Immigration Policy as Industrial Policy *

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Abstract

This paper examines the effect of the 1990 Immigration Act on the size and national-origin composition of immigration to the United States as well as its effects on both the level and composition of U.S. innovation. We exploit a change in immigration law that more than doubled the number of permanent visas for high-skilled immigrants beginning in 1992 and expanded temporary work visas for similar workers to show that this law benefited mainly college-educated Indian immigrants. We use a Bartik-style shift-share instrument to show that increased Indian immigration led to more per capita patenting among both ethnically Indian and non-Indian inventors and shifted the composition of patenting towards medicine-related fields. We also analyze how recently-imposed barriers to Indian immigrants may be limiting innovation today.

Keywords: Innovation, Immigration, Ethnicity

JEL Codes: O31, F22, J15

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1 Introduction

Immigrants make up an increasing share of the U.S. population, approximately 14%, near the historic record of the early 20th century. But immigration patterns have shifted radically since the great migration from Europe over a 100 years ago, both shaped by changing conditions around the world and laws in the United States meant to favor or exclude immigrants based on their characteristics and origin. Immigrants on average are more likely to file patents than natives in the US. Measuring the effects of barriers to immigration on innovation is an important question in the context of barriers to economic growth.

This paper uses multiple natural experiments to measure the effects of immigration on innovation. First, this paper attempts to measure the effects of the 1990 Immigration Act, which expanded legal immigration, on innovation (namely patent filings), especially of college-educated immigrants from India, to the United States beginning in the 1990s. Second, we propose a new research method to explore the effects on patenting when in the mid-2000s country of origin rules became binding in discriminating against the allotment of green cards to primarily college-educated immigrants from India and China.

There is an extensive literature on the relationships between immigration and innovation. Immigrants, despite representing about one in seven residents, represent over two in seven inventors according to patent data (Akcigit, et. al, 2017). However, the increase in immigrant patenting, is very heterogeneous by country of origin. Kerr (2008) documents the rise of patenting by Chinese and Indian inventors since the 1990s which accounts for much of the rise in immigrant patenting. Updated data that Kerr provided us show that 10 % of approved patents from US-based inventors in 2015 were by ethnically Chinese inventors while over 7% were from ethnically Indian inventors. Both patenting shares are much greater than their proportions of the general population of about 1% and 0.8% respectively.

Figure 1

The rise in Indian and Chinese patenting in the 1990s and subsequent leveling in the late 2000s motivates this paper because this trend coincides with the passing of the 1990

Immigration Act and the binding of per-country green card caps for Indian and Chinese highly skilled migrants beginning in 2005.

The 1990 Immigration Act increased green card issuance by approximately 50% beginning in October 1991 and created new visa categories for highly-skilled immigrants and inventors like the H-1B and O-1 visas. Green cards are the colloquial name given to the document that allows an immigrant to live and work permanently and freely in the United States. The law, like the previous 1965 Immigration Act leaves in place caps on the number of immigrants who can receive a green card from each country or territory of birth at 7% of green cards in each category. This isn't a hard cap since most immigrants come from countries which do not reach that limit for any category and a complicated formula allows most of those unused green cards to pass to categories that do reach the limit, in effect making the limit much higher. Per-country caps were not binding for immigrants from any nation but Mexico and for no one in the employment-based (EB) categories which require that nearly all immigrants who qualify for an EB green card have a college degree. Since the 1990 Immigration Act which more than doubled the number of EB green cards relative to prior law, the per-country cap became even less relevant.

But as immigration increased, it became clear that the expansion of EB green cards and temporary work visas mostly led to more immigration of Chinese and especially Indian-born college-educated immigrants. In 2005, the per-country caps became binding for the first time for both Indian and Chinese born immigrants, leading to wait times of months, then years, and now decades for immigrants who are approved for green cards, and ultimately forcing many of them to leave the country or never come in the first place. Kahn and MacGarvie (2020) show that green card wait times cause over 12% of Chinese and over 8% of Indian born PhD students to leave the United States after 5 years of waiting, and increasingly being more likely to drop out with longer wait times. The U.S. Congressional Research Service estimates that currently if an Indian-born person applies for an EB-2 or EB-3 green card, they will have to wait 195 years to receive it, meaning that they will almost certainly die waiting unless there is reform to the immigration laws. Similarly, Chinese-born applicants must wait 18 years. Under current law, the backlog of immigrants from India and China is expected to grow and with wait times for Indians and Chinese EB-2 applicants increasing to 436 and 51 years respectively by the year 2050.

If Chinese and Indian immigrants are the most innovative immigrant ethnicities, then limiting the growth of these groups in the United States by limiting immigration from their countries of origin may hamper innovation which could lead to lower productivity and wages and capital income. Not only would it reduce innovation but also change what gets invented since immigrants from different national-origin groups tend to focus on specific sectors (Acemoglu (2023) provides a framework and empirics for how the path of innovation may be distorted by the presence of markup differences, externalities and other social considerations). In other words, immigration policy may work effectively as a form of industrial policy, benefiting some industries over others.

While the correlation between immigration and patenting doesn't imply causation on its own, it does raise the question over whether foreign inventors meaningfully increase innovation. Theoretically, if there are no spillovers or crowding out effects, one inventor moving to the United States should increase per-capita innovation in the country since most of the population are not inventors. Similarly, if a group of immigrants coming to the United States has more inventors than the average of the U.S. population, then admitting this group would increase per capita innovation.

In the real world, the presence of new inventors can lead to positive spillovers and network effects, especially in a sector where one new idea can spur other ideas. As Kerr (2008) documents, ethnic networks mean that new inventors will propagate knowledge through social networks back to their home country and have positive spillovers on other inventors of his ethnic group and this can have positive effects on the home countries of the foreign inventors.

This paper asks two questions about immigration and innovation, (1) what is the effect of Indian immigration on innovation and (2) what is the effect of the national origin of immigrants on the composition of innovation. To answer these, we exploit the heterogeneous effect of the 1990 Immigration Act on immigration from India instrumenting for the 1990 Indian population in the country. We also propose a strategy to exploit the 2005 randomly-timed imposition of per-country caps to understand the effect of slowed Indian and Chinese immigration on the level and composition of innovation. We find that the 1990 Immigration Act increased patenting per capita in the United States mostly by increasing patenting of computer-related technologies and services.

The specific causation mechanism studied here is how changes in U.S. immigration policy change the number of immigrants and therefore the size of ethnic groups and inventors and how this subsequently changes the number of patents per capita and the composition of patenting.

2 Institutional Setting

2.1 The Immigration Act of 1990

The 1990 Immigration Act effectively increased total permanent legal immigration by 50%, but this was not done uniformly by category. Immediate relatives of US citizens were already guaranteed green cards; these included minor children, spouses, and parents. A green card is the informal name for the document that shows someone is a legal permanent resident with the permanent right to work and live in the United States. Other immigrants seeking a green card were capped in number, meaning that if more immigrants qualified than visas or green cards are available for their category, immigrants need to wait until those in the wait list obtain it before them.

Prior to 1990, the 1965 Immigration Act established family-based and employment-based visas or green cards. expanded the number of family-based immigration visas allotted per year, but also made the definition of family more exclusive by limiting it to immediate family members. The 1965 quotas were flexible based on the number of immediate relatives but this number has reached the level each year to reduce the quotas of other immigrants to up to necessary allowed up to 217,000 family and 58,000 employment based migrants per year, while the 1990 quotas effectively amounted to 226,000 family and 140,000 employment based migrants as well as 55,000 visas given in a lottery with a complicated allocation formula to natives of countries with few new immigrants to the United States. This effectively raised non-immediate relative migration which was already unlimited by 45% by more than doubling Employment-Based visas and creating the Diversity visa lottery while almost leaving the number of family visas unchanged.

Figure 2 provides some initial evidence from U.S. Census data that the implementation of the 1990 Immigration Act was followed by more new college-educated immigrants beginning in 1992, the first full year in which the 1990 Act was in effect.

Figure 2: New college-educated immigrants by year of arrival in 2000 census

Legal immigration did not increase homogeneously. Since EB visas were expanded more than any other category, and these generally require a college education, it would be expected that countries that send more educated migrants and received more EB visas prior to 1990 would receive more post-1990. Since the EB category was expanded more than others as even the Diversity lottery requires at least a high school education, it would be expected that the reform also raised the average education of all new immigrants. This was generally correct but it mostly meant more immigrants from India came to the United States. The average education level of all new immigrants to the United States rose but Indians already had a much higher base than immigrants from other countries of origin which allowed them to take greater advantage of the expansion of employment-based migration.

Figure 3: Education level of main immigrant groups 1970-1990 and 1990-2000

3 Data

We use IPUMS extractions from the 1970, 1980, 1990, and 2000 U.S. Census data to measure the size and location of ethnic and immigrant populations. The reason for not going beyond 2000 is that in 1999 new immigration provisions kicked in allowing immigrants with H-1B visas to stay for longer and effectively further increased the Indian college-educated population in the future while in 2005 the per-country caps kicked in, changing incentives for Chinese and Indian visa holders.

We also use data from the U.S. Patent and Trademark Office (USPTO) to observe the number of patents approved each year in the United States since 1975 and match it with the ethnic names data generously provided to us by William Kerr to approximate ethnicity of US-based inventors. Kerr's technique uses an algorithm to predict the likelihood that each inventor belongs to each ethnic group based on his first name and last name. We match his data with the USPTO data by patent number which allows us to observe the year of the patent, location of the inventor and the category of the invention.

We also make use of Department of Homeland Security immigration data for the summary statistics section to understand the composition of new permanent residents of the United States and Department of State data to observe actual wait times of already-granted immigrant visas.

Finally, we have access to the Department of Labor's PERM database which allows us to observe the characteristics of workers sponsored for permanent residency through the EB-2 and EB-3 green card categories including their nationality, location, sponsoring company, year, and wage offers. We may use this data for our next step in the research of analyzing the impact of the random imposition of green card caps on Indians and Chinese born immigrants in 2005.

To determine immigrant status, we also use data kindly provided by Rebecca Diamond used in Bernstein et al. (2022) which links by address USPTO patent data to data from Infutor which using the first digits of social security number can determine whether one is an immigrant (having their SSN assigned some time after their birth) versus a native (having their SSN assigned some time near the time of birth).

4 Methodology

Bartik instruments are among the most common method used in the immigration literature to identify the effects of immigration on an outcome such as wages. Bartik instruments use previous foreign population as a predictor for future settlement and assume that past settlement is orthogonal to future predicting variables relevant to our outcome.

$$y_{s,t} = \beta_0 + \beta_1 \ln x_{s,t} + \beta_2 X_{s,t} + \epsilon_{s,t}$$

Where $y_{s,t}$ in our case is patenting per capita in time t and state s, $x_{s,t}$ is the number of Indian born individuals and $X_{s,t}$ is a vector of independent variables while $\epsilon_{s,t}$ is our error term.

OLS regressions likely do not correctly identify β_1 since β_1 is correlated with $\epsilon_{s,t}$ and likely β_2 as immigrants don't settle randomly.

The Bartik instrument is popular in the immigration and trade literature as it allows for approximating effects based on location and other variations based on a shift in the share of trade or immigrants who live in each location or work in each industry (Goldsmith-Pinkham, et.al, 2020). Recent literature has cautioned against using shift-share instruments to measure short-term effects of immigration since this approach may partially capture long term adjustment effects as well (Jaeger, et.al 2018). However, this paper studies the effects of Indian immigration over nearly a decade in the 1990s as a result of an immigration policy change suggesting thie may be a good methodological approach.

Our Bartik instrument is based on the share of the Indian foreign-born population living in each U.S. state in 1990, right prior to the implementation of the new immigration law. Like a traditional shift share instrument it is defined as the inner product of the 1990 India immigrant state shares and the Indian immigrant period growth rates:

$$B_{s,t} = \sum z_{s,0} g_t$$

Where $z_{s,0}$ is the share of each state that was born in India and g_t is the growth rate of the national Indian born population between 1990 and 2000. We exclude from the sample small states with few to no Indians by 1990, leaving us with 31 states. This also allows us to avoid some results due to sampling error since some very small states in 1990 had less than five unique individuals who were born in India. In such a case, even an error of one person in the sample would result in a 20 percent change in the share.

After constructing our Bartik instrument, we regress our first stage dependent variable against the Bartik instrument as well as other covariates of interest in the first stage regression and then of our predicted values from the first stage against our outcome variable in a simple 2SLS process. This gives us our main specification results which we express in logs in the results to measure the percentage point change in our outcome variable from a one percent increase in the Indian born population.

$$x_{s,t} = \alpha_1 B_{s,t} + \alpha_2 X_{s,t} + v$$

$$y_{s,t} = \beta_1 x_{s,t} + \beta_2 X_{s,t} + d\hat{v}$$

In the Results section, we explore different methods to cluster errors and weight the results with different outcomes.

5 Results

Table 1 reports the results of the naive method to understand the impact of Indian immigrants on patenting. The first specification is a simple OLS regression of the ethnically Indian share of the population against patenting per capita without controls while the following specifications add controls for other factors that may affect per-capita patenting such as the share of the population that is college-educated or foreign born as well as the state as a proxy for location.

Table 1: OLS Indian immigrants and patenting.

Variable	(1)	(2)	(3)	(4)	(5)
Log(Indian share of the population)	1.079***	0.644***	0.677***	0.676***	0.089
	(0.102)	(0.122)	(0.122)	(0.126)	(0.107)
Log(College-educated share of the population)		2.001***	2.441***	2.445***	3.162***
		(0.369)	(0.440)	(0.520)	(0.340)
Log(Immigrant share of the population)			-0.233*	-0.236*	0.349**
			(0.129)	(0.141)	(0.156)
Decade fixed effects	No	No	No	Yes	No
State fixed effects	No	No	No	No	Yes

As explained in the Methodology section, Table 1 does not really estimate the true effect of Indian immigration on patenting in the United States. The proposed estimation strategy explained in that section is the three-stage least square estimation of the effect of Indian immigration on patenting per-capita using the 1990 Census Indian-born population as the Bartik shift-shares instrument. These estimates are shown in Table 2. All standard errors are clustered at the state level.

Table 2: Impact of Indian immigration on per-capita patenting by state.

Variable	(1)	(2)	(3)
Log(Indian share of the population)	1.091***	0.488*	0.509**
	(0.091)	(0.252)	(0.241)
Log(College-educated share of the population)		2.35***	2.707***
		(0.882)	(0.885)
Log (Immigrant share of the population)			-0.184
			(0.167)

Using our Bartik instrument we measure the impact of a one percent greater Indian resident population in a state to cause a 0.5 to 1.1 percentage point increase in per-capita patenting depending on how the regression is specified. This finding is still significant after controlling for the most relevant factor that affects per-capita patenting in a state which we easily observe, the share of residents with a college degree.

Table 3 reports the results of the same methodology used for Table 2 but with the outcome variable being the share of patents related to physics, rather than patenting overall.

Table 3: Physics-related patents.

Variable	(1)	(2)	(3)
Log(Indian share of the population)	0.274***	0.011	-0.005
	(0.046)	(0.072)	(0.065)
Log(College-educated share of the population)		1.026***	0.770***
		(0.241)	(0.208)
Log (Immigrant share of the population)			0.132***
			(0.047)

Table 4 reports the results of the same methodology used for Table 3 but with the outcome variable being the share of patents related to medicine.

Table 4: Medicine-related patents.

Variable	(1)	(2)	(3)
Log(Indian share of the population)	0.461***	0.352**	0.361**
	(0.063)	(0.142)	(0.153)
Log(College-educated share of the population)		0.424	0.582
		(0.504)	(0.505)
Log (Immigrant share of the population)			-0.081
			(0.141)

While the increase in Indian immigration had no significant effect on the share of physics-related patents after controlling for the college educated share of the population, Indians did seem to significantly increase the share of patents devoted to medicine and lifesaving which are represented in the IPC codes as classes "A61" and "A62". And in physics-related patents both more college educated residents and more immigrants of all kids may have a positive effect not just as a control.

Finally, Tables 5 and 6 report the results of a model where we have the same Bartik instrument but where the outcome variable is not patents per capita but patents per capita invented by ethnically Indian (Table 5) and not ethnically-Indian inventors (Table 6). The goal of this analysis is to understand if the increase in patenting per capita is exclusively due to the presence of more productive Indian inventors in the United States or if there are positive spillover to other groups. It is worth noting that this outcome variable is ethnicity, not country of birth, therefore in Table 5, the spillovers or crowding out to native born ethnically Indian inventors is captured while Table 6 shows the effect on patenting of all other groups.

Table 5: Indian per capita patenting,

$Variable$	(1)	(2)	(3)
Log(Indian share of the population)	1.640***	0.833***	0.849***
	(0.131)	(0.233)	(0.234)
Log(College-educated share of the population)		3.146***	3.356***
		(0.979)	(0.973)
Log (Immigrant share of the population)			-0.111
			(0.156)

Table 6: Non-Indian per capita patenting,

$Variable$	(1)	(2)	(3)
Log(Indian share of the population)	1.074***	0.469*	0.490**
	(0.092)	(0.253)	(0.244)
Log(College-educated share of the population)		2.358***	2.712***
		(0.884)	(0.884)
Log (Immigrant share of the population)			-0.183
			(0.170)

What Tables 5 and 6 tell us is that Indian immigration have a significant positive effect on per-capita patenting by ethnically Indian inventors. This should come at no surprise but the size of the effect is surprising since a one percentage point increase in the Indian-born share of the population is predicted to increase per capita patenting by Indian inventors by between 0.8 and 1.6 percent."Indian per capita patenting" is the total number of patents approved from ethnically Indian inventors in a state s on a decade t divided by the total population of that state.

However, even more interesting is the fact that Indian immigrants did not crowd out non-ethnically Indian inventors but rather these obtained more patents after Indians moved to the United States. A sudden one percentage point increase in the share of the population that is born in India led to between 0.5 and 1.1 percent more per capita patenting by non-Indian inventors. A smaller effect than that for Indian inventors but still significant.

6 Conclusion

This paper contributes to a growing literature about the relationship between immigration and innovation. But instead of looking to understand the relationship of immigration, in general, with innovation, we look into immigration specifically from India to the United States after a legal reform allowed greater numbers of Indians to come and stay permanently.

This is an important contribution because we find a much smaller effect from an increase in immigration on per capita patenting. Hunt (2010) estimates that a one percentage point increase in the share of the population that is an immigrant with a college degree results in a 15 percent increase in per-capita patenting after accounting for spillovers. Our estimate doesn't specify whether the Indian immigrant has a college degree or not but over three in four Indian immigrants do, and our quasi-experimental analysis offers both specifications controlling for the share of the population with a college degree and a specification without it, both tell us that the effect is much smaller than a 15 percent increase, at best between 1 and 2 percent using our methodology. However, we confirm positive spillovers, not just to natives in general but to inventors of different ethnicities from the immigrants, and that these ethnic networks benefit more than those outside of the group albeit not by much more.

But another more interesting contribution of our paper is that immigration has the potential to not just increase innovation but also change what we invent. Indian immigration led to significantly more patenting in the medical field and shifted the composition of innovation towards that field over others. A one percentage point increase in the share of the population that is born in India led to an increase in the medicine-related share of new patents between 0.4 and 0.5 percentage. This has implications for policies such as industrial policy that aim to advantage specific industries. If immigrants from one country tend to benefit a specific industry or a field of study then country of origin might be an important tool to select new migrants.

Take into account as well that our results use patenting per capita by adding up all the decade's patents as outcome variable and the capabilities of immigrant inventors may take longer to show since some of them arrived on the last year of the decade and it's unlikely that they've had time to patent. Therefore, we do expect these results to somewhat underestimate the true impact of Indian immigration on per capita patenting and perhaps also on sector shifts.

Future research we will pursue in this field is about the next big shock in U.S. immigration policy towards Indians, and that is the imposition of per-country caps in 2005 that reduced their labor mobility and led many to begin leaving the country.

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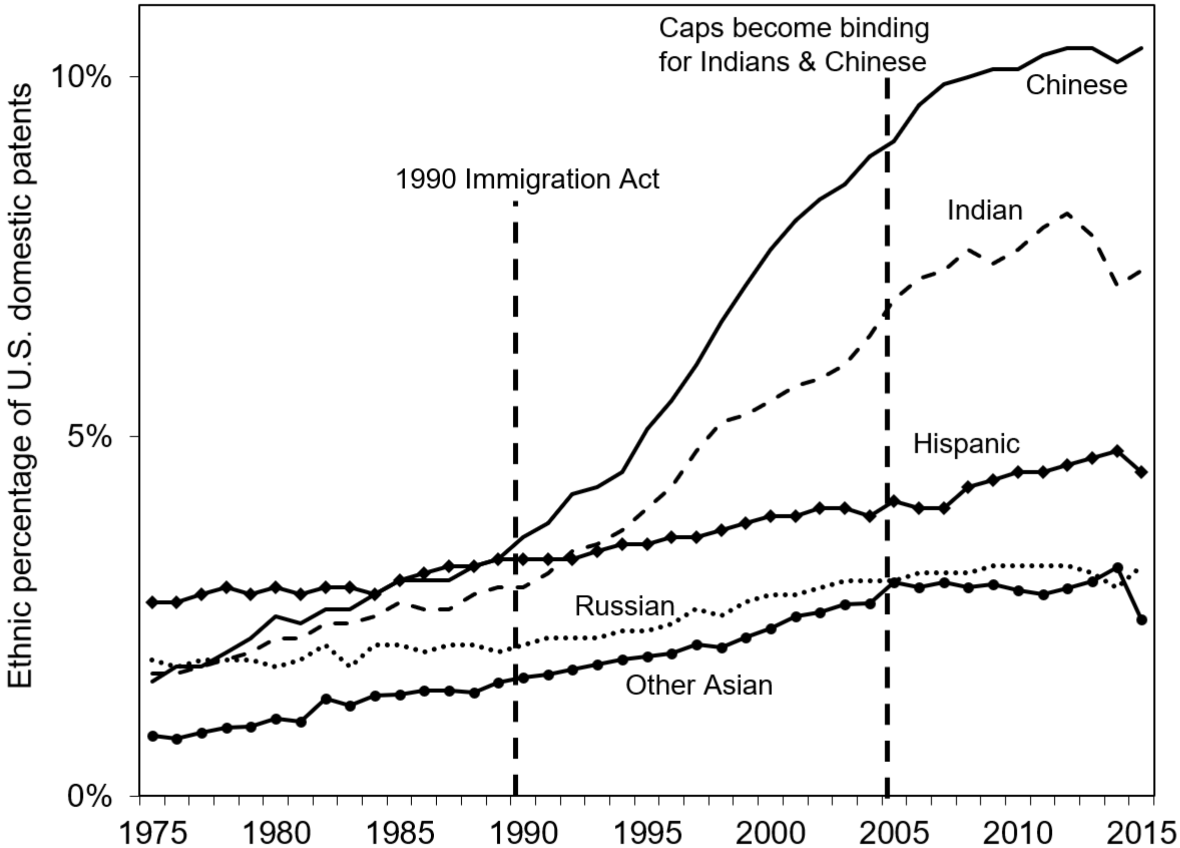
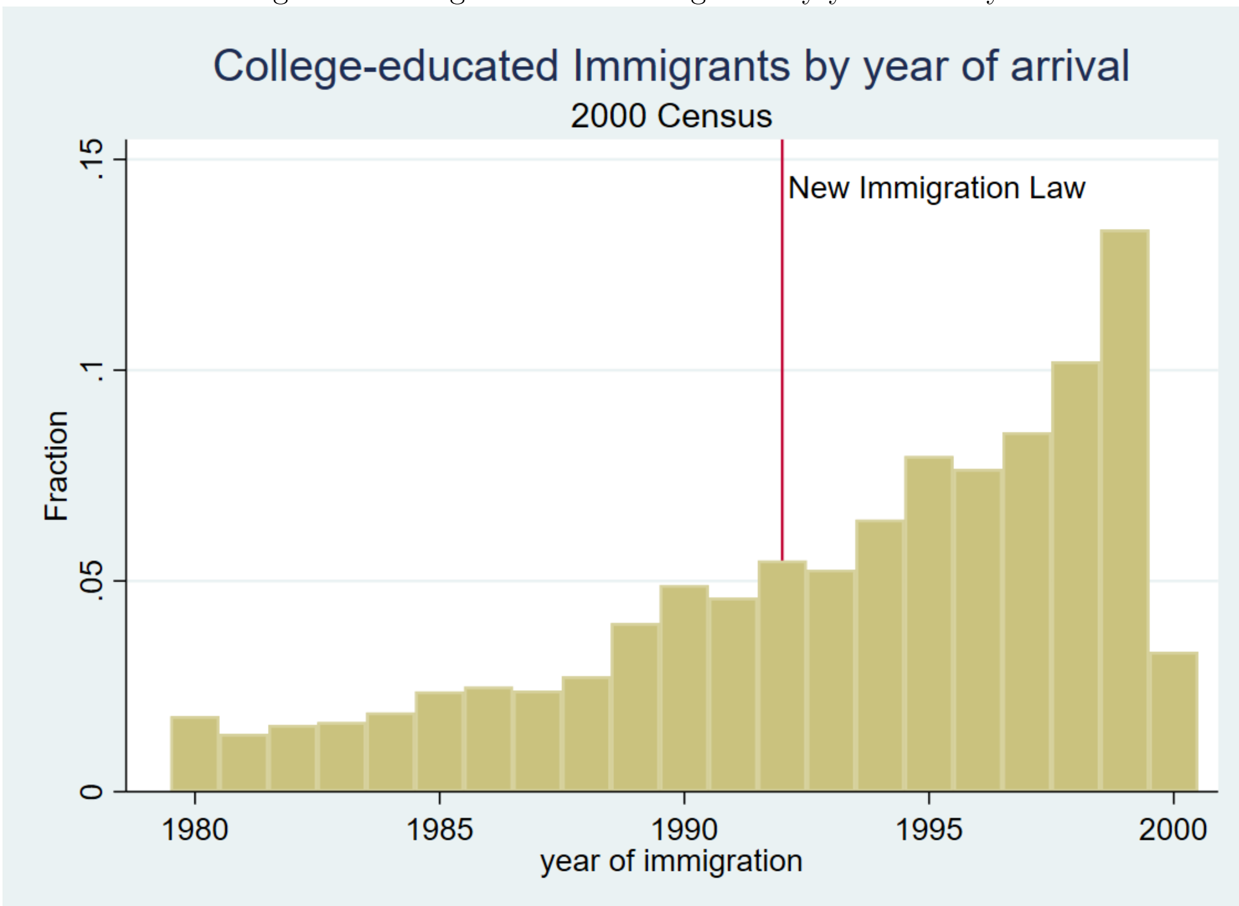
Appendix

Figure 1: Patenting by ethnicity of U.S. inventor over time.



Source: Kerr(2020)

Figure 2: College educated immigrants by year of entry.



Source: IPUMS

Figure 4: Education level of main immigrant groups 1980-1990 and 1990-2000