010. "The Supply Side of Innovation: H-1B Visa Reforms and US Ethnic Invention." *Journal of Labor Economics* 28(3):473–508.

Nelson, Richard and Edmund Phelps. 1966. "Investment in Humans, Technological Diffusion and Economic Growth." *American Economic Review* 56:69–75.

Peri, Giovanna and Chad Sparber. 2010. "Highly-Educated Immigrants and Native Occupational Choice." *Working paper* .

Peri, Giovanni, Kevin Shih and Chad Sparber. 2013. "STEM Workers, H1B Visas and Productivity in US Cities." *Working Paper* .

Romer, Paul. 1990. "Endogenous Technological Change." *Journal of Political Economy* 98(5):S71–102.

Stokey, Nancy L. 2012. "Catching Up and Falling Behind." *NBER Working Paper* .

A Tables for Calibration Strategy

A.1 Key parameters to be calibrated in the model[1]:

- China's population relative to the U.S. $\frac{L_f}{L_l}$ (normalizing U.S. population to 1)
- Knowledge spillover parameter: ω
- Pareto shape parameters for talent distribution θ. (The Pareto scale parameter is normalized to 1)
- Different research efficiencies: η_l (U.S.) and η_f (China)
- Probability of high-skilled migration from China to the U.S.: p
- Talent cutoffs ϵ_l^* and ϵ_f^*

[1] Standard parameters in the model, including coefficient of relative risk aversion γ, labor share in final production β and discount rate ρ are not listed here, but their calibration is specified in the supplementary tables.

A.2 Parameters to be calibrated independently:

	Function	Targeted Moments	Data Source
γ	$u(c) = \frac{c^{1-\gamma}-1}{1-\gamma}$	$\gamma = 2$ (try other values for sensitivity test)	Hall 2009 (JPE)
β	$\beta = 1 - \alpha = 0.67$	Labor share in output in the US= 0.67	NIPA
ρ	$r = \rho + \gamma \cdot g \Rightarrow \rho = 0.01$	Long term r=5%, g=2% in the U.S.	World Bank
$\frac{L_f}{L_l}$	$\frac{L_f}{L_l} = \frac{Pop(China)}{Pop(U.S.)} \approx 4$	Population in China: 1.36 billion Population in US: 0.32 billion	World Bank
ω	$g_f = \eta_f H(t) \left(\frac{\bar{A}}{A_f}\right)^{\omega}$	$log\,(g_f) = log\eta_f + \omega log \left(\frac{\bar{A}}{A_f}\right) + controls$	Penn World Table
θ	$\frac{\theta}{\theta-1}\epsilon = \frac{\int_{z>\epsilon} zf(z)dz}{1-F(\epsilon)}$	Citation weighted publication counts for top 100 scientists in biology, chemistry, economics, genetics, immunology, microbiology, neuroscience, pharmacology, and physics	Essential Science Indicator (Thomson Reuters) Employment in each field: BLS Employment data

A.3 Parameters to be calibrated jointly:

Jointly:	Functions	Targeted Moments	Data Source
$\{\eta_l,\, \epsilon_l^*,\, \frac{\eta_l}{\eta_f}\, \epsilon_f^*,\, p\}$	$f(\eta_l,\, \frac{\eta_l}{\eta_f},\, p,\, \epsilon_l^*,\, \theta,\, \gamma,\, \rho,\, L_l,\, \frac{L_f}{L_l}) = 0$	Solution to US Planner's problem	N/A
	$h\left(\frac{\eta_l}{\eta_f},\, g,\, p,\, \epsilon_l^*,\, \epsilon_f^*,\, \theta,\, \omega,\, \gamma,\, \rho\right) = 0$	Solution to China Planner's problem	N/A
	$1 - F(\epsilon_l^*) = L_R^l(t)$	Share of researchers in US	UNESCO
	$g = \eta_l H_l(\theta, \eta_l, \epsilon_l^*) + \eta_f H_{imm}(\eta_l, \frac{\eta_l}{\eta_f}, \epsilon_l^*, \theta, p)$	long term growth rate of US	World Bank
	$\frac{L_R^{imm}(\eta_l, \frac{\eta_l}{\eta_f}, \epsilon_l^*, \theta, p)}{L_R^{domestic}(\theta, \eta_l, \epsilon_l^*)}$	$\frac{\#\, of\, US-born\, researchers\, in\, US}{\#\, of\, Chinese-born\, researchers\, in\, US}$	NSCG