Foreign-born College Students:
How much could they contribute to the US economy?

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Abstract: *The Unites States College and University system is schooling an increasing number of students from all over the world. For a very large portion of those, namely those on F1 visas and those with no documentation, the transition to the US labor market can be very difficult, if not impossible. This results into re-migration or under-employment of these highly skilled workers. We quantify the size of these populations and the employment and wage losses to US states and local economies from the constraints imposed by immigration status on those students. We suggest that some recent policies that have increased legal access to jobs for these two categories, such as the extension of optional practical training (OPT) in 2008 and the temporary status granted by DACA to undocumented college educated in 2012 may have increased their college to local jobs transition rates. There is scope for larger gains when adopting policies that would substantially increase the labor perspectives in the US of F1 and undocumented college students. We suggest some local policies that could prove to be innovative ways to strengthen local economies and link immigration policies to local economic incentives.*

I. Introduction

The population of foreign-born students in US Colleges and Universities has grown substantially during the last decade. This study focuses on the impact that this could have on US local economies as these students graduate and join the labor market. To analyze these effects it is useful to distinguish three groups of students, based on their immigration status. Excluding visitors and tourists, the largest and fastest growing US visa category in the recent years has been the F1-student visa group. This visa category admits students to the US and a large part of them are college students. Almost 600,000 new F1 visas were issued in 2014 up from only 110,000 in 2001, hence more than quintupling in 14 years. Almost half of the F1-visas were given to students attending universities or community colleges[1] and several prestigious public and private universities (such as University of California, University of Illinois, University of Michigan, Purdue University and Boston University) are among the largest users of those visas. We will call this group the F1-foreign students[2]. A second very large group of foreign-born college students in the

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[1] Adding exchange student on J1 visas the count reached 930,000 new visas in 2014. This was up from 380,000 F1 visas in 2010

[2] In comparison, the number of college educated foreign-born admitted each year with H1B visas as "specialized workers" has been much smaller and it was constrained by strong quotas. Only 141,000 H1B visas were issued for

US is constituted by the children of immigrants, who arrived in the US between pre-school and high school and attended college while still non-naturalized citizens. This second group has usually a more permanent and stable migration status, obtained from their parents who have often become permanent residents or on the way to become such. Hence, this group of students has substantially different perspectives to stay in the US and can legally access almost all employment opportunities. We will call this group "non-F1 foreign students". An exception, however, within this group is constituted by the group of children of undocumented immigrants. These are mainly of Mexican and Central American origin and they arrived in the US in largest numbers between 1990 and 2005. For them, even after college graduation, the uncertainty on their immigration status can be a substantial hurdle to transition to stable employment. We will call this group "undocumented foreign students".

In this study we provide a picture of the size and geographic distribution of the F1, and undocumented foreign student population, in US states and in some representative metropolitan areas. While the two groups of students are quite different from each other they share the feature that their immigration status may hinder or prevent their transition to employment in the US. In some states F1 and undocumented foreign students constitute a non-trivial percentage of the total college population and of the recent graduating cohorts (up to 4% in our sample of college-attending students in 2005-2009 who entered the labor market in 2010-2014).

In spite of the significant number of F1 and undocumented foreign students, the impact on the local economies of these locally trained, talented and highly skilled college students is rather limited. The reason is that a very large share of these students, after graduating from prestigious private and public universities return to their countries of origin or move to another country, city or state in search of the few job opportunities available to them in the US. It is very likely that the limited number of options allowed to them by their immigration status is one of the main reasons why these two groups do not transition into employment, after college graduation, at the same rate as foreign-born children of documented immigrants, a group that we will use a reference

In several instances business leaders, educators and policy makers have emphasized that the legal difficulty in retaining foreign students after graduation is a drain on US-produced human capital. Some have gone as far as claiming that, as a consequence of this "brain drain", technological growth and innovation will happen in China, India and other growing countries rather than in the US in the future. Certainly the international competition for talent (from Canada, Europe and other Asian economies) may lure these college graduates elsewhere when the options for staying in the US are small. These graduates from US universities are professionals, scientists, engineers, professors with high productivity and they would contribute to the US economy, they would earn high salaries and pay high taxes. Still, in the current state of things, they mostly leave the cities

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college-educated foreign workers to the US in 2014. The figures are from the Department of State, and they are available at: https://travel.state.gov/content/visas/en/law-and-policy/statistics.html (accessed December 22, 2015).

and states where they attended college, and often the US altogether, because of lack of working visa opportunities.

In our analysis we first calculate the average transition rates from college to employment of F1 and undocumented foreign students and we compare them to those of documented foreign college students in the same cohort and location, in order to establish how large the difference is. In particular we take the perspective of a local economy (a metropolitan area or a state) and we analyze what fraction of foreign college educated there took a local job within 4 years of graduation, in 2010-2014. Several studies such as Moretti (2004a), Moretti (2004b) have emphasized that the presence of college educated workers in a city has positive wage and productivity effects on other workers too. Kantor and Whalley (2014) have measured the positive knowledge spillovers from Universities to local economies, part of which is channeled through students who graduate and enter the local labor market. By losing a share of the human capital that is locally generated a state or a city misses part of the positive productivity effect that human capital would have.

Peri, Shih and Sparber (2015) show that an increase in college educated workers in STEM fields, by one percent of the labor force increases by 5-6% wages of other college educated in a metropolitan area. As two thirds of the F1 foreign students pursue a bachelor in a science, technology, engineering or mathematics (STEM) field it seems that losing them to opportunities abroad will result in losses for the local economy that go beyond losing the income they generate and can extend to ideas, innovation and growth that they could have generated.

We quantify the very direct impact of college graduates by estimating the extra employment and extra local wage income that U.S. States and metro areas would obtain if the F1 and undocumented students had the same college to employment transition rates as other documented foreign students. These calculations provide a sense of the magnitudes at stake. Then we consider two policy changes that affected potential labor market access of these two groups and we estimate how they changed the local college to employment transition rates from two years before to two years after their implementation. The first policy considered is the introduction of a 17 month extension to the Optional Practical Training (OPT) program for foreign STEM students, in 2008. This extension allowed F1 students to work for up to 29 months after graduation (extending the allowed 12 month period of post-graduation OPT) in the US. The second is the introduction of the Deferred Action for Childhood Arrivals (DACA) in 2012 that allowed a temporary work permit for undocumented college graduates and granted them protection from deportation. Our analysis estimates whether they have generated a change in the employment transition rates of those groups, using a difference in difference approach.

The results suggest that the college to employment transition rate for F1 foreign students increased by 5 to 25 percentage points within two years of the implementation of the policy. The effect however is rather noisy and imprecisely estimated. We also find an increase in the college to local employment transition rates for undocumented foreign students after DACA by 3 to 13 percentage points, also imprecisely estimated. The

magnitude of the effect is not trivial but the estimates are not very precise and not statistically significant, in part because of the noise due to the limited size of the sample and the aggregate nature of the data. Nevertheless, the evidence is consistent with the idea that the existing and restrictive immigration policies play a role in reducing the rate of local college to employment transition of F1 and undocumented foreign college students. Even limited policy changes, as those considered, had some effect on such transition rates. A much more significant step such as granting legal status and a path to permanent residence to students graduating from US universities would likely have larger effects.

At the aggregate US level such a loss of human capital can be costly. Local economies, however, are the units that may experience the more direct effect of those lost opportunities. The fact that US universities compete to attract F1 foreign students, and that several US states have allowed full access of undocumented students to their public universities implies that States and cities recognize the value of the human capital of foreign students. It is very puzzling that once the human capital is produced, and these students graduate from Universities, immigration policies are the hurdles causing the dissipation and loss of valuable human capital. From a local economy perspective (US metropolitan area or a US state) educating a foreign student will translate in smaller positive effects on the local economy if those students leave the city or the state. The "local multiplier effect" of a University on the economic output of a city may be reduced if the outflow of these graduates drains the city of a large share of valuable human capital.

As the number of foreign students increases in US universities, the ability to retain them in the local economy will affect significantly their economic spillovers. While usually these students pay their way through tuition fees, and hence may benefit public university that way, and they may contribute to revitalizing the intellectual environment in Universities, their contribution to the growth of the local community would be much larger if they had the option of working in it, at least for a while.

In the light of the number and results presented in this report we will suggest some interesting local policies and immigration policies aimed at retaining the gains from those college educated and at correcting the loss produced by the current immigration laws.

II. Mechanisms and the Economics Effect of college graduates

It is not easy to measure how many foreign college students on F1 visas or foreign undocumented college graduates leave the country or do not transition into employment after college. There are no large and representative dataset following individuals from school into the labor market in the US. Moreover no large dataset collects information on foreign-born that include their immigration status and the standard demographic and labor market variables. Only very recently some studies have started to use administrative data on F1 visa students (from the SEVIS system, an electronic database administered by the State Department) to analyze the post-graduation employment perspective of this group (e.g. Demirci 2016). Limitations in the information provided about jobs, their duration, and their possible transition to other visa or to a different

immigration status constraint the ability of analyzing the transition from college to employment using only the administrative F1 data. Moreover these data record information during the period of study and immediately afterwards but do not follow an individual in their job market.

What we do in in this study is to aggregate individuals into cohorts and follow them from college into employment between the age of 20 and 29. In particular we follow a cohort of foreign-born students who were attending college in 2005-2009 and then we analyze whether they moved into the labor market in 2010-2015. Matching administrative data with census data and considering individual characteristics from the American Community Survey we identify among students those who were likely to be on an F1 visa, as opposed to those who were likely to be children of immigrants and have a more stable immigration status, inherited from their parents. Finally we also identify those who are likely to be undocumented and arrived as children in an immigrant household. Considering such cohorts across 50 states and 277 metropolitan areas we can estimate, using a regression analysis described in the Appendix, the college to employment transition rate for each group and we can identify by how much foreign-born children of immigrants with stable immigration status are more likely to transit into local employment relative to F1-students and to undocumented foreign students.

Such analysis allows us to quantify how many foreign-born locally-educated college graduates leave a state or metropolitan areas upon graduation. While our procedure only uses aggregate data and is based on a probabilistic match, and so it should be taken with some caution, it produces the first quantification of the average college to employment transition rates in US states or metropolitan areas for these students, separating them by immigration status. It is natural to consider their status as potentially responsible for at least part of the smaller transition rates. Such loss can affect local economies through at least four channels.

First, and most directly, college educated earn high wages and would contribute substantially to total local income in a State and Metropolitan area. Their presence increases the average wages in the local economy, they have a positive net fiscal effect (as they pay high taxes and do not use much public welfare) and they contribute to local aggregate demand, possibly generating a local multiplier in terms of jobs. In terms of size of the local economy and of its tax base their departure is a clear loss. We will quantify it in the next section.

Second, most of the literature on economic growth and economic agglomeration (e.g. Moretti 2004a, Moretti 2013, Iranzo and Peri 2009) emphasizes that college educated workers have a positive productivity externality. Hence, their departure could also lower the productivity and wages of people who are left behind. By facilitating the adoption of better and more productive technologies, by helping local learning and increasing local knowledge, college educated workers affect positively the productivity and average wages of a city, above and beyond their direct effect, described above. The possible existence of

positive externalities from college graduates makes the economic loss from their departure larger than just the income they earn.

Third, the higher concentration of college educated may also increase the quality of important local amenities of a city (Diamond 2015). Better schools, better medical facilities, better cultural amenities, better functioning local institutions are also potentially important consequences of college educated presence. Those amenities are valued much especially by other college educated. Cities that loose foreign college educated, therefore, are also less attractive to native college educated as they will offer fewer of those amenities. This may generate some negative multiplier that amplifies the effect.

Finally, as two thirds of the foreign college students (especially on F1 visas) pursue a STEM degree, their departure means fewer scientists and engineers, which implies less innovation, less patenting and less technological growth (see Hunt and Gauthier Loiselle, 2009 and Kerr and Lincoln 2010, for a quantification of foreign-born contribution to US innovation). This may lower productivity growth and wages in these cities (e.g. Peri et. al 2015) and the long-run effects, accrued over decades, can be extremely significant, in that some cities grow at lower rate than they would if they could retain those students.

Overall, it is difficult to quantify all the short and long run potential effects from the missing employment of foreign college educated. We can, however, begin with measuring the magnitude of the decline in the size of the cohort of college educated in US states and cities associated with the smaller college to employment transition of F1 and undocumented. Then we evaluate the wage income and state income tax lost because of this. We will present such analysis in the next section.

III. Data and Results

III.1 Overview of the Data

Our method to identify F1-visa students considers the cohort of college students in the age range 20-24 during the period 2005-2009 from the American Community Survey. We select as "likely" F1 students those attending college, who are foreign-born, not naturalized, arrived in the US at 16 years of age or later and are not "dependents" in a household. We construct this group in each state and in each of 277 metropolitan areas that we can codify consistently over the period. Then we verify that the number of F1 college students, calculated from the ACS as described above, is close to the number of students in that age range and state (or metro area) on an F1 visa, as measured by the SEVIS database. We obtain a fairly good match by state (see Appendix VII.a for details in the matching) and hence we are confident that we identified a student population with high probability of being on an F1 visa. To the contrary foreign-born college students in the same age group who arrived in the US before age 16 and are dependent in a household or live by themselves are likely children of immigrants who arrived after birth. They represent the "foreign-born" control group (non-F1), and they are likely to have a more

permanent immigration status derived from their parents who have been in the US for years. Among non-F1, however, those who arrived between age 0 and 10 from Mexico and Central America and are attending college, are considered as "likely undocumented" students, as most of the undocumented youth, attending college in the period 2005-2009 arrived from Mexico or Central America during the 1990's.

Figure 1, 2 and 3 describe the geographical distribution of F1 college students, in the age group 20-24 for the years 2005-2009 as percentage of the college population. Figure 1 shows their presence in each of the 48 contiguous US states, denoting with a darker color a larger share. Figure 2 represents the ten states with the highest F1 share among the college population (left panel) and the 10 states with the lowest share in the college population (right Panel). Finally Figure 3 shows the metropolitan areas with the highest percentage of F1 among college students and the corresponding values.

Some states on the West coast (such as Washington and Oregon) stand out for their large shares of F1 students. These states are attractive to Asian students for geographic reason and this group constitutes a large and growing share among F1 visas. Also some metro areas known for their universities (such as Ann Arbor ,MI, Cambridge MA, Santa Barbara, CA) show very large shares of F1 students implying that some of the large and well established US universities are attracting a large number of F1 visa students. The list of top-universities in terms of F1 is shown in Appendix Table A1 and it confirms this impression. At the same time, some states that are not traditional destination of American college students, such as Kansas and North Dakota, have relatively large share of F1. This implies that some universities are attracting foreign students as an alternative strategy to attracting out of state students.

As comparison Figure 4 shows the geographic distribution across US states of non-F1 foreign students, those arrived as young children with their family. This distribution resembles more closely the distribution of total immigrants in the US, with California, Florida, New Jersey and New York appearing as important poles of attraction. The interesting thing emerging from this comparison is that the geographical distribution of F1 students does not coincide with that of other immigrants. In fact the correlation between the share of F1 and the share of non-F1 students among college students across US states is quite low, as shown in Figure 5. This provides an important opportunity in terms of new and valuable human capital to states that usually do not attract many immigrants or students from out of state. This opportunity may represent a resource for growth in the educational institutions of those states. However if these student leave the place where they obtained their college degree once they graduate, such opportunity would not translate into an increase in the human capital intensity of their labor force.

The distribution of F1 and non F1 students across regions (and countries) of origin is shown in Table A2 of the appendix. China, Korea and the rest of Asia are very large contributors to the F1 population. Their presence has grown further in the recent years. Mexico and Latin America, instead, are the largest contributors to the non-F1 student population.

Finally the distribution of "likely undocumented" college students partly mirrors the distribution of overall immigrants, and is quite concentrated. This group has a sizeable presence in California, Florida, Texas and New York (between 1.5 and 2.5 % of the college student population) and to a lesser extent in Illinois and New Jersey (around 1%) but is almost absent in other states. Figure 6 shows the percentage of college students who are foreign-born children of documented immigrants (blue bar), those on F1-visas (green bar) and foreign-born children of likely undocumented immigrants (orange bar). Panel A includes the states with largest foreign (overall) presence and Panel B those with smallest foreign presence among college students. It is clear that outside the 6 states mentioned above, the presence of undocumented college students is quite small and it is small when compared to F1 and to other foreign-born students. Nevertheless, given the potentially large impact that college education of this usually disadvantaged group can have on the local communities we will analyze the transition of those students into employment as well.

III.2 College to Employment transition rates
Our estimates of the college to employment transition rate of each of the considered groups (F1, documented and undocumented foreign college students) is obtained from ACS data relative to the cohort of students in the age range 20-24 and attending college in 2005-2009. They are also observed as workers in 2010-2014 when they are 25-29 years old. We identifying all college students in a city or a state (who are in the majority US born, about 94-95% of them) and measure how large is the group of those that are employed as college graduates in the same city or state five years later. As there is some measurement error we use a regression technique to obtain an average transition rate.

We evaluate the average college to local employment transition rate for F1, non-F1 and undocumented foreigners. A simple regression analysis described in the appendix, provides the estimate of this average rate estimated for US states and cities. A transition rate of 0 means that on average no student of that type become worker in that state/metro area within 5 years of graduation. A transition rate of 1, on the other hand, implies that all students of that type turn into workers in the same state (or metro area) within 5 years.

We report in Table 1 the estimated average transition rates from our preferred specifications[3]. The tables shows results when using the decomposition between F1 and non-F1 students (columns 1 and 2) and then separating the three groups of F1, non-F1 documented and non-F1 undocumented (columns 3 and 4). Each entry of the table can be interpreted as the average transition rate (between 0 and 1) of the group from college into employment within the State (columns 1 and 3) or within the Metropolitan area (column 2 and 4) where they obtained their college degree. The numbers in parenthesis are the standard errors of the estimates. The presence of measurement error could produce estimates of the rate to be smaller than 0 or larger than 1.

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[3] For a series of alternative specifications the interested reader can see the Appendix.

Three clear results emerge from the estimates of Table 1. First, when considering F1-students their transition rates are never significantly different from 0. While the standard errors are large and one cannot rule out small transition rates of 0.1 or 0.2 (i.e. 10 or 20% of those students become workers in the local economy within 5 years from graduation), rather than 0, in general the estimates are consistent with a loss of 80 to 100% of these students, within the first five years after graduation. The negative estimates in column (1) and (3) are not statistically different from 0 and they can be considered, essentially, as imprecisely measured zero transition rates. This zero result is common to both college to employment transition in metro areas and state economies and it appears in all the estimates.

The second important result is that non-F1 students and, when we break down the group, the documented among them, have a transition rate into local employment equal to 80-100%. Hence their transition into local employment is very high, similar to that of natives (calculated with a similar model also close to one[4]) and consistent with the idea that most of them on average are employed in the local economies within 5 years of graduation. Educating foreign-born who arrived in the US as children in immigrant families, allows local economies to increase college educated in their labor force almost one for one. Third, and finally, when considering undocumented students, their transition rate to local employment is 20 to 30 percentage point lower than for documented foreign students. The imprecision of the estimates (whose standard error is between 0.28 and 0.37) is large and one cannot rule out much smaller differences with documented or, a smaller transition rate for undocumented. We will take the point estimates of these transition rates as reference, aware that they could be imprecisely estimated. The indication is that this group has a significant rate of transition to local employment but somewhat smaller than for the documented immigrant group.

Our analysis of the cohort under consideration emphasizes that F1 students were substantially different from other foreign-born in their transition rate into local employment. While, in principle, some of these students could remain in the US, at least for a while, either on some visa extensions (OPT) or on other visas, our aggregate analysis reveals that State or metropolitan areas where they study are unable to retain them, on average.   Our analysis reveals that this is very different from the aggregate behavior of other foreign students who are very likely, instead, to become employees in the state or metropolitan area where they study.

The results on college to employment transition rates of undocumented students are less clear. Because of possible measurement error (of the undocumented) and of the noise in the data, we find weaker suggestive evidence that their ability to transit to local employment is 20 to 30 percentage point lower than that for documented in the first 5 years after graduation. They seem however much more likely to become local workers than the F1 students. Their lower transition rates, relative to documented, may be due to

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[4] A regression of the (log of) citizen college educated workers 25-29 in 2010-2014 on the (log of) citizen attending college, 20-24 in 2005-2009 gives a transition rate of 0.998 (s.e. 0.024) at the state level and of 1.1 (s.e. 0.02) at the metropolitan area level.

the fact that some of them leave the country, or because some of them take a longer period to find a job, or because they have to follow the few opportunities available to them, often in a different state or metro areas.

III.3 Direct loss of employment, wage income and tax revenues

As we discussed in section II there could be several effects of increasing the retention rates of foreign college graduates on a local economy. Using the estimated transition rates in subsection III.2 above and the average wage of a foreign-born college educated in a state we evaluate here the very direct effect, on employment and wages. The thought experiment done in this section consists in calculating the increase in college employment as share of the cohort entering the labor market between 2010 and 2014 obtained from increasing the college to employment rate of F1 and of undocumented to the level of documented foreign students. We also evaluate the dollar increase in total wage income and total state income taxes that this would entail. We do this experiment for States, using the coefficients estimated in specification (1) and (3) of Table 2. We report these numbers separately for F1 and undocumented, and we show only the top ten states in terms of potential gains from this increase (or equivalently of current losses from the lower transition rates).

Table 2 shows the lost employment as share of the new cohort of college educated who entered the labor market in 2010-2014, associated with the zero transition rates of F1 students. In some states such as Massachusetts, Oregon and Hawaii, the new cohort of employed college educated workers would be 2.9 to 4.5% larger if F1 students had transition rates similar to other foreign-born students. All top ten states lost more than 2% of the new college graduate cohort in their employment because of small transition rates of F1. Interestingly the states of Kansas and of North Dakota, because of their relatively high share of F1 visas, experienced significant losses in their cohort of college educated.

Table 3 shows the employment loss associated to lower college to employment transition of undocumented students for the top ten states, always expressed as share of the cohorts graduating in 2010-2014. Because the presence of these students is larger in the traditional immigration states those are subject to larger losses. The loss is smaller in percentage terms (the highest value is a half of a percentage point in California) than for F1 because the local college to work transition rates of undocumented immigrants are not as low as for F1. Still for the top states the loss of undocumented college graduates is between 0.3 and 0.5% of the new college educated cohort.

Let us emphasize that this is the loss from lower college to employment transition rates of F1 and undocumented, assuming that the other native and foreign-born college graduates are employed at the same rate as before. If there are also negative external effects, so that companies have to relocate, or they innovate less and then their growth slows down, there can be larger effects in terms of jobs lost. On the other hand if F1 and

undocumented workers crowd out native college educated the loss of total employment would be smaller.

In order to give a dollar quantification of the employment loss calculated above, in Table 4 and 5 we show the overall wage income loss, obtained by multiplying the number of college workers lost to the state by the average yearly wage of college educated foreign-born in that state in the age range 25-29 (expressed in constant 2014 $). Next to it we calculate the state income tax lost in each state, calculated by assuming that those college educated earners would have no dependents (no children, parents, etc.), which is reasonable given their age, and received no exemptions or deductions at the state level.

We use the actual tax schedule, by state, in 2014 as produced by the TAXSIM model[5], which is used to simulate tax liability for each individual in each state. Some states (such as Washington, Texas and Florida) have no state income tax and hence no loss. The tables only include the ten states that would experience the largest losses of wage income. California's wage loss associated to the low retention of F1 students was around 2 billion dollar per year and for New York the loss amounted to 1.7 billion in 2014$. Those states also had a significant aggregate income loss associated to the lack of retention of undocumented. The loss amounted to more than 600 million dollar and 200 million, respectively. The numbers are smaller for smaller states but, combining the two types of losses, Texas, Illinois and Florida forego several hundred million dollars in income by not retaining F1 and undocumented students.

Similarly in terms of state income taxes lost, California and New York gave up respectively, 60 and 77 million dollars of revenue associated with the departure of F1. They also missed about 20 and 10 million, respectively, associated with the lack of employment transition of undocumented college students. While these numbers are not too large (as the state income taxes are only a few percentage points) they constitute certainly valuable revenue for the states. These foregone revenues increase with the number of foreign-born students who are educated in US universities.

III.4 Analysis of possible effects of DACA and OPT

In the previous analysis we have suggested that differences in college-to-employment transition rates across groups can be due to their different immigration status. However, there is a more direct way to test whether policies that have increased the employability of F1 or undocumented foreign students have translated into a higher college to employment transition rate for those two groups. In particular for the F1 visas we consider the extension to optional practical training (OPT) for STEM students from 12 months to 29 months after graduation that was introduced in 2008. OPT is a form of part-time employment combined with training that has allowed several college educated students in STEM fields to find research-type jobs temporarily in the US. In 2008 the

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[5] See Feenberg, Daniel Richard, and Elizabeth Coutts, An Introduction to the TAXSIM Model, Journal of Policy Analysis and Management vol. 12 no 1, Winter 1993, pages 189-194. URL: http://www.nber.org/taxsim/

possibility of working in these positions, for STEM graduates, was extended by 17 month from 12 to 29 so that these people could have a longer period in the US labor market. For the undocumented workers, instead, we consider the Deferred Action for Childhood Arrival (DACA) Act, introduced in 2012. This policy allows temporary work permits to undocumented college educated people who arrived as children and have attended College. DACA has provided protection against deportation for this group and it has allowed them a renewable temporary working permit. Uncertainty surrounds this policy however about its future, and it is unclear if it will be renewed, expanded or eliminated. Our analysis considers whether the college-to-employment transition rate for F1 visas (in the first case) and for undocumented foreign students (in the second case) increased from before to after introduction of the policy, relative to the transition rate of documented foreign students in the same cohort, who are a reasonable "control group" as they are similar in origin, age and opportunities, to the treated group but they were unaffected by the policy.

In a difference in difference approach we consider, for the first policy episode, the two cohorts aged 23-24 in 2006 and who graduated (in 2006 and 2007) right before OPT was extended and the two cohorts that graduates right after that (2008 and 2009). We evaluate the change in college to employment transition rate of F1 relative to non-F1 students from before to after the policy. For the second policy episode we do a similar exercise for the change in college-to-employment transition probability of undocumented versus documented in 2010 and 2011 (pre-DACA) relative to 2013 and 2014 (post-DACA). As we consider a shorter period of transition (only 2 years) and fewer cohorts, relative to the analysis in section III.2 above, the overall transition rates are lower as people may take time to find jobs or they may graduate later than age 24[6]. Considering the analysis at the Metro-Area level we report the estimates of the difference-in-difference policy effect on the treated group in Table 6. This coefficient measures the change in college to employment transition rate from before to after the policy. The change in transition rate pre-post OPT extension for F1 relative to non F1 was between 0.07 and 0.25 depending on the specification. These results are reported in the first row of Table 2, where each column corresponds to a slightly different specification. The baseline specification is shown in column (1), then we exclude the large state of California (column 2) or we include state-effects (column 3) or state and time fixed effects (column 4). The introduction of the policy is estimated to have increases the transition rate from college to local employment of F1 (relative to non F1) by 7 to 25 percentage points. In most cases the standard error of the estimated effect is large so statistical significance is small, but given the very low estimated of baseline transition rates of F1 (not different from 0) in Table 1 the point estimates are quite large and suggestive of potentially significant effects.

For DACA the effect was not as strong. They are reported for similar specifications, as estimated for OPT, in the second row of Table 6. They show an increase in the college to employment transition rate of undocumented (relative to documented students) between 0.04 and 0.09 from pre to post DACA. As the differential in transition rates between documented and undocumented estimated in Table 1 was only 20 to 30 percentage point

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[6]For the foreign-born likely documented the basic transition rate was about 0.4 in this case.

this increase could have been significant and it reduced the gap by a up to one third of its size. In all the estimates of the effect of DACA, however, the standard errors of the estimates are large enough that it is hard to do precise inference or to exclude zero effect. The point estimates, however, are suggestive of an effect in the right direction. More detailed analysis on individual data and longer time periods may be needed to definitely support these results, but the preliminary evidence from this simple difference in difference analysis, suggests that the two policies reduced the gap in college-to-employment transition rates for undocumented immigrants and F1 immigrants and hence they worked in the right direction.

III.5 Breakout analysis: Midwestern states

The analysis for the whole United States has shown that several traditional immigration states (such as California and New York) would significantly increase their growth in college educated share of the labor force if they could retain F1 and undocumented college students into local employment. Several other states that attract a significant share of F1 students, such as Oregon, Washington and Massachusetts would benefit significantly too. Looking at the list in Appendix Table A2, some of the universities attracting a large number of F1 students are in Midwestern states. Purdue University, University of Indiana, Michigan State University and University of Illinois are all among the very top schools in terms of the number of foreign students they educate. In this section we briefly show how the presence of F1 and undocumented student is distributed in Midwestern states and how the low retention rates for those students, which seems to be a typical feature for these states as much as it is for the country, reduces their aggregate income and their aggregate tax revenues relative to what they could be.

Figure 7 shows the presence of F1 students as share of the college population age 20-24 in Midwestern states and it reveals that states such as Kansas, North Dakota, Iowa and Minnesota are hosting a significant share of their college population as F1 students. They are, in fact, 2-3% of their total student body. Midwestern states, with some prestigious universities, could continue to increase this share. The metropolitan area of Ann Arbor, for instance, home to University of Michigan and the metropolitan area of Urbana-Champaign, home to University of Illinois both have a higher share of F1 students. Figure 8 graphs the Midwestern metropolitan areas with largest share of F1 showing that several of them have more than 3% of their student population accounted for by F1 visa students. On the other hand Midwestern states seem to have a much smaller population of undocumented college students, relative to the top immigration states of California, New York, Florida and Texas. The one exception is Illinois where close to 1% of college students have high probability of being undocumented. Illinois is also the state with the highest percentage of foreign college students overall with almost 4% of its college population being foreign born, most of them children of immigrants, who arrived in the US as school age children and then attended college there.

Our regression analysis confirms that also for the Midwestern states the rate of college to employment transition of F1 students is extremely low, and not significantly

different from 0, just as for the national average. These states are not able to retain the tens of thousands of foreign college students who come to get a college education on an F1 visa.

If those F1 students would be retained as workers in the Midwestern states, Illinois would experience a 700 million $ increase in its aggregate income, and Minnesota and Ohio about 500 million each. Michigan's wage income would add 350 million $. This extra income would generate extra revenues from state taxes between 12 and 33 million dollars per year for those states. Table 7 shows these figures for all Midwestern states, obtained by calculating the extra income and taxes generated by increasing college-to-local employment rates of F1 and undocumented students to the same level as for documented foreign students. Higher college to employment transition rates of undocumented students would generate less of a gain in Midwestern states, relative to retention of F1, due to the smaller number of undocumented students in the Midwestern states.

Just as the rest of the nation, several University institutions in Midwestern states are beginning to understand the value and the positive effects of attracting international students. As this continues to happen, the potential income, employment and tax revenues that would be gained by retaining some of those students, at least for some years, after graduation increases. The potential gain from retaining these students was already in the order of 3-4 percent of the new cohorts of college educated entering the labor market in 2010-2014. This amounts to hundred million dollars of income for large states and in some cases a few billions. Also non-trivial are the gains in revenues from state income taxes that retaining F1 students would produce. Given the size and the growing trend of this phenomenon and informed by our research that finds such a low rate of retention of F1 students into local employment we propose some policies that could realize some of the potential gains quantified in this paper.

IV. Policy Recommendations

Three simple facts emerged from our analysis and they provide an important starting point to think of policies that could improve the status quo. First, a growing number of international students applied and was admitted to US universities in the last few years. This is because US universities are leader in the world for teaching and research. Most of the top Universities in the world, according to any ranking[7], are in the US. Hence a very large number of highly talented international students would be extremely excited to study in the US. Second, these students are willing to invest (their own money) in their education and US universities are eager to admit the best among them. Third, the US scientific and technological sector require a large number of highly qualified and creative people to continue being the leader in the world and an engine of a growing economy. Students selected by demanding US universities,

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[7] See, among others, the US News and World Report here http://www.usnews.com/education/best-global-universities/rankings which includes 8 US universities among the top 10 and 80 among the top 100.

who graduate and earn titles in STEM fields would be a fundamental input in this process. Moreover our analysis found that a significant amount of income would be generate in local US economies if a fraction of them was retained as worker at least for some years.

Based on these considerations we suggest some policies that we think are in line with our findings and would contribute to fairness and US economic growth.

1) We should allow a provisional visa, similar to an H-1B, to all students who graduate with a college degree in a STEM field from a four-year US University within a list of accredited institutions. This visa would be valid for three years and renewable for three more and it could be converted in a permanent permit (green card), after 6 years, if the employer would sponsor the person and the worker chooses to stay. The access to a permanent permit should not be included in the yearly quotas for employment preferences nor in the quota by country. The immigration status before college should be irrelevant to access these visas, so that also undocumented students would be able to benefit from it. An added bonus is that the STEM focus of the program would contribute to direct towards STEM fields several of the undocumented students improving a situation in which minorities are under-represented in STEM fields.

   The advantage of this provision would be that the deserving students who would like to work in the US have a simple and direct way of doing it as long as they have a job offer. This option allows them some years of experience in the US. While some of them would leave after these initial years some may like to stay permanently and the option of a permanent permit (green card) would allow them to do so. This policy would very likely increase college-to-local employment transition with benefits for the local economy.

2) An alternative, and more "conservative" option would be to augment the currently issued H1B visa by an extra number (say initially 60,000 extra visas) reserved to students who graduate in a STEM field from a four-year US University within a list of accredited institutions. Just as there are 20,000 additional H-1B visas for individuals who obtained a US master or higher degree it would be reasonable to give a preference to US college graduates and this can be done by adding visas reserved to them. Hiring on H-1B visas US college-educated STEM workers would reduce the risk of employers rotating temporary foreign workers, paying them less than fair wages as alleged by some critics of the H1B programs. These workers will likely have several different employment options and will choose the most advantageous and will have knowledge of the US labor markets sufficient to increase their bargaining power with any employer, making them less subject to potential exploitation as allegedly found in some case for H1B visa workers.

   While any "mechanical" cap on the number of visas is undesirable as the number of students who stay should be just driven by their ability to contribute to the US economy (within a job) and their choice, the present option would improve on the

current situation by providing some students with the option to remain in the US for a while. To improve efficiency and receive a signal from the market on how valuable these graduates are, this system can be combined with an auction of these visas to employers so that those who are willing to pay more (i.e. for whom the worker has larger productivity) have more chances to get these graduates. The market clearing price of the visa would reveal how large the demand for those workers is. The revenues from each visa from the auction could be returned to the Universities that educated the foreign students producing for them a strong incentive to select the most employable and valuable students.

3) A different approach to benefit the local economies would entail linking more closely the university where a student gets her education and the initial job permit that she receives. Just as the F1 visa limits the student to a specific university, one could award to students graduating from that university (in STEM fields) a temporary working permit as the one described under 1) but with the further provision that the student must stay for an initial period, say three years, with an employer in the same state where the university is.

 Limiting the student geographically is less restrictive than what done by some visas that link the worker to a specific employer, and hence would not constrain much the student's options. At the same time this provision maximizes the economic benefit for the local economy of educating foreign students. After the initial three years the person should be allowed to renew the permit to work anywhere in the US for three more years and after that she should have the option of a Green card. This would create a strong commonality of interests between local universities and employers at the local level, with the goal of selecting the best and more productive foreign students-workers. This way, revitalizing local universities by attracting foreigners would also help revitalize local business providing them highly educated individuals looking for good local options.

4) In order to encourage new foreign graduates who are starting a business, and to capitalize from the high propensity of some foreign students to be entrepreneurs, foreign students who graduate from US universities with a plan to start a business could be given access to an "investor" visa on the line of an E2, but with smaller requirements in terms of investment and people hired.

While it is important that the immigration laws evolves to be less of an impediment for deserving individual who want to work and invest in the US, it will always be the case that many of the people educated in US universities will go back to their countries. A very important role of the US university system is also that of educating the economic, cultural and business leaders of the world with positive effect in strengthening business, academic and cultural ties between the US and these countries. In this respect it may be important that people with a US university education could maintain an easier access to investing and starting businesses in the US even after they have returned to their countries. Hence the easier access to E2

visas could be maintained even for US university graduates who have gone back to their country of origin for some years.

V. Conclusion

The US occupies the enviable position in the world of having the most renowned and prestigious universities and hence a large potential supply of highly talented students who are ready to invest years of their life to learn in these universities and become highly productive scientists, engineers and business leaders. While the effects of this leadership are evident in the growing number of foreign students educated in US universities, the potential impact of these students on job creation, firm productivity and innovation in the US is currently muffled. The reason is that some of these students, because of their temporary visa status or because their undocumented status, will not become employed in the US and will not contribute with their human capital to the growth of the US economy.

In this study we measure the size of this phenomenon, we describe its geography in the US and we quantify the potential effect that simple policies increasing the legal access to labor opportunities for these highly talented foreign students could have. By increasing the college-to-employment transition rates of F1 and undocumented students several US states would experience increase of their income by hundreds of million dollars with important increases in their employment and tax revenues. The most important effects, however, as these students would contribute to science, technology and innovation could be in the long-run growth of the US economy and of its crucial leadership in technology and science. These effects are not measured here. The measured effects, however, are large enough to imply large positive effects from simple policies that would allow local US economies to retain these students as employees.

The policies we suggest make economic sense for states that educated foreign students and could retain some of the value added from their human capital. Moreover as some of these policies apply also to undocumented college students they would help to integrate in high paying jobs and leadership positions a new generation of undocumented Mexican/ Central American youth, with positive effects on the Hispanic communities in several US states.

We think that Universities, States and Cities can be very important actors in these policy changes and they should encourage research in this area and promote fact based and well informed analysis that leads to reasonable policies for fairness and economic growth.

VI. Appendices

VII.a Validation of F1 student definition using SEVIS data

The construction of the number of foreign student on F1 visas in each year and state is done by selecting in the ACS individual data the group with higher probability of being in this visa status based on individual characteristics and then validating this choice by matching the number of F1 students obtained with this method with those in the SEVIS data.

The individuals with highest probability of being on an F1 visa are the foreign-born who arrived in the US when they were 16 years old or older. They should also not be dependents/spouses in a household with a different head of household. In order to validate our choice we do two things. First we check that the aggregate number produced by this selection is not too far from the number obtained by the F1 administrative data for the whole US. Second, we calculate from the ACS the distribution of these "imputed" F1 students across states and check how they compare to the distribution of the corresponding F1 students from the SEVIS (USCIS) data across States.

The aggregate number of imputed ACS-F1 is growing over time and it is equal to 355,175 in 2014. The aggregate number obtained from SEVIS is 308,858. While certainly our method includes some non-F1 students, the ACS aggregate value is not too far from that obtained from administrative source. More informative and even more relevant is the correspondence between ACS-F1 and SEVIS-F1 across US states, as it provides an important check of the correlation of these values across states. This is represented in Appendix Figure A1, for all US states, and in Appendix Figure A2, for the US states excluding the four largest so as to show better the distribution of the non-top states. If the count of F1 college students were exactly the same from either source, then the point corresponding to each US state would be exactly on the 45 degree line of Figure 1 and 2. Deviations from the 45 degree line imply the existence of error in measuring F1 visa students in the ACS sample. The figures show that all US states line up not far from the 45 degree line and that some states are above and some below it. This implies that our method has some error but that the error is not systematic in one direction (over or under measuring the F1 students) and that the error is not too large (most deviations are between 5 and 10%).

VII.b Regression analysis of the transition rates

The specification producing the estimates of college-to-employment transition rates is as follows:

$$\left(\frac{Empl^{Coll,25-29,Foreign}}{Empl^{Coll,25-29}}\right)_{2010-14,i} = \alpha + \beta_{F1}\left(\frac{Stud^{Coll,20-24,F1}}{Stud^{Coll,20-24}}\right)_{2005-09,i}$$

$$+ \beta_{non-F1}\left(\frac{Stud^{Coll,20-24,foreign\ non-F1}}{Stud^{Coll,20-24}}\right)_{2005-09,i} + \varepsilon_i$$

(A1)

The dependent variable is the count of foreign born college educated in age bracket 25-29, employed in period 2010-14 in geographic unit "i" (that could be a state or a metropolitan area), standardized by the total college educated employment in age 25-19 in the same geographic unit. The first explanatory variable is the number of F1 college students age 20-24 in 2005-2009 in the same geographic unit. They represent the same age cohort as the employee in the dependent variable, when they were college students. The second is the number of non-F1 foreign students also in the same cohort. These two values are standardized by the aggregate college population 20-24 in that period. The standardization adjusts for the size of a local college-age cohort and the coefficients β_{F1} and β_{non-F1} estimate the average college-to-employment transition rate for F1 and non F1 when there is measurement error in the employment variable. These two coefficients are those reported in Table 1 columns (1) and (2) when the regression is estimated on US states or on US metropolitan areas respectively. A similar specification, that includes as explanatory variable the undocumented foreign students allows for estimating their college to employment transition too. The specification would be as follows:

$$\left(\frac{Empl^{Coll,25-29,Foreign}}{Empl^{Coll,25-29}}\right)_{2010-14,i} = \alpha + \beta_{F1}\left(\frac{Stud^{Coll,20-24,F1}}{Stud^{Coll,20-24}}\right)_{2005-09,i} +$$

$$+ \beta_{doc-non-F1}\left(\frac{Stud^{Coll,20-24,doc\text{-}non-F1}}{Stud^{Coll,20-24}}\right)_{2005-09,i} +$$

$$+ \beta_{undoc}\left(\frac{Stud^{Coll,20-24,foreign,undoc\text{-}non-F1}}{Stud^{Coll,24-28}}\right)_{2005-09,i} + \varepsilon_i$$

(A2)

The coefficients β_{F1}, β_{non-F1} and β_{undoc} are those reported in Table 1 columns (3) and (4). The regressions are derived from identities which would hold exactly if all college students were to become workers in the state/metro area within 5 years of graduation. However with some leakage, imperfect transition and error, a regression is needed and the coefficients provide the average transition rates for each group.

VII.b Difference in difference estimates of the OPT extension effects and pre-post DACA effects on college to transition rates

The coefficients in the first and second row of Table 6 are obtained from a regression similar to (A1) with some changes. In the first row we consider two cohorts including college students 23 and 24 years old in 2006 and then as college graduates in 2007 and 2008 before the OPT extension was approved. The other included cohort-area observations are for individuals who were 23 and 24 years old in 2008 and college student and then they were college graduates in 2009 and 2010, right after the OPT extension. Observations in the regression represent 277 metropolitan areas and there are two cohorts per metro area. We pool these units and we regress the foreign employment as share of total employment in the cohort on the number of F1 college students and non-F1 college students as share of total students in the same cohort 2 years earlier. We include state fixed effects and cohort effects and we introduce a post-2008 graduation dummy interacted with the number of F1-students as share of the cohort. This allows estimating different college to employment transition rates for F1 and non F1 and before and after 2008. The coefficient on the interaction variable, in different specifications, is reported in Table 6 row 1 and provides the difference in difference estimator between pre and post policy.

In row 2 of Table 6 we do the same analysis, with two 2-year cohorts of individuals centered around 2012 as graduation year. Namely we pool the cohort that graduated right before and right after 2012 for each Metro area in a regression and we use the number of foreign-born in employment (as share of the cohort) as dependent variable and the number of documented or undocumented students (as share of the cohort) in the same cohort two years earlier. The coefficient on the interaction variable (post 2012-undocumented college students) captures the difference in difference estimate of the DACA policy on college to employment transition differentials and it is reported in Row 2 of Table 6.

References

Demirci, Murat (2016) "International STEM Students and the US Labor Market: The Role of Visa Policy" manuscript university of Virginia, Charlottesville.

Diamond Rebecca (2015) "The Determinants and Welfare Implications of U.S. Workers' Diverging Location Choices by Skill: 1980-2000" SIEPR Working Paper.

Hunt, Jennifer & Marjolaine Gauthier-Loiselle, 2010. "How Much Does Immigration Boost Innovation?" American Economic Journal: Macroeconomics, American Economic Association, vol. 2(2), pages 31-56, April.

Iranzo Susana and Giovanni Peri, (2009) "Schooling Externalities, Technology, and Productivity: Theory and Evidence from U.S. States," The Review of Economics and Statistics, MIT Press, vol. 91(2), pages 420-431, May.

Kantor Shawn and Alexander Whalley (2014) "Knowledge Spillovers from Research Universities: Evidence from Endowment Value Shocks," The Review of Economics and Statistics, MIT Press, vol. 96(1), pages 171-188, March.

Kerr William & William F. Lincoln, (2010). "The Supply Side of Innovation: H-1B Visa Reforms and U.S. Ethnic Invention," Journal of Labor Economics, University of Chicago Press, vol. 28(3), pages 473-508, 07.

Moretti Enrico (2013) "The New Geography of Jobs" Houghton Mifflin.

Moretti, Enrico, (2004). "Estimating the social return to higher education: evidence from longitudinal and repeated cross-sectional data," Journal of Econometrics, Elsevier, vol. 121(1-2), pages 175-212.

Moretti, Enrico (2004). "Workers' Education, Spillovers, and Productivity: Evidence from Plant-Level Production Functions," American Economic Review, American Economic Association, vol. 94(3), pages 656-690, June.

Peri, Giovanni, Kevin Shih and Chad Sparber, (2015). "STEM Workers, H-1B Visas, and Productivity in US Cities," Journal of Labor Economics, University of Chicago Press, vol. 33(S1), pages S225 - S255.

Ruiz, Neil (2014) "The Geography of Foreign Students in US higher education: Origins and Destinations" Brookings Brief, August 29, 2014, http://www.brookings.edu/research/interactives/2014/geography-of-foreign-students#/M10420 (accessed January 18th, 2016)
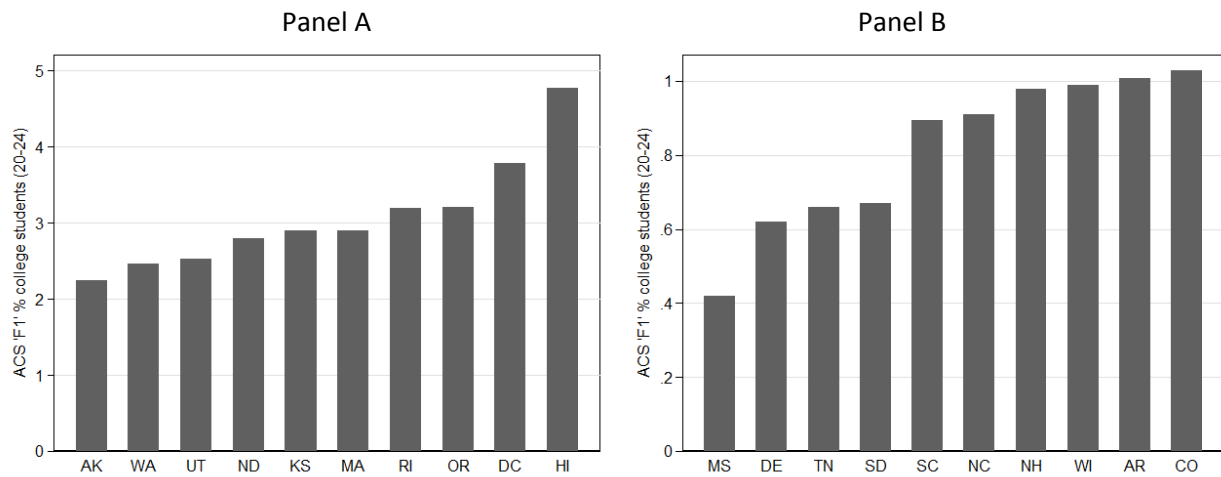
Figures

Figure 1
Map of ACS-F1 students as percentage of 20-24 years old college students, 2005-2009
US states (excluding Alaska and Hawaii)
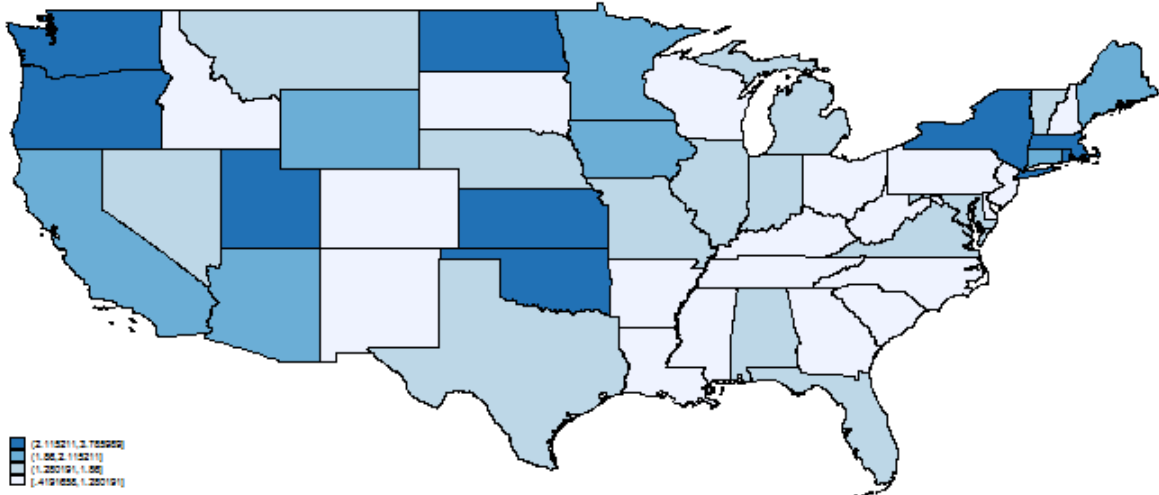
Note: The map shows the percentage of F1 foreign students in the college population of each state. Darker color implies larger share. The share is calculated from ACS data as described in the text and it is relative to the period 2005-2009.
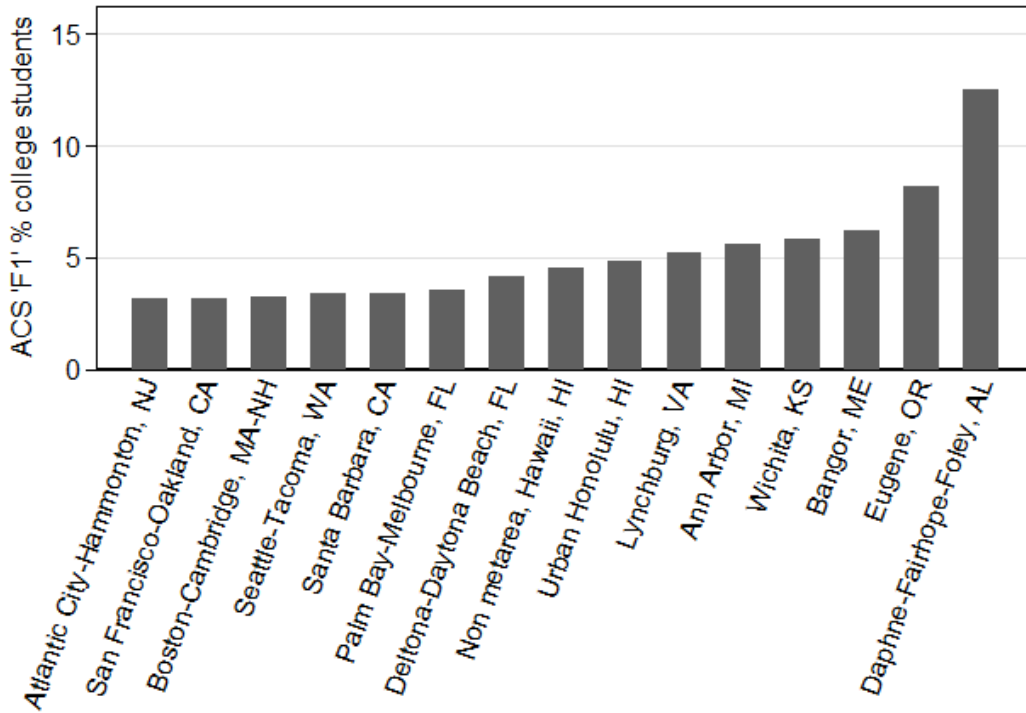
Figure 2
US states with highest and lowest F1 visa students as percentage of 20-24 years old college students

Note: The chart shows the 10 states with the largest percentage of F1 among 20-24 years old college students (Panel A) and the ten states with the smallest percentage of F1 among college students (Panel B).

Figure 3
US metropolitan areas with highest F1 visa students as percentage of 20-24 years old college student
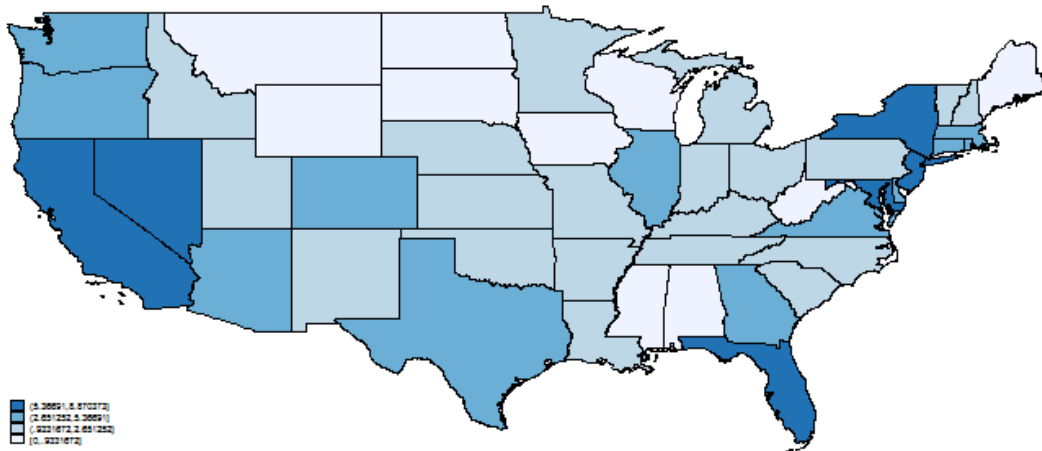

Note: The chart shows the 15 metropolitan areas with the largest percentage of F1 among 20-24 years old college students. F1 students are defined from the ACS following the method described in the text.
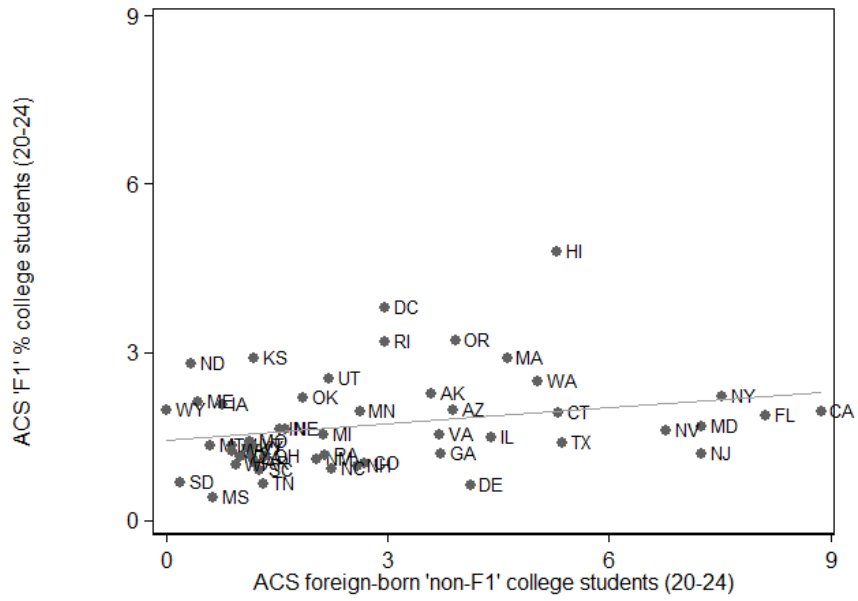
Figure 4
Map of non-F1 students (from ACS) as percentage of College students
US states (excluding Alaska and Hawaii)

Note: The map shows the percentage of non-F1 foreign students in the college population of each state. Darker color implies larger share. The share is calculated from ACS data as described in the text and it is relative to the period 2005-2009.

Figure 5

Correlation between F1 and non-F1 foreign-born as share of 20-24 years old college students,

ACS data by state (with linear regression line)

Note: F1 and non-F1 students are calculated form the ACS as described in the text. The period considered is 2005-2009.
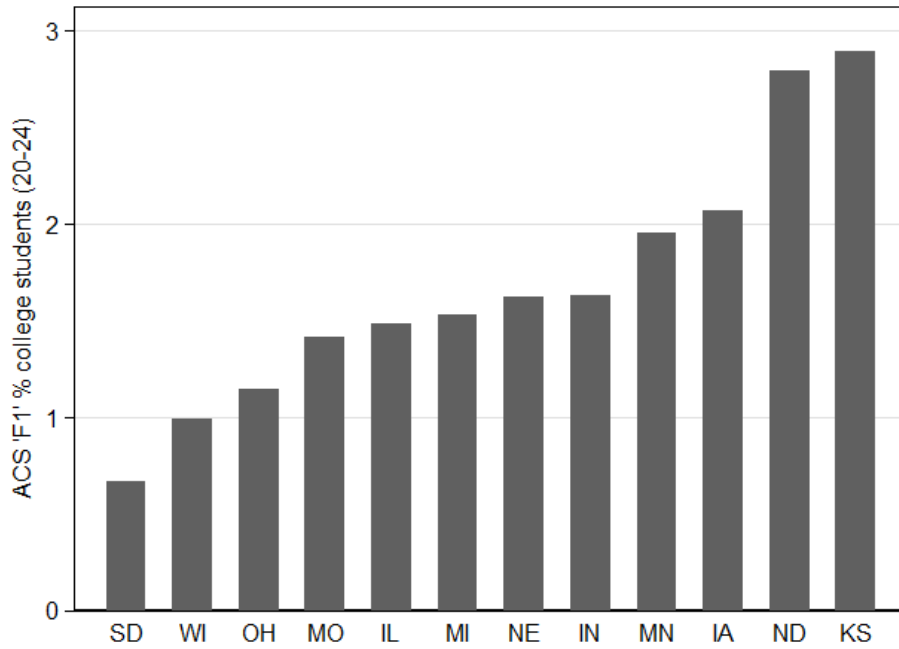
Figure 6
Non-citizen students as percentage of college students: F1, likely undocumented and likely documented non-F1
10 largest (left graph) and 10 smallest states (right graph)
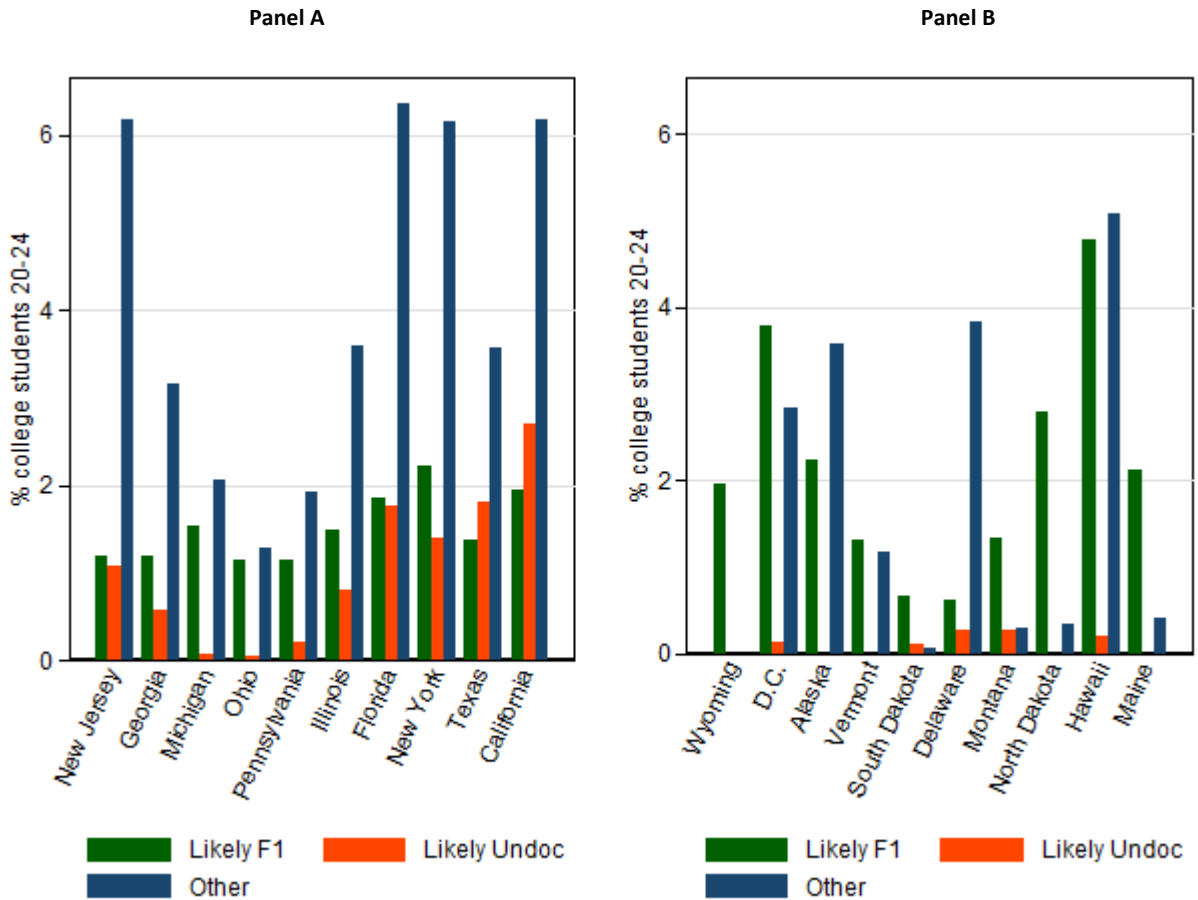
Panel A   **Panel B**

Note: The bar chart shows the foreign students as percentage of the college population age 20-24 in the period 2005-2009, divided into three groups: F1 students (green), likely undocumented students (orange) and non-F1 likely documented students (Blue). Panel A shows the ten states with largest percentage of total foreign students and Panel B the 10 with the lowest percentage.

Figure 7
Midwest states: F1 visa students as percentage of 20-24 years old college students

Figure 8
Midwest metro areas with highest F1 visa students as percentage of 20-24 years old college student

Note: The chart shows the 15 metropolitan areas in Midwestern states with the largest percentage of F1 among 20-24 years old college students. F1 students are defined from the ACS following the method described in the text.

Figure 9
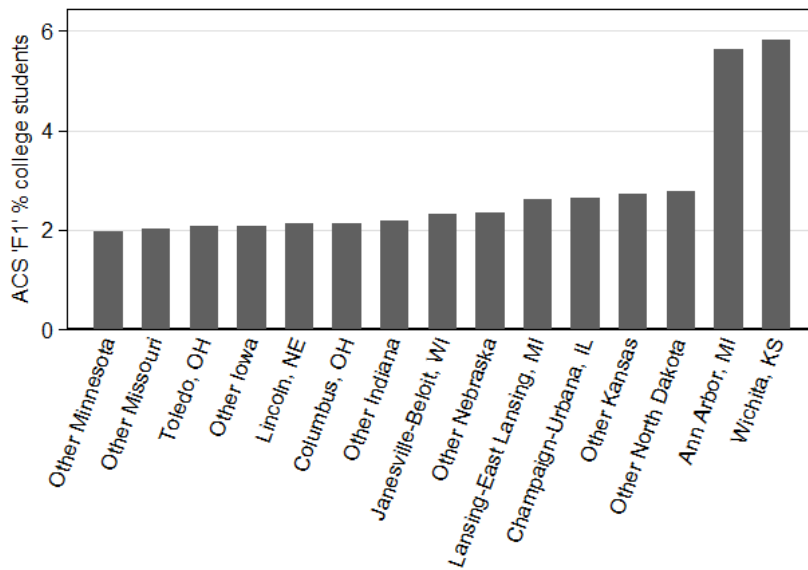**F1, likely undocumented and likely documented non-F1 students: top and bottom states**
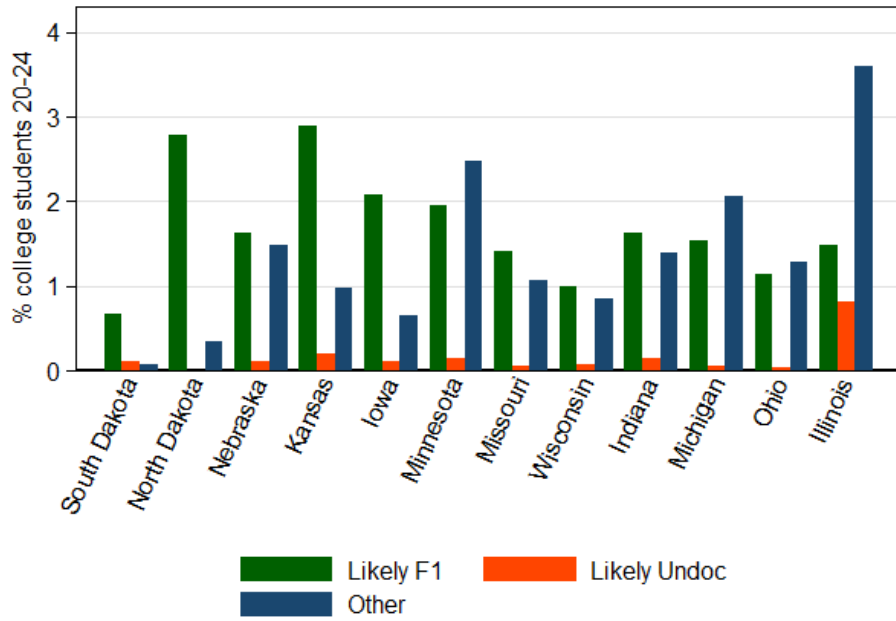
Note: The bar chart shows the foreign students as percentage of the college population age 20-24 in the period 2005-2009, divided into three groups: F1 students (green), likely undocumented students (orange) and non-F1 likely documented students (Blue).

Table 1
Estimated Transition Rates from college to local employment
US States, cohort of college students age 20-24 in 2005-2009 and college educated in 2010-2014

Transition rates	(1) US States	(2) US Metropolitan areas	(3) US States	(4) US Metropolitan areas
Foreign F1	-0.04	0.12	-0.20	0.17
	(0.16)	(0.12)	(0.23)	(0.17)
Foreign non-F1 (all)	0.92**	0.82**		
	(0.03)	(0.04)		
Foreign non-F1 documented			0.98**	0.83**
			(0.18)	(0.10)
Foreign non-F1 undocumented			0.77+	0.54*
			(0.38)	(0.27)
R-squared	0.95	0.82	0.96	0.85
Observations	51	277	51	277

Note: Each column shows the transition rate from college to local employment estimated from a different regression. Column (1) and (2) shows the basic weighted specifications including only 2 groups, F1 and non-F1. Column (3) and (4) shows specifications with 3 groups and including district and state fixed effects.
Heteroskedasticity robust standard errors are reported in parentheses. $^+ p < 0.10$, $^* p < 0.05$, $^{**} p < 0.01$

Table 2

Loss of F1-students' employment as share of college-educated cohort

Top 10 states, cohort of college students in age group 20-24 in 2005-2009

	State	Share of college-educated lost
1	Hawaii	0.045
2	District of Columbia	0.036
3	Oregon	0.030
4	Rhode Island	0.030
5	Massachusetts	0.027
6	Kansas	0.027
7	North Dakota	0.026
8	Utah	0.024
9	Washington	0.023
10	Alaska	0.021

Note: We calculate the share of the college educated cohort lost to employment by multiplying for each state the share of F1 students in the college population by the difference in the estimated transition probability for F1 and non-F1 foreign students from college education into employment from table 1. The cohort considered is the one in the age group 20-24 during the period 2005-2009 and attending college. The coefficients used are those from column (1) of Table 1.

Table 3

Loss of undocumented students' employment as share of college-educated cohort

Top 10 states, cohort of college students in age group 20-24 in 2005-2009

	State	Share lost
1	California	0.0058
2	Texas	0.0039
3	Florida	0.0038
4	Nevada	0.0031
5	Arizona	0.0031
6	New York	0.0030
7	New Mexico	0.0024
8	New Jersey	0.0023
9	Illinois	0.0017
10	Massachusetts	0.0017

Note: We calculate the share of the cohort lost to employment by multiplying for each state the share of likely undocumented students by the difference in the estimated transition probability for likely documented and likely undocumented foreign students from college education into employment. The cohort considered is the one in the age group 20-24 during the period 2005-2009 and attending college. The coefficients used are those from column (3) of Table 1.

Table 4

Loss of wage and state tax income from low college-employment transition rates of F1-students

Top 10 states in US 2014 $

	State	Wage income lost in *US 2014 $*	State Tax Income lost in *US 2014 $*
1	California	2,010,546,688	61,952,719
2	New York	1,617,664,000	77,433,201
3	Texas	887,849,600	0
4	Washington	702,837,504	0
5	Illinois	616,624,320	29,210,751
6	Massachusetts	613,043,328	27,460,444
7	Florida	560,862,976	0
8	Minnesota	464,424,416	20,465,232
9	Ohio	462,027,936	10,614,124
10	New Jersey	448,070,112	11,267,289

Note: We calculate the wage income lost by taking the difference in the estimated transition probability for F1 and non-F1 foreign students from college education into employment and multiplying it by the number of F1 students in the state (2005-2009), by the employment rate of foreign college educated in the cohort, and by the average wage of college-educated foreign born in 2010-2014. The cohorts considered are those in the age group 20-24 during the period 2005-2009 and attending college. Their employment rate and wage is evaluated in the period 2010-2014 as the cohort is 25-29 years of age in the same state. The coefficients used are those from column (1) of Table 1. The State Tax income lost is calculated by multiplying the number of employees lost times the state tax they would pay, based on the state-specific rates and the average income of a college educated foreign born in the state in 2014 as described in the text.

Table 5

Loss of wage and state tax income from low college-employment transition rates of undocumented

Top 10 states in US 2014 $

	State	Wage income lost in *US 2014 $*	State Tax Income lost in *US 2014 $*
1	California	632,208,768	19,480,797
2	Texas	263,711,920	0
3	New York	228,584,080	10,941,702
4	Florida	120,121,448	0
5	New Jersey	91,624,832	2,304,022
6	Illinois	75,626,536	3,583,403
7	Arizona	41,419,256	973,249
8	Massachusetts	37,420,940	1,676,220
9	North Carolina	27,492,448	1,302,036
10	Washington	26,050,318	0

Note: We calculate the wage income lost by taking the difference in the estimated transition probability for likely documented and likely undocumented foreign students and multiplying it by the number of likely undocumented students in the state (2005-2009), by the employment rate of foreign college educated in the cohort, and by the average wage of college-educated foreign born in 2010-2014. The cohorts considered are those in the age group 20-24 attending college in the period 2005-2009. Their employment rate and wage is evaluated in the period 2010-2014 as the cohort is 25-29 years of age in the same state. The coefficients used are those from column (3) of Table 1. The State Tax income lost is calculated by multiplying the number of employees lost times the state tax they would pay, based on the state-specific rates and the average income of a college educated foreign born in the state in 2014 as described in the text.

Table 6
Pre-post policy change in college to Employment Transition rates, Metropolitan Areas
Assuming graduation when 24 years of age, 1-2 years after graduation

Transition rates	(1) All Metro Areas	(2) No California	(3) With state FE	(4) With State and Time Fixed effects
Difference F1-nonF1, pre-post OPT extension	0.07 (0.13)	0.05 (0.14)	0.10 (0.13)	0.25$^+$ (0.14)
Difference in undocumented-documented, pre-post DACA	0.04 (0.07)	0.03 (0.10)	0.05 (0.06)	0.09 (0.10)

Note: Each entry is a coefficient from a different regression, estimating a transition rate for each of 2 groups, and allowing for a post-policy effect and a post-policy interacted with group. The coefficient reported is the one on the interaction between post-policy and treated group. We include the cohorts that graduate from 2 years before to 2 years after the policy changes, in 227 Metro areas.

Table 7
Loss of wage and state tax income in Midwestern States

State	F1 income lost	undocumented income lost	State income Tax loss, F1	State income Tax loss undocumented
Illinois	713,461,248	99,712,544	33,805,846	4,724,667
Indiana	230,728,176	5,034,776	7,667,732	167,319
Iowa	106,720,728	1,534,390	4,236,965	60,917
Kansas	161,069,856	2,798,431	5,621,819	97,674
Michigan	352,185,888	3,673,360	13,660,756	142,484
Minnesota	537,359,296	10,235,102	23,679,165	451,018
Missouri	217,179,520	2,528,878	8,042,223	93,645
Nebraska	92,571,368	1,737,659	3,722,815	69,881
North Dakota	53,994,868	0	536,769	0
Ohio	534,586,464	4,577,340	12,281,005	105,155
South Dakota	5,563,840	245,063	0	0
Wisconsin	211,320,752	4,471,924	9,554,170	202,183

Note: The first two columns report the wage income lost because of lower employment transition of F1 and undocumented college students, using the same calculations and in the previous tables. The other two column report the imputed loss of state income tax revenues, also calculated as I the previous tables.

Appendix

Table A1:
Schools with largest population of F1 visas nationally, period 2005-2009

State	School	Number of F1 students
NY	The City University of New York	44,343
CA	Santa Monica College	21,943
TX	Houston Community College System	17,955
IN	Purdue University	17,259
IN	Indiana University	17,111
MI	Michigan State University	14,912
IL	University of Illinois	13,129
CA	Academy of Art University	12,320
TX	The University of Texas at El Paso	12,178
UT	Brigham Young University	12,139
CA	San Francisco State University (SFSU)	11,594
WA	University of Washington	11,346
NY	The New School	10,953
CA	University of Southern California	10,880
HI	Brigham Young University-Hawaii	10,530
AZ	Arizona State University	10,493
OH	The Ohio State University	10,201
MA	Boston University	10,143
FL	Miami Dade College	10,107
NY	State University of New York at Buffalo	10,015
MN	University of Minnesota	9,673
PA	The Pennsylvania State University	9,577
OR	University of Oregon	8,938
WI	University of Wisconsin-Madison	8,932
NY	New York University	8,771
CA	California State University, Northridge	8,442
FL	Florida International University	8,202
CA	City College of San Francisco	8,095
MI	University of Michigan	7,974
PA	University of Pennsylvania	7,914

Note: The data source is the SEVIS system of the USCIS that records all approved F1 visas. The figures are cumulative for the period 2005-2009.

Table A2.

Number of foreign-born college students, F1 and non F1 by nationality

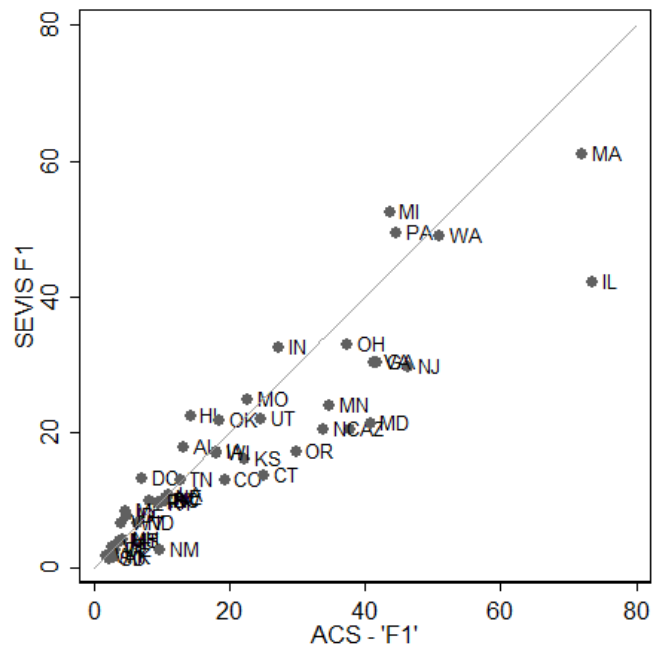|	**F1 (ACS)**	**Non F1 (ACS)**
Canada	51,466	74,735
Rest of Americas	359,774	1,002,290
Mexico	159,230	787,907
Western Europe	92,486	123,387
Eastern Europe	164,217	338,684
China	146,357	196,053
Japan	93,893	45,769
Korea	130,265	155,757
Philippines	32,759	154,925
Vietnam	22,695	88,917
India	73,211	180,296
Rest of Asia	158,794	231,888
Africa	255,605	335,494
Oceania	12,269	2,0518
Other	2,475	3,780

Note: Source: ACS, year 2005-2009. F1 college students are identified as those non-citizens who arrived in the US at 16 or older and do not live in a household as dependent. This definition matches best the number of F1 students as reported in the SEVIS (USCIS) over the period 2005-2009, by state. Non-F1 college students are foreign-born who do not match the F1 definition.

Figure A1:
Correspondence in the count of SEVIS-F1 college students and ACS-F1 college students
US States, Pooled numbers, 2005-2009
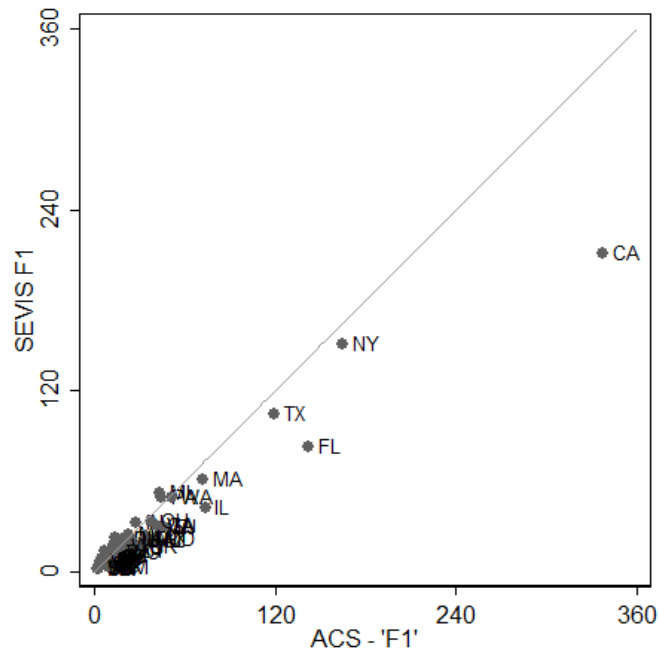
Note: Count of students attending college with and F1 visa. Vertical axis shows data from SEVIS. The horizontal axis shows imputation from ACS.

Figure A2:
Correspondence in the count of SEVIS-F1 college students and ACS-F1 college students
US States, excluding California, New York, Texas and Florida; Pooled numbers, 2005-2009

Note: Count of students attending college with and F1 visa. Vertical axis shows data from SEVIS. The horizontal axis shows imputation from ACS.