Essays on Immigration

A DISSERTATION SUBMITTED TO THE FACULTY OF THE UNIVERSITY OF MINNESOTA

BY

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Dedication

To my wife Tory thank you for always being my cheerleader

Abstract

This dissertation studies the interaction of immigration and fiscal policy. Chapter 1 establishes patterns of fertility, education, earnings for both immigrants and their children. Chapter 2 studies the substitutability of similarly qualified immigrants, as measured by educational attainment and degree field, and natives in production. I find a much greater degree of imperfect substitutability than previous literature and as a result can show the effects of previous immigration on the wages of unskilled workers is close to 0. Chapter 3 incorporates the findings from chapters 1 and 2 into a calibrated general equilibrium model with which I can run a number of immigration policy experiments. Using this framework I show that omitting the correlation between the skills of parents and their children will likely understate the effects of any immigration policy change in the U.S.

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1 Birth, Education and Taxes: An Immigrant's Perspective

1.1 Introduction

The focus of immigration reform has been on the skill composition of the immigrants allowed to come live and work in the United States. While working, like those who are U.S. born immigrants pay taxes, receive benefits. Outside of work they form families who's members go on to work. There is a large body of literature showing a correlation between the labor market outcomes of parents and children. This implies that the future benefits of an immigration policy which alters the skill composition of immigrants today can potentially be amplified through the children of these newly-formed families. This paper will establish patterns of immigrant fertility, intergenerational transmission of education, the earnings of the second generation of immigrants and ultimately the fiscal contributions they make.

Current U.S. immigration policy allows for approximately 700,000 working age immigrants to come to live and work in the U.S. annually. Close to 70% are admitted on the grounds that family members are already resident in the U.S. This immigration policy is indeed designed to have familial ties at the heart of it, unlike those in countries such as Canada or the U.K, which place greater weight on education, language ability and prior work experience. This has led many policy makers to consider the potential benefits for the U.S. of moving to a similar system. One facet of current policy that receives less attention is the per country cap on immigrants. Currently the total number of immigrants allowed in to the U.S. each year from any given cannot exceed 7% of the total number of immigrants allowed in to the U.S. Currently potential immigrants from India and China, traditionally some of the most successfully immigrant groups are bound by this per country constraint. Therefore, removing these per country caps while keeping immigration at the same level may provide additional positive outcomes from immigration to the U.S.

Any change to U.S. immigration policy has the potential to change both the demographics and the skill composition of the labor force. These changes have implications for labor markets through wages and for public finances through net tax revenues. Policy changes will not only have effects today, but in the future through the outcomes of immigrants' children, the second generation.

The bulk of the literature that explore the educational attainment, income, taxes paid and benefits received by immigrants and their children such as Storesletten (2000), Lee and Miller (2000) and Card et al. (2000) use data from the 1980 and 1990. In this chapter I present evidence that the profile of recent immigrant arrivals differs from arrivals in the 1980s and 1990s, in terms of both educational attainment and country of origin. This change in the composition of immigrant arrivals motivates the use of updated data to compare the educational attainment and earnings of the second generation with their own parents and those with U.S. born parents. Further, I compare the taxes paid and benefits received by the second generation with their own parents and those with U.S. born parents. In addition, I will present evidence that these observations vary by the parental country of origin.

1.2 Data

1.2.1 Country of Origin

This paper explores fertility, intergenerational transmission of education, fiscal participation of immigrants and their children. These variables will likely differ by the immigrant's source country or for the case of children the source country of their parents. For some of the excercises I will perform showing individual country results are not informative therefore I will categorize country of origin into three categories: low-income, middle-income and high income. I reconcile this categorization with the World Bank definition by first combining the low income and lower middle income into one group and redefining the upper middle income as middle income. This implies that an immigrant from a "low income" country is one who comes from a country with a GNI (Gross National Income) of less than $4,035, "high income" as any country with a GNI above $12,476 and 'middle income' as any country with a GNI in between.

1.2.2 Immigration and Demographic Changes

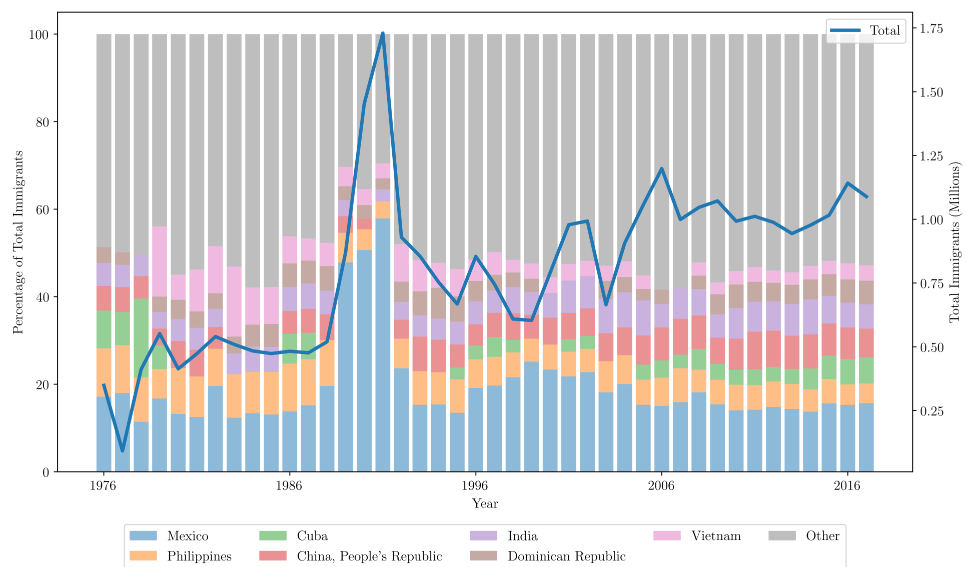
One of the most significant changes in immigration policy came in 1965 with the Immigration and Nationality act when the U.S. moved to a system of immigration that put emphasis on family based migration. Figure I shows how the number of immigrants has changed over the past four decades. During the 1970s and 1980s close to 500,000 immigrants arrived in the U.S. annually. This number spiked to over 1.75 million in the early 1990s before decreasing to around 750,000 for the rest of the decade. Since 2000 the number of immigrants arriving has remained steady at around 1 million per year.

Figure I also show the composition of immigrant source countries. The individual countries displayed on the graph were chosen because they have been the in the top 10 source countries for the majority of the past 40 years. To give some perspective each of these countries were in the top

10 source countries for 32 out of the 41 years in the sample, the country which has the next highest rate of being in the top 10 was the U.K. which appeared only 8 times, all of which were in the early 1970s.

A consistent theme from the past 40 years is that Mexico has always been the top source of immigrants to the U.S. However, starting in the mid 90s China and India have been increasing their share at the expense of Vietnam and the Philippines.

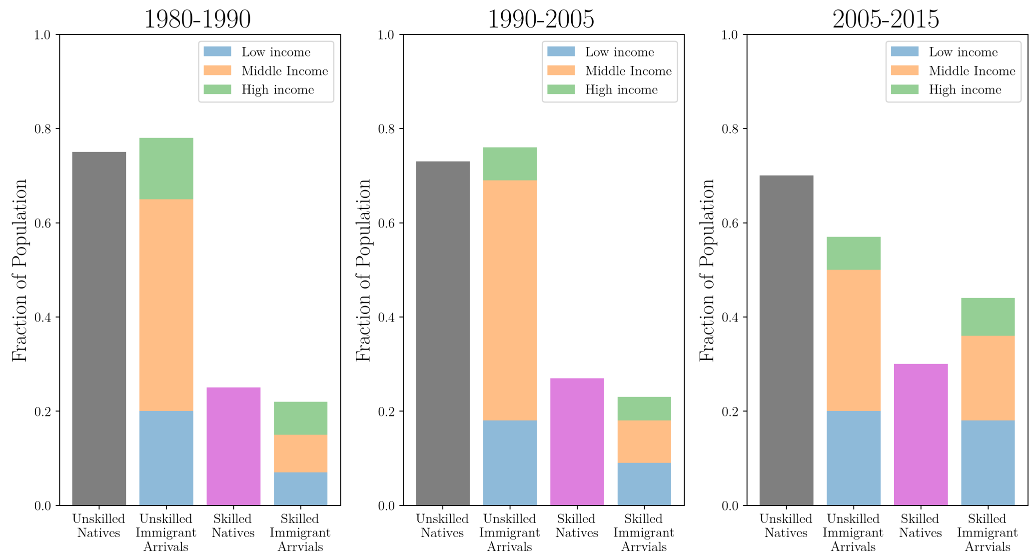
Figure I: Arrivals and Composition of Immigrants Since 1976



(a) Arrivals data taken from the Department of Homeland Security Yearbook 1976-2017

Figure I uses data from the Department of Homeland Security which doesn't disaggregate immigrant arrival numbers by educational attainment. To overcome this lack of granularity in the Department of Homeland Security date I use the 1990 Census 5% sample, 2007 ACS 3 year sample and the 2015 ACS 5 year sample (IPUMS USA) figure II shows how the profile of immigrant educational attainment and country of origin has changed over the past 35 years. Recently immigrants have a higher skilled to unskilled ratio than U.S. natives. Further, the country of origin composition has changed. While the number of immigrants from middle income countries has remained stable at close to 50% of all immigration, immigrants from low income countries now make up close to 40% of all immigrant arrivals, up from close to 30% in 1980 and 1990.

Figure II: Composition of Native Population and Population of Immigrant Arrivals 1980 - 2005



(a) Arrivals data taken from 1990 Census 5% sample, 2007 ACS 3 year sample and the 2015 ACS 5 year sample (IPUMS USA) figure II

(b) Low, middle and high income refers to immigrant country of origin

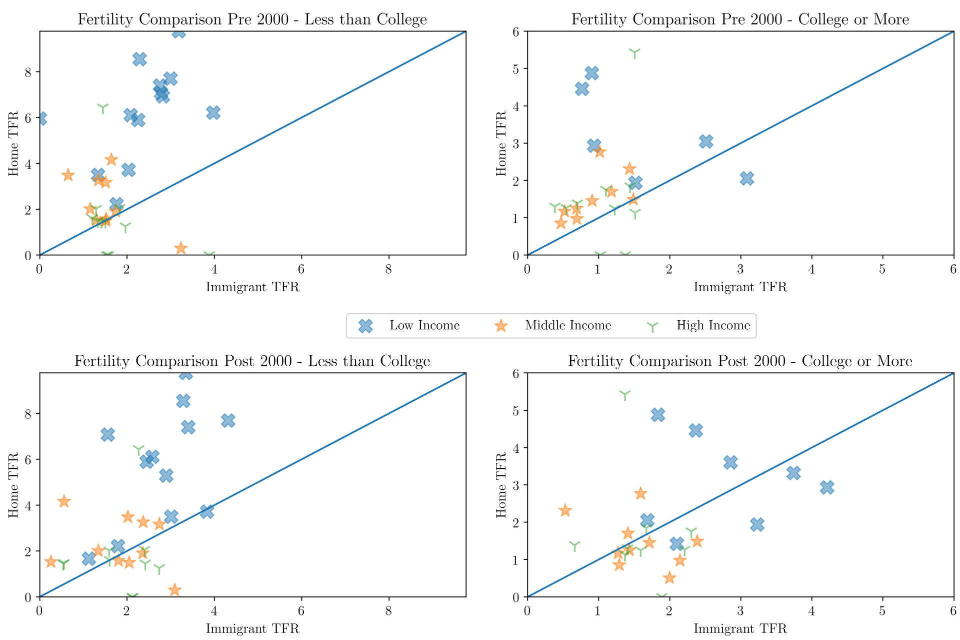
1.2.3 Fertility

In economies with pay-as-you-go retirement systems, the worker-retiree ratio is an important variable in the funding of such systems. Given the close link between the worker-retiree ratio and demographics, which itself is determined in part by fertility rates, any change to immigration policy that can affect fertility rates can also affect the funding of retirement systems. In this section I will establish the fertility rates of different immigrant groups across time. It is well established that immigrants are a highly selected group. As such, we cannot just simply use the fertility rate of an immigrant's home country to approximate the fertility rate of an immigrant once in the U.S.

To analyze immigrant and native fertility, I calculate the TFR (Total Fertility Rate) for each immigrant's country of origin, that is, the number of children a woman can expect to have if she lives to the age of 45. To obtain the TFR, I first calculate source country-age-specific fertility rates, that is the number of children born to immigrant women from a specific source country. I then divide the births by the number of women in that age group, using five year age bins. To disaggregate by educational attainment, I separate observations into college or more and less than college. This gives a dataset of individual source country age-specific total fertility rates by educational attainment.

Figure III displays the comparison of the TFR between and immigrant and the U.S. and the TFR of their compatriots who are still at home disaggregated by education and time period. In figure III if an observation is above the 45 degree line it implies that, immigrants have fewer children than their compatriots who stayed at home. In figure III for those with less than a college education regardless of time period these immigrants have fewer children than their counterparts who remain in their home country. For those with a college education figure III shows many observations close to the 45 degree line implying that fertility rates of immigrants with a college degree are similar to their home country counterparts.

Figure III: Comparison of Immigrant's Fertility With Their Home Country by Education and Over Time

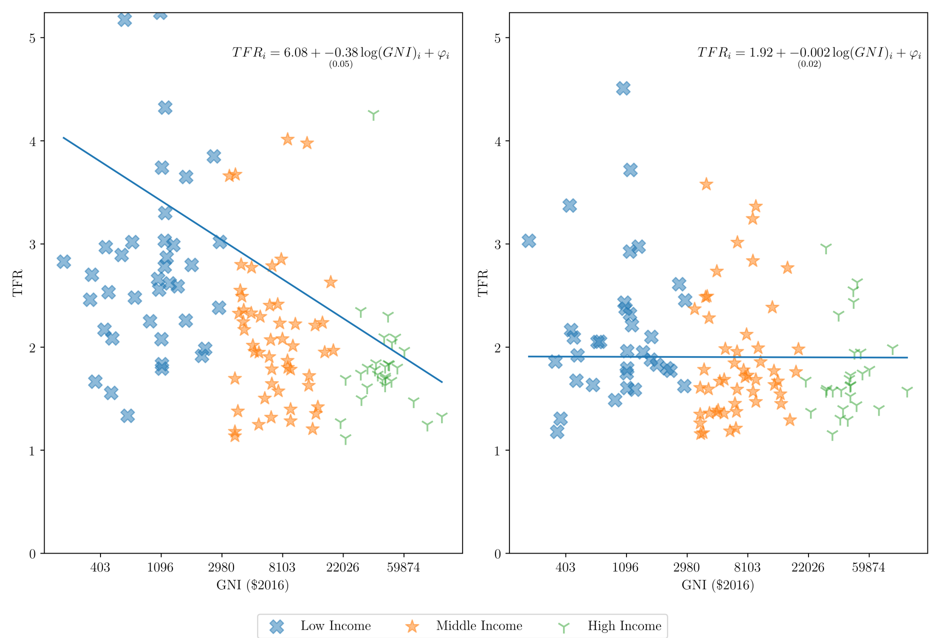


(a) Immigrant data taken from the 1970-2000 Census 5% Samples, 2007 ACS 3 Year Sample, 2012 ACS 5 year Sample and 2017 ACS 5 year Sample (IPUMS USA)

(b) Home country data taken using the public micro data from the Census of a number of countries, the full list is in the appendix

Figure IV displays the relationship between GNI and TFR with the line of best fit resulting from a regression of TFR on log GNI weighted using total number of observations collected when calculating TFR. Figure IV shows there is a great deal of heterogeneity in the TFR of immigrants and that there is a negative relationship between TFR and GNI for those with less than a college education. However, there is no relationship between TFR and GNI for those with college for more.

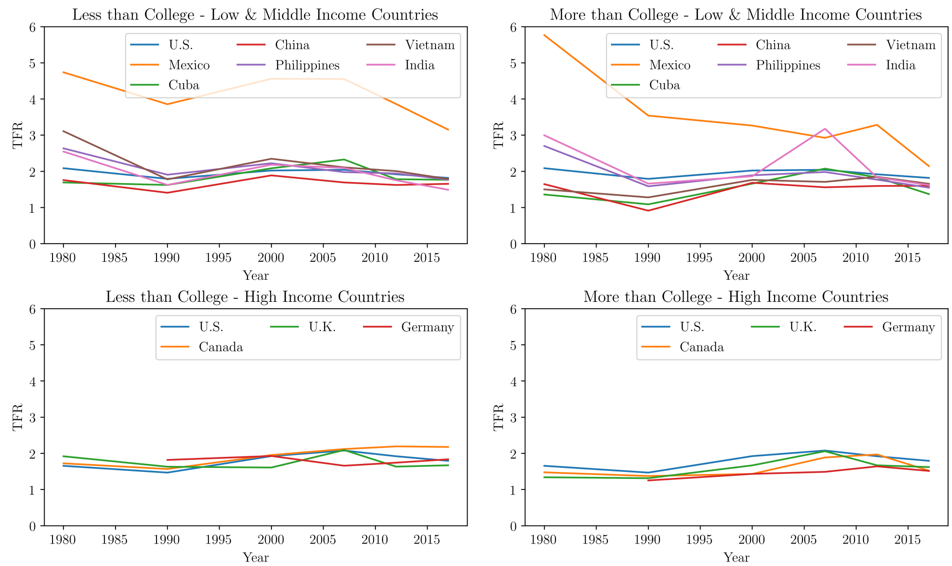
Figure IV: Immigrant Fertility by Education



(a) TFR is calculated by taking the mean of each country's TFR weighted by total observations for each year from the 2000 Census 5% sample, 2007 ACS 3 year sample, 2012 ACS 5 year sample and 2017 ACS 5 year sample (IPUMS USA) figure II

Given the heterogeneity in fertility rates and that the composition of immigrant source countries is dominated by a small group of countries in figure V I show the TFR over time for different education groups for the top immigrant source countries. This figure shows that there has been little change over time for immigrants from the top immigrant source countries with the exception of Mexico. Over the past 40 years figure V shows that Mexicans has had much higher fertility rates than other immigrant groups. However, figure V also shows that it is declining over time, for those with a college education their fertility is close to converging with those from other immigrant groups.

Figure V: Top Immigrant Source Country Fertility Over Time



Figures III, IV and V all suggest that there are differences across immigrant groups. To formalize this and to see if the TFR of immigrant groups is different from their U.S. counterparts I use the following regression:

$$TFR_{i,e,t} = \beta_0 + \sum \beta_{g,e,t} \times origin_{i,g,t} \times education_{i,e} + \sum \alpha_t \times Year + \epsilon_{i,e}$$

where $origin_{i,g}$ is a dummy for a country's income category and $education_{i,e}$ is a dummy for college or more and less than college. Table V displays the results of this regression. From Table V it is evident that immigrants with less than a college education on average have more children than their U.S. born counterparts. For example a woman from a low income country can expect to have 3.04 children compared to 2.04 for the U.S. Another conclusion from table V is that when measuring the fertility of immigrant groups, the inclusion of Mexico is important. Including Mexico in the regression implies that a woman from a middle income country can expect to have an additional 1.1 children.

From table V it is evident that immigrant women who have a college education would expect to, on average have fewer children than their U.S. born counterparts.

Table V: Results of Regression of TFR on Country of Origin

	Including Mexico		Excluding Mexico	
	Less than College	College or More	Less than College	College or More
Low Income	0.991***	-0.056	1.002***	0.056
	(0.076)	(0.153)	(0.047)	(0.079)
Middle Income	1.445***	-0.233	0.235***	-0.325***
	(0.052)	(0.146)	(0.049)	(0.083)
High Income	-0.041	-0.501*	-0.027	-0.391***
	(0.106)	(0.219)	(0.066)	(0.114)
Observations	426	426	420	420

1.2.4 The Second Generation

Any change in immigration policy today has the potential to also change the composition of the future labor force through the children of immigrants. To assess how any such policy change will affect the labor force and, in turn, its impact on public finances, I consider how the children of immigrants adapt to a country that is different from their parents'. Clearly, if the children adapted poorly and were limited to low paid work, this would put additional strain on public finances. To perform this analysis, I use data from the CPS Census supplemented by data from the GSS. Like Card et al. (2000) and Schoellman (2010), I show that the children of immigrants are a largely successful group and beneficial to public finances and that the magnitude is dependent on their parent's country of origin.

A second generation immigrant is defined as any child of two immigrant parents [1], whether born abroad or arriving in the U.S. before the age of 16. Currently there exists no large scale dataset that links the labor market outcomes of immigrants and their children. To overcome this problem I follow the literature, using a grouping estimation strategy as in Borjas (1993) to asses the educational and

[1] I also perform the analysis based on a second generation immigrant as having just one immigrant parent and find little difference.

labor market outcomes of parents and children. The estimation strategy is as follows: to measure the educational attainment and labor market outcomes of immigrant parents and of U.S. born parents, I use data from the 5% 1990 U.S. Census. I restrict the sample to fathers with a child under the age of 16 years old. The bound of 16 years old ensures that the immigrant child completes some of their education in the U.S. I then regress educational attainment and log hourly wages on source country and region of residence dummies, age and age squared as shown in 1.

$$y_{i,g} = \beta_0 + \sum_g \beta_g source_i + \sum_r \beta_r region_{i,g} + \beta_1 age_{i,g} + \beta_2 age^2_{i,g} + \nu_{i,g} \qquad (1)$$

With these parameters I can calculate the average schooling and earnings by country of origin at the age of 40. Further, with this sample I create a distribution of weights by age group and region of residence.

To measure the educational attainment and earnings outcomes of the second generation of immigrants and those with U.S. born parents, I use the CPS March supplement from 2007-2017 (IPUMS CPS) which records where respondents were born and where their parents were born, unlike the larger sample ACS and Census. I restrict the CPS (Current Population Survey) sample to ensure that every respondent was younger than 16 years old in 1990. If there are fewer than 30 observations for any individual parent country I drop all the child observations associated with that source country.

For each respondent in the CPS I assign the parental schooling and hourly earnings based upon the place of birth of their father. For both male and female respondents I regress the educational attainment and hourly earnings on father's birthplace [2] controlling for region, age, age squared and the. When performing each regression I use the age-region of residence weighting distribution created using the 1990 Census. Figures VI, VII and VIII display the mean predicted of each variable of interest when both the fathers and children are 40 years old, by country of origin.

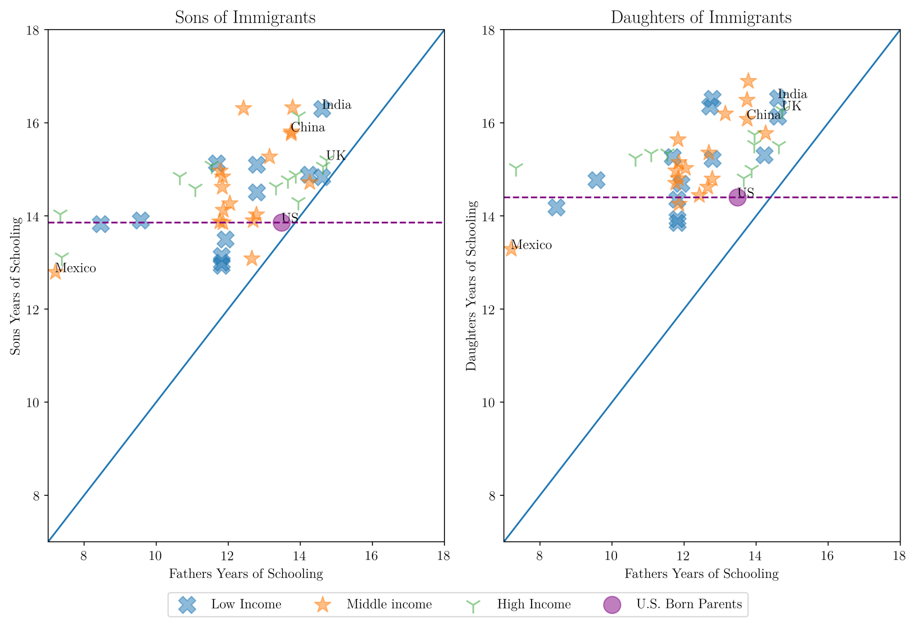
In Figure VI if an observation is above the solid line, it implies the child has achieved a greater level of schooling than its parents. If an observation is above the dashed line then it implies that that observation attains on average a higher level of schooling than their counterpart with at least one U.S. born parent. In Figure VI it is evident that even if the immigrant parents arrive with low levels of schooling, their children tend to attain on average higher levels of schooling.

For example, children of Mexican immigrants attain on average 13 years of schooling. This is less

[2] I also perform each analysis using data on mother's and find little difference with respect to educational attainment. On average daughters earn close to 5% more than their mothers, the son's earn 20% more.

than their counterparts with U.S. born parents who on average attain 13.7 years, but much higher than their parents who obtain just 7 years. Further, it is also evident that the majority of second generation immigrant groups attain higher average levels of schooling than their counterparts with U.S. born parents.

Figure VI: Years of Schooling of First and Second Generation Immigrants



(a) Child data from the CPS 2007-2017 (IPUMS CPS). Parent data from 1990 U.S. Census 5% sample. (IPUMS USA)

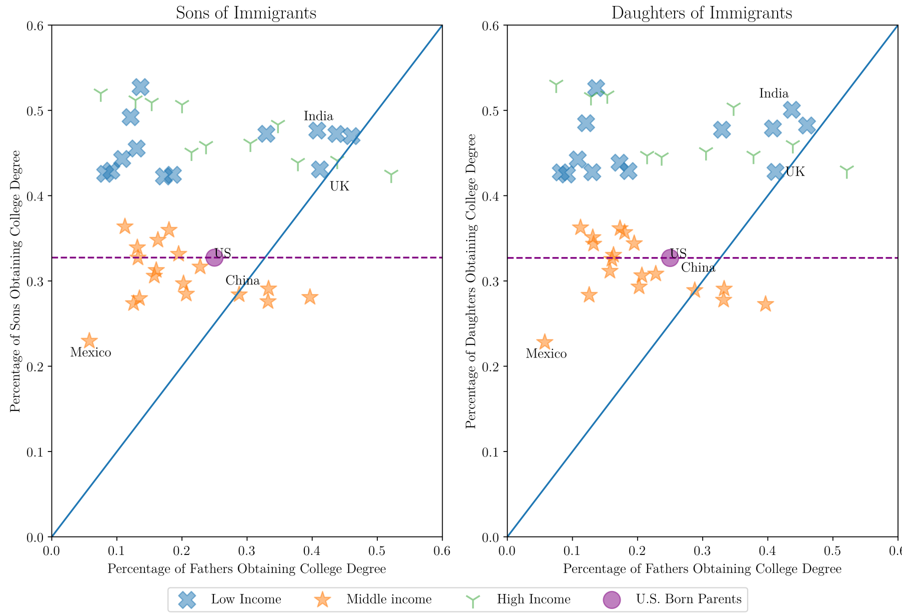
(b) Any point above the solid blue line indicates the child has a more years of schooling than the parent.

(c) Any point above the dashed purple line indicates the a child with immigrants parents has more years of schooling than their counterparts with two U.S. born parents.

Figure VII shows the percentage of second generation immigrants and their parents that completed college. On average the second generation of immigrants are attaining a college education at a higher rate than their parents and their counterparts with U.S. born parents. The notable exception is second generation immigrants with parents from middle income countries. While a greater fraction of this group attain a college degree than their parents, it is a lower fraction than their counterparts with U.S. born parents. Further exploration of the data reveals that many immigrants from middle income countries are completing some college, but not all four years, with many completing an associates degree.

Figure VIII establishes that the higher levels of education for children of immigrants does translate into higher hourly earnings, with the majority of second generation groups earning more than

Figure VII: College Attainment of First and Second Generation Immigrants



(a) Child data from the CPS 2007-2017 (IPUMS CPS). Parent data from 1990 U.S. Census 5% sample (IPUMS USA).

(b) Any point above the solid blue line indicates a greater fraction of the children finished college than the parent.

(c) Any point above the dashed purple line indicates a greater fraction of the children with immigrant parents finished college than their counterparts with two U.S. born parents.

their counterparts with U.S. born parents.

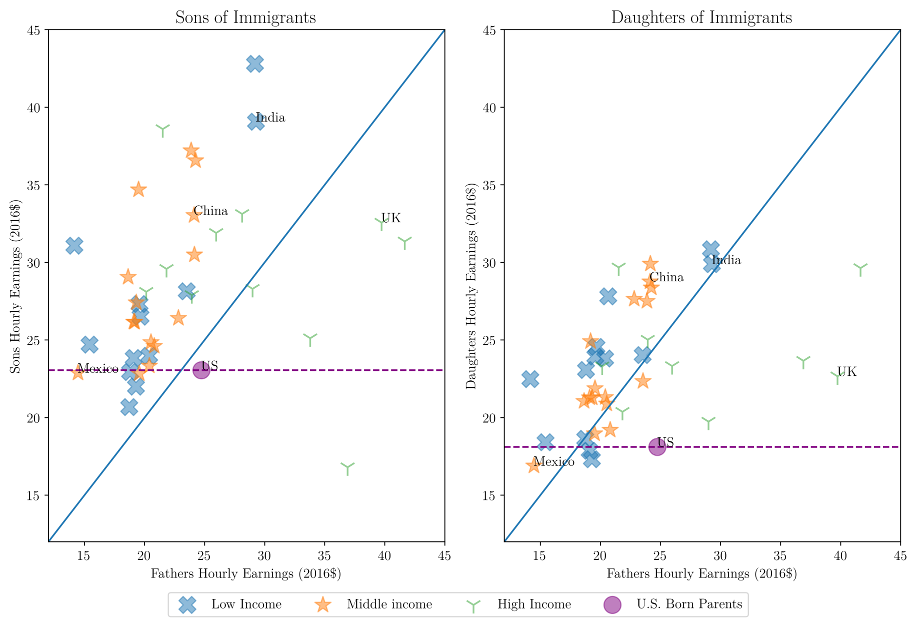
The above analysis presents the mean educational attainment and earnings of immigrant children unconditional on parental education. To supplement the above analysis and provide evidence that conditioning on parents educational achievement is important, I use the GSS (General Social Survey), a bi-annual, nationally representative survey with a focus on social attitudes in the U.S. Important to this analysis, it covers the respondents' educational attainment and country of birth as well as their parent's educational attainment and country of birth.

To calculate the probability of a child going to college conditional on their parent's education, I first merge the responses of each survey between 2000-2016, dropping any respondent under the age of 30 [3]. Merging over years gives a reasonable sample size for the children with immigrant parents [4]. I then split the sample into those whose parents either had, or had not, completed college. To obtain the probabilities of interest, I use a the results of a probit model with a dummy for whether the

[3]This is done to avoid having respondents who are likely to return to education.

[4]It also assumes that the transmission of education from parents to children did not change in these years.

Figure VIII: Hourly Earnings of First and Second Generation Immigrants



(a) Child data from the CPS 2007-2017 (IPUMS CPS). Parent data from 1990 U.S. Census 5% sample (IPUMS USA)

(b) Any point above the solid blue line indicates the child earns more per hour than their parent group

(c) Any point above the dashed purple line indicates the a child with immigrants parents earns more per hour than their counterparts with two U.S. born parents

child completed college as the dependent variable. The regressors are dummies for parent's nativity status, age, sex and region in which the child lived at age 16 and family income at age 16.[5] Table VIII displays the mean predicted values of the model with the standard errors.[6] In Table VIII we see that the inter-generational transmission of education for both immigrants and natives is similar. However, it does appear that conditional on their parents having a college education, immigrant children have a higher probability of completing college than those with comparable U.S. parents.

While the GSS does not report the specific country of birth for parents, I can break down the data by using ethnicity of the child as a crude proxy for parent's country of origin (conditional on the child having immigrant parents).[7] This gives the following options for parent's origin: U.S. born, asian-indian, asian-non-indian, hispanic, white and other. I then perform the same exercise that generated

[5]The family income variable is the child's assessment of their family income aged 16 with 5 options between far below average and far above average

[6]The predicted value is the probability of a child attaining a college degree, therefore the probability of not attaining a college degree is 1 minus this probability

[7]ethnicity to country of origin is not a 1:1 mapping. However, analysis of the top countries of immigrant origin to the U.S. show that in each country has a ethnicity that accounts for at least 80% of the population.

Table VIII: Intergenerational Education Transmission Matrices by Parent's Nativity

U.S. Born Parents

		Children LC	Children C
Parents	LC	0.77	0.23
		(0.004)	(0.004)
	C	0.37	0.63
		(0.009)	(0.009)

Observations: 12,462

Immigrant Parents

		Children LC	Children C
Parents	LC	0.76	0.24
		(0.009)	(0.009)
	C	0.32	0.68
		(0.02)	(0.02)

Observations: 1,596

(a) Data is from the General Social Survey 2000-2016

(b) LC indicates less than college, C indicates college or more

Table VIII for each ethnicity. To map the matrices to the low, middle, high income countries that are defined in 1.2.1 I do the following. I obtain a population distribution over ethnicity for each country group using the 2007-2017 CPS restricting the sample to second generation immigrants over the age of 30.[8] I then compute an average matrix for each country group using the matrices weighted using the population distribution calculated from the CPS.

Table VIII: Intergenerational Education Transmission Matrices by Parent's Country of Origin

Low Income

		Children LC	Children C
Parents	LC	0.53	0.47
		(0.07)	(0.07)
	C	0.15	0.85
		(0.04)	(0.04)

Medium Income

		Children LC	Children C
Parents	LC	0.75	0.25
		(0.07)	(0.07)
	C	0.44	0.56
		(0.1)	(0.1)

High Income

		Children LC	Children C
Parents	LC	0.70	0.30
		(0.01)	(0.01)
	C	0.35	0.65
		(0.04)	(0.04)

(a) Data is from the General Social Survey 2000-2016 and CPS 2007-2017 (IPUMS CPS).

(b) LC indicates less than college, C indicates college or more.

[8] The one exception is that I classify anyone with two asian-indian parents as asian-indian, since the CPS ethnicity does not distinguish between asian-non indian and asian-indian.

From Table VIII it is evident that there are differences in inter-generational transmission of education by an immigrant's country of origin. While the immigrant's transmission of education on average looks nearly identical to natives, when broken down by country of origin we do see starker differences. For those with parents from low income countries, the transmission of college education happens more frequently than for those of middle and even high income countries. This result is driven by the fact that close to 80% of the low income group identify as Asian-Indian or Asian-non-Indian - two groups for which the persistency of completing college between generations is high. It is a result that fits with the 'model minority' narrative of Wong et al. (1998).

1.2.5 Fiscal differences

In subsections 1.2.3 and 1.2.4, I establish that immigrants have on average more children than the current U.S. native population and on average those children outperform natives in terms of earnings. To assess the effects on public finances due to any change in immigration policy, we must also consider how much immigrants receive in benefits. The 1996 Welfare Reform Bill established the principle that immigrants are usually unable to claim any form of government transfers within the first 5 years after arrival in the U.S. There are exceptions, for example, immigrants themselves are eligible for the ETIC (Earned Income Tax Credit) as well as the CTC (Child Tax Credit). The children of immigrants are also eligible for Medicaid and Children's Health Insurance Program.

1.2.6 Transfers by Nativity

To assess the use of government transfers by immigrants, I use CPS data from 2011, 2013, 2015 (IPUMS CPS). I use the CPS given that it has a wide array of data on government transfer programs and identifies second generation immigrants.

Each observation is a household and I consider a household to participate in a government transfer program, y if any member of the household reports participation.

The country of origin is assigned to each household based upon the head of household's country of origin and can be either, low, middle, high or U.S. I assign the education of each household based upon the highest level of education received by the head of the household.

To establish the use of government benefit programs by immigrants compared to natives I use the following linear probability model where i denotes a household. The variable y is a binary variable of 0 or 1 if a household participates in a government transfer program. X_i contains information on log hourly wages, age, age squared, country of origin dummies, and region of residence.

$$y = \beta_0 + \gamma \times X_i + \epsilon_i$$

The results shown in VIII compare the probability of participating in a government transfer program relative to U.S. native households with high school education. While household's headed by immigrants from low and middle income countries participate in government programs at a higher rate than U.S. native households with a high school education the differences are small. The exceptions here are child medicaid and EITC for which the differences are larger.

Table VIII: Probability of Participating in Government Transfer Programs

	Adult Medicaid	CHIP	EITC	TANF	SNAP	SSI
Constant	0.793**	0.943**	1.779**	0.143**	1.052**	0.150**
	(0.010)	(0.010)	(0.013)	(0.004)	(0.010	(0.005)
Low income - HS	0.023**	0.086**	0.132**	-0.005**	-0.008**	-0.007**
	(0.005)	(0.005)	(0.006)	(0.002)	(0.004)	(0.003)
Middle income - HS	0.007**	0.126**	0.158**	-0.004**	0.012**	-0.021**
	(0.004)	(0.004)	(0.004)	(0.001)	(0.003)	(0.002)
High income - HS	-0.067**	-0.010**	0.008**	-0.004**	-0.034**	-0.025**
	(0.007)	(0.006)	(0.009)	(0.002)	(0.005)	(0.004)
Native - coll	-0.056**	-0.056**	-0.066**	-0.005**	-0.041**	-0.013**
	(0.001)	(0.001)	(0.001)	(0.000)	(0.001)	(0.001)
Low income - coll	-0.040**	-0.036**	-0.026**	-0.009**	-0.039**	-0.013 **
	(0.004)	(0.004)	(0.004)	(0.001)	(0.003)	(0.002)
Medium income - coll	-0.050**	-0.016**	-0.012**	-0.008**	-0.030**	-0.021 **
	(0.005)	(0.004)	(0.005)	(0.001)	(0.003)	(0.002)
High income - coll	-0.086**	-0.036**	-0.035**	-0.008**	-0.036**	-0.028**
	(0.005)	(0.005)	(0.006)	(0.001)	(0.003)	(0.002)

Note : * Reject at 5% level, ** Reject at 1% level

Note : All specifications include controls for wage income, age, marital status and number of children

1.2.7 Taxes Paid

subsection 1.2.6 shows only one side of the story and makes the point that immigrant's on the whole are no more or less likely to participate in government transfer programs than those who are born in the U.S. To fully consider immigrant's fiscal participation I must also consider the taxes paid and all programs that they can potentially partake in.

To this I consider the following transfers: EITC, CTC, workers compensation, supplemental social security, TANF, unemployment, veterans' benefits and foodstamps as well as Medicaid, Medicare and social security. Since 2008 the CPS only contains information on whether a respondent has received Medicare or Medicaid and not the value of the care received, I impute the value of Medicare received using the Annual Centers for Medicare Medicaid Service public use file, which breaks down the average per-capita Medicare expenditures by state. To impute the value of Medicaid, I use the Medicaid actuarial report from 2011, 2013 and 2015, values which are broken down into average per-capita spending on children, adults, disabled and the elderly. I only assign the value of disability-related Medicaid to a respondent if the respondent reports receiving supplemental social security. Further, I divide total government consumption, after subtracting defense and education spending, by the total population and treat that as a cash transfer to respondents. I treat the education spending as a transfer to those between the ages of 4 and 18 who were born in the U.S.

The taxes I consider are federal, state, FICA, property and sales taxes. I set sales tax paid equal to the state tax as in Evans (2017), which finds very little difference between the amounts paid. Each value of taxes and benefits is scaled, so that when aggregating each variable, I match data from 2015 national accounts.

With this dataset I create a lifecycle profile of taxes and benefits received at each age and by country of origin and parent's country of origin. With this lifecycle profile I calculate the ratio of present value of taxes paid to present value of benefits received as illustrated below.

$$\text{Tax to benefit Ratio} = \frac{\sum_j \left(\frac{1}{1+r}\right)^j Taxes_j}{\sum_j \frac{1}{1+r}\Big)^j Benefits_j}$$

I calculate this ratio for children of immigrants assuming they are born tomorrow. When calculating the ratio for immigrants themselves, I assume they arrive tomorrow at the average age of immigrants of their country of origin group. Table VIII presents these results. Further, I assume a discount rate of 3%. If the value in the Table is 1, it would imply that the net present value of taxes is equal to net present values of benefits and therefore increasing the portion of that group would have no effect on aggregate public finances.

From Table VIII it is clear that there are differences in the contributions to public finances, within the cohorts of both first and second generation immigrants and compared to those with two U.S. born parents. The second generation of immigrants with high school education have a similar tax-benefit ratio compared to those with U.S. born parents at 0.4. The bigger differences become evident with the second generation that completes college. For each of the three categories of second generation immigrants, they have a higher tax benefit ratio than their counterparts with U.S. born parents.

Given that the U.S. does not bear the cost of education for the first generation immigrants, it is not surprising that the tax-benefit ratios are higher for those with a college education. However, the opposite conclusion can be reached for the high school educated first generation. Table VIII gives a snapshot of the contribution of different groups to public finances.

Table VIII: Lifetime Tax to Benefit Ratio by Country of Birth and Parent's Country of Birth

	Less than College	College
Two U.S. born parents	0.40	1.22
Second generation		
Low income	0.40	1.67
Middle income	0.33	1.33
High income	0.47	1.44
First generation		
Low income	0.45	2.19
Middle income	0.40	1.83
High income	0.55	2.57

(a) Data is from CPS 2011-2015 (IPUMS CPS)

(b) Present value of both taxes and benefits is calculated assuming a 3% discount rate

While informative, table VIII masks the heterogeneity in how much immigrants and their descendants will pay in taxes, based on the arrival age of the immigrant. For a more comprehensive understanding of what an immigrant and their descendants will contribute in taxes and receive in benefits over their lifetimes, based upon age of arrival we can use a generational accounting approach like Lee and Miller (2000) as well as Auerbach et al. (1987). The central idea behind generational accounting uses the inter-temporal government budget constraint

$$\sum_{s=0}^{D} P_{t,t-s} + \sum_{s=1}^{\infty} \frac{P_{t,t+s}}{(1+r)^s} = \sum_{s=t}^{\infty} \frac{G_s}{(1+r)^{s-t}} - W_t \quad (2)$$

$P_{t,k}$ is the net tax payment in time t of birth cohort k and D is the age of death. Therefore the first term on the left hand side is the net tax payments by the current generations that are alive, the second term is the net contributions of future generations. On the right hand side is the discounted value of government consumption and net wealth in year t. The $P_{t,k}$ term can be rewritten as follows where T is the per capita tax payment and ψ is the population size of the birth cohort k at time t.

$$P_{t,k} = \sum_{s=\mu}^{k+D} \frac{T_{s,k}\psi_{s,k}}{(1+r)^{s-\mu}} \quad (3)$$

$$\mu = \max(t,k) \quad (4)$$

Equation 2 can be split further into the following equation where N represents natives and I immigrants.

$$\sum_{s=0}^{D} (N_{t,t-s} + I_{t,t-s}) + \sum_{s=1}^{\infty} \frac{(N_{t,t+s} + I_{t,t+s})}{(1+r)^s} = \sum_{s=t}^{\infty} \frac{G_s}{(1+r)^{s-t}} - W_t \quad (5)$$

Similarly I obtain the following expression

$$I_{t,k} = \sum_{s=\mu}^{k+D} \frac{T_{s,k}\psi^I_{s,k}}{(1+r)^{s-\mu}} \quad (6)$$

$$\mu = \max(t,k) \quad (7)$$

In this equation the $\psi^I_{s,k}$ will represent the mortality and changes in the immigrant population. Given that wages for immigrants vary by education level, age of arrival and country of origin so will the $T_{s,k}$ term. Further, for second generation immigrants it will also depend on their parents' education and country of origin as outlined in subsection 1.2.4. To parameterize the net tax payments $T_{s,k}$ I use the same data from the CPS as I did for the cross-subsectional exercise. Further, I calculate the NPV (Net Present Value) value of each immigrant and their descendants, assuming they cannot receive any benefits for the first 5 years after arrival and a maximum age of arrival at 50. I limit the age of arrival to 50 so that they can collect a social security payment and only 5% arrive after the age of 50. I calculate the NPV assuming a 2%, 3% and 4% discount rate. I also assume productivity increase of 1% and increases in Medicare and Medicaid costs of 0.8% above increases in GDP as per CBO(2018). As part of this exercise I calculate the contribution not only of the initial immigrants themselves, but also of their descendants.

To do this I calculate the NPV of the descendants and multiply it by the fertility rate of each immigrant as calculated in subsection 1.2.3. Finally I take survival probabilities from the multiple death and mortality data.

Figure IX: NPV by Age of Arrival and Country of Origin - College or More

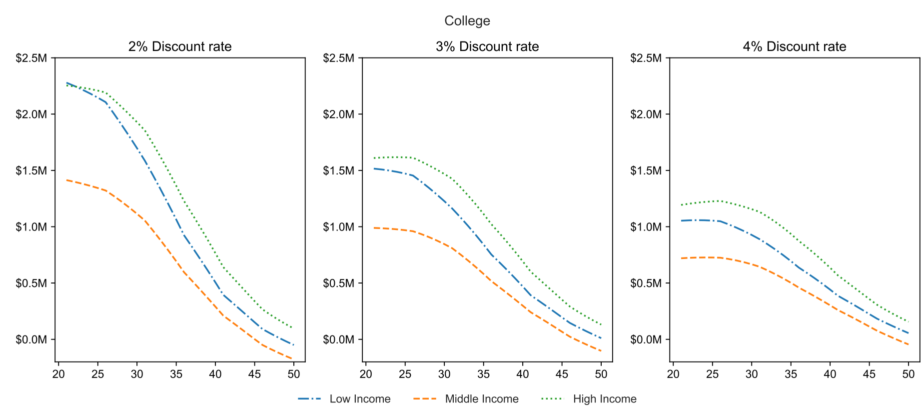


Figure X: NPV by Age of Arrival and Country of Origin - Less than College

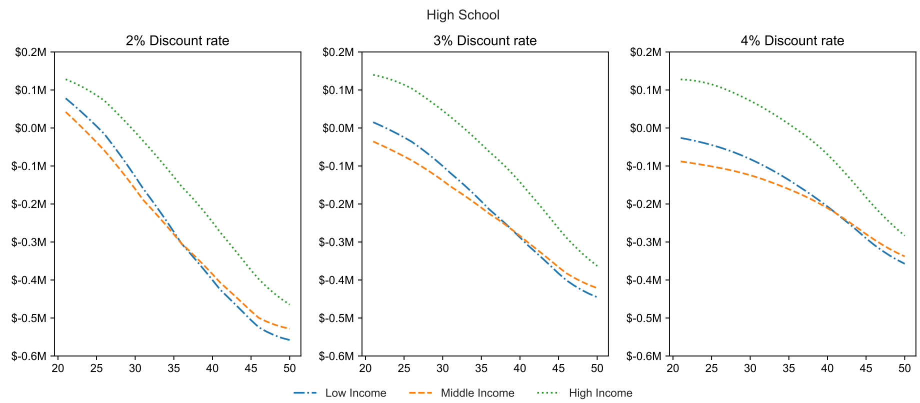


Figure IX shows that the net present value for immigrants with a college education or more have a positive net present value at almost every age of arrival and country of origin. There are however significant differences between the the different countries of origin, with those from high income countries having a net present value of over $2 million and those from middle income closer to $1.5 million. These findings are consistent with Orrenius (2017) who finds that the net present value for immigrants with a college education has increased since Lee and Miller (2000) paper. In addition it is also consistent with the findings of Lagakos et al. (2018), that returns to experience and education are highly heterogeneous by their country of origin. Therefore if wages are different then so will be taxes paid and benefits received.

Figure X shows that for those with less than college education the net present value is negative at nearly every age of arrival. Unlike those with a college education or higher there is less dispersion between countries of origin.

Common to both the college educated and high school educated is that the net present value is highly sensitive to the assumed discount rate. Figure IX and figure X would indicate that only allowing young college educated immigrants would be preferable from the perspective of a current U.S. resident.

1.3 Conclusion

In this chapter I establish a number of facts related to the fertility, educational attainment and fiscal participation of immigrants and their offspring, the second generation.

First that the fertility rates of immigrants from low and middle income countries are higher than those from high income countries. Second the children that immigrants do have tend to outperform their own parents both in terms of educational attainment and earnings. Further, the second generation of immigrants outperform their counterparts with U.S. born parents and that the performance of the second generation is correlated with their parents source country. Immigrants who attain a college education contribute more to public finances more than immigrants without a college education and far more than those with U.S. born parents with a college education. Unsurprisingly given that the second generation who attain a college degree earn more than their counterparts with U.S. born parents they contribute more to public finances. However, they contribute less than their parents since the second generation require educating in which is a substantial burden to public finances.

In this chapter I am the first to establish that these results are heterogeneous with respect to the original immigrant parent's source country. This is of relevance given that the composition of immigrant source countries and educational attainment has changed substantially since 1990 when many analyses of immigrant's fiscal contributions were done.

This chapter outlines the fiscal participation by various groups residing in the U.S. and suggests that some groups contribute more than others, to fully understand the effects of changing immigration policy and how those contributions would change we need to understand the effects that immigrants will have on wages and ultimately tax receipts. These effects will be outlined in chapters 2 and 3.

2 Immigration and Wages

2.1 Introduction

This chapter seeks to quantify the effect on wages of native U.S. workers when immigration policy is not based solely upon educational attainment, but also considers the country and field of education.

First suppose that an immigrant's skills and educational attainment are perfectly transferable, to the point that college-educated immigrants worked in the same occupations as college-educated Americans. If this perfect transferability existed, then the naturally-arising question would be: is there an optimum number of college-educated immigrants that the U.S. can allow, to maximize the welfare of its current citizens? However, there is a sizable literature which suggests that immigrants education and skills do not transfer perfectly. Possible reasons for this imperfect skill transfer are, among others, occupational licensing and the possibility that the education attained in another country is inferior to education attained in the U.S. When taking into account this friction, the relevant policy question doesn't relate simply to the number of college educated immigrants, but also to the transferablility of the education that immigrants have attained This paper abstracts from this potential friction and focuses on the fact that the size of this 'friction' varies by the country in which education was received.

To ascertain the effects of immigration on wages taking into account the country of origin and education field of immigrants I construct a nested CES production function that allows for heterogeneity of inputs along these lines. I then estimate the relevant elasticities of substitution and simulate the effects of recent waves of immigrants on the U.S. born workers.

I find that immigration between 1990 and 2011 increased the wages of college educated workers in the U.S. by around 3.6% while decreasing the wages of those with less than college by around 0.4%.

2.2 Related Literature

This paper primarily relates to two strands of the immigration literature. The first considers the level of substitutability of immigrants and natives in production and what fraction of skills developed by immigrants in their home country transfers to the U.S.. The second is testing the effect of immigration and immigration policy changes on wages.

Borjas (2003) takes a factor proportions approach to investigating the effects of immigrants on native wages, finding that immigrants have decreased the wages of low-educated U.S. natives by a maximum of 9%. In contrast Ottaviano and Peri (2012), by considering immigrants and natives as imperfect substitutes, find that immigration between 1990 and 2006 actually had an effect (on wages) between -2.2% and +1.7%, depending on the nesting structure and parameterization of the model. Another related approach has been to consider the tasks that immigrants perform when working. Schoellman (2010) considers an occupation as a set of skills, for example cognitive, manual or interpersonal and he differentiates occupations by how extensively each occupation uses each skill. Using the aforementioned framework, he estimates the skills of immigrants from different countries by observing which occupations they choose. With this model, Schoellman (2010) finds that immigration to the U.S. has decreased wages of U.S. native workers by at most 5% and that the effect varies largely by occupation. Peri and Sparber (2009) also defines occupations by skill concentration and then estimate the elasticity of substitution between each skill. They find that among workers with high school education or less, immigrants work in occupations that are more intensive in manual skills, whereas their native U.S counterparts work in occupations that are relatively communication intensive. These occupational choice patterns imply that immigration has had very little impact on U.S. native wages given that they work in very different occupations to immigrants. This paper furthers the contributions of those papers not only by analyzing the effect of past immigration policy on wages, but by considering the counterfactuals of having immigration policy based upon merit.

Implicit in all of the aforementioned papers is some element of imperfect skill transfer of immigrant skills, and there is a substantial body of literature which concentrates solely on quantifying this imperfect skill transfer. More recently, Lagakos et al. (2018)find that there is a strong correlation between GDP per capita and returns to an immigrant's home country experience. For example, they find that Mexico and Guatemalan immigrants wages are 20% higher upon entry to the U.S. labor market for those of immigrants with 20 years experience compared to those with 5 years. The equivalent t figures for Canadian, British and German immigrants are 100%, 200% and 160% respectively. Furthermore, they establish that this correlation also holds when considering educational attainment. **?** use NIS (New Immigrant Survey) data, a dataset unique in that it has information on immigrants pre- and post migration allowing the analysis of immigrants earning and occupation patterns upon arrival in the U.S. First, they find that immigrants do experience wage gains on migration and the gains are negatively correlated with their home country's GDP per capita. For example, immigrants from a country with 1/16 to 1/8 of the U.S. GDP per capita earned 200% more in the U.S. compared to their home country. This is in contrast to immigrants from countries with more than 1/2 the U.S GDP per capita, who earned around 20% more. However, they also find that immigrants undergo a significant occupation downgrade upon migration. This result is established by looking at the immigrant's occupation pre- migration and comparing the wage they could expect after migration - had they continued their pre-migration occupation - with the wage they actually receive upon migration. They find that over 65% of immigrants from poor countries move to a lower wage occupation than they had in their home country, while around 10% stay in the same occupation and 25% move to a higher paying occupation. Again, this is in contrast to immigrants from high income countries, of whom 50% stay in the same occupation or move into a higher-paying occupation. The common conclusion of these papers is that skill transferability is an issue for immigrants and that is correlated with the immigrant's source country GDP per capita. Given that this paper wishes to concentrate on the effects of moving to a high skill immigration policy, it seems reasonable to concentrate on the degree of transferability of the skills of immigrants with college degrees.

While many papers in the immigration literature concentrate first on establishing the substitutability of immigrants and natives, the same papers go on to attempt to quantify the effect of immigration episodes on wages. Using quasi-natural experiments Card (1990, 1997) finds that there are close to zero effects of immigrants on wages and that at most, immigrants cause a 3% decrease in wages. Borjas (2003) argues that the reason that such small effects are found is that Card (1990), **?** focuses solely on a local labor market. Further, Borjas (2003) argues that **?** ignores the fact that immigrants may already be entering a slack labor market, or that if the labor market is tight, immigrants and natives may move to different areas of the U.S. not covered by the study, thus making it appear as though immigration has no effect.

Many of the aforementioned papers do estimate the effect of event-specific immigrant waves on native wages, or on what would be the effect had there been no immigrants at all (Borjas (2003), Schoellman (2010)). However, there are other papers that do set out to analyze the effects of a specific policy, such as the complete opening of borders. Most notably this has been done by Klein and Ventura (2009) along with Kennan (2014). Both papers take a general equilibrium approach so as to analyze the welfare effects. Klein and Ventura (2009) try to assess the impacts of open borders through the lens of a life-cycle model and run the counterfactual of expanding the EU. They find that this would increase output by 3% over a 50 year period. Kennan (2014) takes a factor proportions approach and divides immigrants into high and low skill categories based on education. Kennan (2014) then assesses the impact of open borders. Kennan (2014) finds worldwide income gains between 94% and 129%, depending on the parameterization and the type of agent. These papers make a valuable contribution in quantifying just how large the gains could be from opening borders.

Another avenue of immigration policy research that relates to this paper is the effect of H1B visas on various outcomes. H1B visa programs receive attention because they are the largest immigration program that is based upon skills. Lee (2017), along with Bound et al. (2017), examine the effects of increasing the number of H1B visas (high skill temporary visas) made available; while an interesting exercise, it does only address a very small part of U.S. immigration. H1B visas make up around 10% of visas given out each year and only to high skill applicants. Furthermore, H1B visas are employment-contingent and imply perfect skill transfer between the immigrant's native country and the U.S. . This paper seeks to quantify the effect of changing to a merit based immigration policy when skill transfer is imperfect.

2.3 Background

A sizeable proportion of the current literature which estimates the impact of immigration on wages concentrates on the fact that much of recent immigration has been by those with a high school degree or less. Ottaviano and Peri (2012), Borjas (2003) and Borjas and Katz (2007) all estimate the elasticity of substitution between high school graduates and dropouts with little consideration given to the different types of college graduates and how their labor substitutes with native U.S citizen in production. However, if we are to consider the costs and benefits of moving to a merit-based immigration system whereby individuals are considered on their educational attainment, it would appear more relevant to concentrate on quantifying the role of those who are college-educated and investigating how substitutable college-educated immigrants are with both high school educated Americans and college educated Americans.

Currently, 80% of immigrants granted access to U.S. labor markets are not granted access on the basis of their skills. Much immigration is based upon family ties, with no formal selection by immigration authorities on the applicant's educational or career attainment. This is in contrast to the immigration system of Canada, in which 60% of immigrants are selected based upon merit. Part of what motivates this paper's research is that, despite having a merit based system, the earnings gap between immigrants and similarly-qualified natives that has been well documented in the U.S. by

Aydemir and Skuterud (2008) still exists in Canada.

This paper departs from the research referenced above by arguing that not all immigrants educations are of equal transferability and consequently, how we consider immigrants skills in production will alter the effects of any policy change. This paper builds on the results established in Hendricks and Schoellman (2017) and Lagakos et al. (2018) as discussed in Section 2, in noting that immigrants from poorer countries do not receive the same returns to their qualifications as their counterparts from richer countries.

For the analysis that follows I use ACS data from 2009-2016 (IPUMS USA) figure II relating to workers who work 34 hours a week or more, for 40 weeks or more per annum. I calculate potential experience using age and educational attainment as in Clark and Jaeger (2006). I use the World Bank 2016 country income level classification as a proxy for educational transferability. For countries that are classed as middle income or below (i.e any country with a GDP per capita of less than $12,000 in PPP), as a low transferability education country and any country with a GDP per capita of more than $12,000 as high income. I define any country with an income classification of high income as a high transferability education country. [9]

If it were the case that immigrants with certain levels of educational were perfect substitutes with their native counterparts, it would be reasonable to expect that they would have similar earnings and occupation profiles. To illustrate this point, I first separate observations into various educational field and transferability groups. Table 1 shows the average wages of various skill groups calculated using a basic Mincerian specification, regressing the log of hourly wages on education and years of experience both US and foreign, as well as quadratic terms for each of the experience variables. In the same regression I also interact the experience variables with educational attainment and educational transferability. The interaction terms are to capture the differences in returns to experience by country of immigrant origin which is highlighted in Lagakos et al. (2018). Table 1 illustrates that when making comparing all immigrants with college education they have similar lifecycle earnings profiles as Americans with a college education. However, after breaking down the groups by educational transferability and field, some notable patterns emerge. Table 1 shows that the returns to a degree obtained in the U.S. varies little whether obtained by an immigrant from a country with low educational transferability or high educational transferability. Furthermore, this result also extends to STEM degrees obtained from U.S. universities.

[9] In all of the tables that follow I only use immigrants without a U.S. education with 10 years foreign experience which is the average that immigrants arrive to the U.S. with, the results are robust to this choice.

Table 1 shows that immigrants from high educational transferability countries earn around 40% more than their low education transferability counterparts. Table 1 also shows that immigrants with a STEM degree from a low educational transferability country earn less than immigrants from high educational transferability countries and their American counterparts, however, they still earn around 20% more than other low transferability education immigrants. From table 1 we can see that immigrants with college education from a low educational transferability country have earnings profiles similar to Americans with only a high school education.

Table X: Mean Wage of Education - transferability Group (2016 $)

Education-transferability Group	0-5	5-10	10-15	15-20	20-25	25-30	30-35	35-40
American High School	11.4	15.1	18.9	22.5	25.4	27.2	27.5	26.4
American College	18.5	23.7	28.8	33.5	37.0	38.8	38.9	37.0
American College STEM degree	20.0	26.5	33.3	40.0	44.6	47.7	48.3	46.4
All immigrants with college	24.3	28.9	33.2	36.8	39.46	40.9	-	-
Low transferability College	21.2	23.6	25.8	27.7	29.3	30.5	-	-
Low transferability College with STEM degree	28.7	33.2	37.0	39.8	41.4	41.6	-	-
Low transferability Child Education, U.S College	18.9	24.4	29.8	34.5	37.8	39.2	38.4	35.7
Low transferability Child Education, U.S STEM degree	21.6	29.5	37.5	44.8	49.9	52.0	50.7	46.2
High transferability College	36.5	40.4	43.5	45.8	48.0	47.0	-	-
High transferability College with STEM degree	37.8	46.5	54.7	61.0	64.8	65.5	-	-
High transferability Child Education, U.S. degree	19.8	26.2	32.6	38.3	42.3	44.0	43.2	40.0
High transferability Child Education, U.S. STEM degree	19.8	28.5	38.0	47.0	53.8	57.0	56.0	51.0

In table X I compute an occupational similarity index for each skill-transferability combination similar to Borjas and Doran (2012). The index compares the degree to which the occupational distributions of two groups overlap, with more substitutable groups having greater overlap. To compute this index I_{ij} I use the following

$$I_{ij} = 1 - \frac{1}{2}\Sigma_o |s_{io} - s_{jo}|$$

where s_{io} is the share of education-transferability group i that are employed in occupation o according the three digit SOC codes provided by the BLS. Table 2[10] shows that the degree of similarity between low transferability educated college immigrants and Americans with high school is 0.57, this means that 43% of low transferability educated college immigrants would have to change occupations to have the exact same distribution as Americans with high school. The groups with the greatest overlap with college educated Americans are immigrants from low transferability education countries that obtain a U.S. college degree. While there is a substantial overlap of college educated Americans with immigrants from high transferability education countries that obtain a U.S. college degree it is less than that of their low transferability education counterparts. The central takeaway from table 2 is that there is overlap in the occupational distribution of immigrants and Americans. Furthermore, the degree of overlap differs by transferability of education and education field.

[10] Further disaggregation by years of experience is in the appendix

Table X: Occupation Similarity Index

Education-Transferability Group	American High School	American College	American College STEM
Low transferability High School	0.62	0.24	0.22
High transferability High School	0.59	0.46	0.43
Low transferability College	0.57	0.61	0.53
Low transferability College STEM	0.45	0.48	0.68
Low transferability Child Education, U.S. College	0.48	0.78	0.67
Low transferability Child Education, U.S. College STEM	0.33	0.52	0.78
High transferability College	0.27	0.54	0.49
High transferability College STEM	0.21	0.38	0.57
High transferability Child Education, U.S. College	0.36	0.71	0.59
High transferability Child Education, U.S. College STEM	0.25	0.46	0.68
American College	0.45	1.0	0.66
American College STEM	0.38	0.66	1.0

Table X shows that the degree of overlap between immigrants with a high transferability college education and Americans with a college education is smaller than the overlap of their low transferability education counterparts. Given that the index calculated above cannot account for the skills involved in each occupational choice I present table X as summary evidence of the type of occupations each group chooses. As in Lagakos et al. (2018), I classify occupations as either skilled or unskilled and table X shows the proportion of immigrants of each education level who are in skilled or unskilled occupations. The patterns that emerged when considering wages also appear when considering which occupations immigrants work in.

Table X: Percent of Education - transferability Group in a Skilled Occupation

Education-transferability Group	0-5	5-10	10-15	15-20	20-25	25-30	30-35	35-40
American High School	18.5	24.0	27.1	28.7	29.2	29.0	28.7	27.6
American College	65.1	72.6	75.7	76.5	76.3	76.8	77.6	77.3
American College STEM degree	74.6	80.6	82.6	82.1	83.0	83.3	83.6	83.6
All immigrants with college	74.2	73.7	75.4	76.4	75.6	75.6	-	-
Low transferability College	54.0	50.0	52.3	54.0	55.2	54.1	-	-
Low transferability College with STEM degree	77.4	67.1	68.9	70.2	72.5	72.7	-	-
Low transferability Child Education, U.S College	62.6	70.6	75.5	76.4	75.1	73.6	75.0	75.3
Low transferability Child Education, U.S STEM degree	81.2	85.7	86.9	87.3	85.0	86.1	85.1	85.8
High transferability College	86.0	82.6	79.2	78.1	79.7	84.0	-	-
High transferability College with STEM degree	91.2	90.7	89.5	89.8	91.4	89.0	-	-
High transferability Child Education, U.S. degree	72.0	80.0	81.3	81.6	81.7	81.1	77.8	77.9
High transferability Child Education, U.S. STEM degree	88.1	91.1	86.0	91.0	90.8	90.4	87.6	85.7

The evidence reported in this section suggests, but is by no means conclusive, that low educational transferability immigrants with a college degree are better considered as unskilled inputs into the production function than skilled inputs. To further justify this, I must estimate a production function that has both skilled and unskilled inputs which are also disaggregated over educational transferability and see how the elasticities of substitution change.

2.4 Measuring Effects of Immigration on Wages

The previous section establishes that immigrants with similar levels of experience and education earn different amounts and work in different occupations to their U.S. native counterparts. This observation also varies by the country in which the education as received. These observations provide the motivation for exploring whether immigrants can be thought of as imperfect substitutes with U.S. born workers in production. To do this I will construct and estimate a CES production function that separates labor inputs not only by educational attainment but also by the field of education and where the education was obtained. This paper will concentrate on the estimation of the relevant elasticities of substitution and then compare the effects of changing immigration policy with a partial equilibrium model that is standard in the immigration literature.

2.5 Parameterization of the Production Function

Production uses capital (K) and labor (L) combined together according to a Cobb-Douglas specification. The labor inputs are aggregated using a CES (Constant Elasticity of Substitution) specification. Labour inputs differ by education e and educational transferablility q. Education can take values H for high school or less and C for college or more. transferablility q can be low transferablility LQ , high transferablility HQ, STEM ST American educated immigrant AI or American A.

$$
\begin{aligned}
Y &= AK^{\alpha}L^{1-\alpha} \\
L &= \left[\theta_U L_U^{\frac{\sigma_{SU}-1}{\sigma_{SU}}} + \theta_S L_S^{\frac{(\sigma_{SU}-1)}{\sigma_{SU}}}\right]^{\frac{\sigma_{SU}}{\sigma_{SU}-1}} \\
L_U &= \left(\theta_{H,LQ} L_{H,LQ}^{\frac{\sigma_U-1}{\sigma_U}} + \theta_{H,HQ} L_{H,HQ}^{\frac{\sigma_U-1}{\sigma_U}} + \theta_{H,A} L_{H,A}^{\frac{\sigma_U-1}{\sigma_U}} + \theta_{C,LQ} L_{C,LQ}^{\frac{\sigma_U-1}{\sigma_U}}\right)^{\frac{\sigma_U}{\sigma_U-1}} \\
L_S &= \left(\theta_{C,HQ} L_{C,HQ}^{\frac{\sigma_S-1}{\sigma_S}} + \theta_{C,UI} L_{C,UI}^{\frac{\sigma_S-1}{\sigma_S}} + \theta_{C,ST} L_{C,ST}^{\frac{\sigma_S-1}{\sigma_S}} + \theta_{C,A} L_{C,A}^{\frac{\sigma_S-1}{\sigma_S}}\right)^{\frac{\sigma_S}{\sigma_S-1}}
\end{aligned}
$$

An alternative is to consider low transferability college workers as unskilled workers in which case the total labor supply of unskilled and skilled workers will be

$$L_U = \left(\theta_{H,LQ} L_{H,LQ}^{\frac{\sigma_U - 1}{\sigma_U}} + \theta_{H,HQ} L_{H,HQ}^{\frac{\sigma_U - 1}{\sigma_U}} + \theta_{H,A} L_{H,A}^{\frac{\sigma_U - 1}{\sigma_U}}\right)^{\frac{\sigma_U}{\sigma_U - 1}}$$

$$L_S = \left(\theta_{C,LQ} L_{C,LQ}^{\frac{\sigma_S - 1}{\sigma_S}} + \theta_{C,HQ} L_{C,HQ}^{\frac{\sigma_S - 1}{\sigma_S}} + \theta_{C,AI} L_{C,AI}^{\frac{\sigma_S - 1}{\sigma_S}} + \theta_{C,ST} L_{C,ST}^{\frac{\sigma_S - 1}{\sigma_S}} + \theta_{C,A} L_{C,A}^{\frac{\sigma_S - 1}{\sigma_S}}\right)^{\frac{\sigma_S}{\sigma_S - 1}}$$

This production function departs from the standard classification of labor inputs by classifying immigrants with a low transferablility education as unskilled inputs rather than skilled as discussed in section 3. Within the labor aggregation σ_{SU} refers to the elasticity of substitution between skilled and unskilled inputs, σ_U is the elasticity of substitution between unskilled inputs and σ_S is the elasticity substitution between skilled inputs. The θs are the relevant factor share parameters. When conducting my analysis I also measure the elasticities of substitution when classifying immigrants with low transferablility college as skilled inputs. Under this specification the aggregate unskilled and skilled labor will be as follows.

$$L_U = \left(\theta_{H,LQ} L_{H,LQ}^{\frac{\sigma_U - 1}{\sigma_U}} + \theta_{H,HQ} L_{H,HQ}^{\frac{\sigma_U - 1}{\sigma_U}} + \theta_{H,A} L_{H,A}^{\frac{\sigma_U - 1}{\sigma_U}}\right)^{\frac{\sigma_U}{\sigma_U - 1}}$$

$$L_S = \left(\theta_{C,LQ} L_{C,LQ}^{\frac{\sigma_S - 1}{\sigma_S}} + \theta_{C,HQ} L_{C,HQ}^{\frac{\sigma_S - 1}{\sigma_S}} + \theta_{C,AI} L_{C,AI}^{\frac{\sigma_S - 1}{\sigma_S}} + \theta_{C,ST} L_{C,ST}^{\frac{\sigma_S - 1}{\sigma_S}} + \theta_{C,A} L_{C,A}^{\frac{\sigma_S - 1}{\sigma_S}}\right)^{\frac{\sigma_S}{\sigma_S - 1}}$$

The structure of the production function implies that the effect on wages for any native worker group of labor supply changes due to immigration can be broken down into two components, direct and indirect partial effects. The direct partial effect is the effect on wages due to changes in the supply of immigrants that are used as similar labor inputs to natives in the production function. For example, the partial effect of immigration on unskilled natives (Americans with high school education) will come from changes in labor supply from other high school educated immigrants and college educated immigrants with a low transferablility education. The magnitude of this effect will primarily manifest itself through the value of elasticity of substitution. If σ_U, the elasticity of substitution among unskilled workers is high i.e. close to perfect substitutes, then changes in the labor supply of unskilled immigrants can have potentially large negative effects on the wages of unskilled natives. However if σ_U is low then the changes in wages will be smaller.

The indirect partial effect of immigration on wages of natives comes from changes in the labor supply of immigrants of different labor inputs. Again using unskilled natives as an example, the indirect effect of immigration on their wages will come from changes in the labor supply of skilled immigrants. As with the direct partial effect, the indirect partial effect will depend primarily on the magnitudes of σ_{SU}, the elasticity of substitution between skilled and unskilled labour inputs.

2.6 Data

The main dataset for my analysis is the 1980 Census 5% sample, 1990 Census 5% sample, 2000 Census 5% sample as well as the 2007 ACS (American Community Survey) 5 year and 2016 ACS (IPUMS USA) figure II. 5 year sample. Following Katz and Murphy (1992) I construct two slightly different samples to produce measures of hours worked and of each cell and average ages of each cell.

The sample for creating the labour supply includes anyone who is 18 to 65 and not living in group quarters with less than 40 years experience. I classify any worker as having college or more if they have completed 4 or more years of college, otherwise I assign them to the the high school or less group. I limit the sample to those with less than 40 years total experience regardless of whether the experience was gained in the U.S. or abroad.

$$Experience = age - sch - 6$$

Where sch is the imputed years of schooling from their education level.

All immigrants are assigned a transferability level of low if they are from a country the World Bank classifies as low, lower-middle, middle or upper middle income i.e a GNI per capita of $12,235 in 2016. I assign a transferability of high if an immigrant is from a high income country as defined by the World Bank (higher than $12,235).

I assign 'U.S. immigrant' transferability to any immigrant who arrived before the age of 22 who has a bachelor's degree, before the age of 25 if they have a masters or professional degree and 28 if they have a doctoral degree. Below is table describing the 8 types in the analysis. I assign STEM transferability to any immigrant I observe working in a STEM career in my sample using the BLS list of STEM occupation codes.

To calculate the total hours worked by any type g in metro area f in a year t I do the following

$$L_{gct} = \Sigma_i hours_{igft} \times weeks_{igft} \times weight_{igft}$$

The sample that I use to measure wages is more restrictive. I use the sample described above excluding those who are self-employed or work in the government. In the 1980 Census some incomes are topcoded, to get around this I multiply any topcoded by value by 1.5 as in Ottaviano and Peri (2012). I then adjust wages to 2016 dollars using the CPI and take the mean wage for each type $g$in city $f$in time t weighting by the number of hours worked by each observation.

Table X: List of types

	Education level	Transferability
Unskilled (U)	High school	Low transferability
	High School	High transferability
	High School	Native U.S.
	College	Low transferability
Skilled (S)	College	High transferability
	College	U.S educated immigrant
	College	STEM
	College	Native U.S.

2.7 Summary Statistics

Table X: Skilled Workers

	HQ	U.S. Native	U.S Educated Immigrant	STEM
Hourly wage (mean) (2016 $)	45.0	35.2	33.7	43.1
Hourly wage (s.d)	42.4	28.7	30.6	29.7
U.S. Experience (Years)	12.6	17.4	15.0	12.6
Foreign Experience (Years)	6.7	0	0	3.7
College (%)	64	66	61	45
Masters (%)	32	30	34	39
PhD (%)	4	4	4	16
Average Hours	45.8	44.4	43.5	43.2
Average Weeks	51.0	51.0	51.0	51.0

Table X: Unskilled Workers

	LQ	HQ	U.S. Native	LQ with College
Hourly Wage (mean) (2016 $)	15.8	23.7	20.2	28.1
Hourly Wage (s.d)	13.1	18.9	14.5	26.1
U.S. Experience (years)	13.4	18.3	19.5	12.4
Foreign Experience (years)	5.9	5.4	0	7.3
Less than High School	41	10	9	0
High School (%)	36	42	46	0
Some College (%)	25	48	45	0
College (%)	0	0	0	73
Average Hours	41.7	42.9	42.5	42.7
Average Weeks	51.0	51.0	51.0	51.0

2.7.1 Production Function to Regression

Using an unskilled worker type as an example in any city f at time t

$$\begin{aligned}\log w_{u\in U} &= \log((1-\alpha)K^{\alpha}L^{-\alpha}) \\ &+ \frac{1}{\sigma_{SU}}\log(L) - \frac{1}{\sigma_{SU}}\log(L_U) \\ &+ \frac{1}{\sigma_U}\log(L_U) + \log\theta_U \\ &- \frac{1}{\sigma_U}\log(L_{u\in U}) + \log\theta_{u\in U}\end{aligned}$$

Where $w_{u\in U}$ is the average hourly wage of an unskilled worker type u in year t. Since this holds for each $u \in U$ to eliminate the aggregate effects the equation for each $u \in U \setminus (H, A)$ can be rewritten as

$$\log\left(\frac{w_{u,t}}{w_{H,A}}\right) = -\frac{1}{\sigma_U}\log\left(\frac{L_u}{L_{H,A}}\right) + \log\left(\frac{\theta_u}{\theta_{H,A}}\right)$$

To identify the elasticity of substitution σ_U I regress the the log wage ratio of each group $u \in U \setminus (H, A)$ to U.S. born with with less than college.

$$\log\left(\frac{w_{u,f,t}}{w_{(H,A),f,t}}\right) = \rho_{u,f,t} + \rho_1\log\left(\frac{L_{u,f,t}}{L_{(H,A),f,t}}\right) + \nu_{u,f,t}$$

After estimating this equation I can back out the set of θ's using the residuals and by making the restricting it such that

$$\sum_{u\in U}\theta_{u\in U} = 1$$

An analagous set of equations will identify σ_S. This specification will suffer from omitted variable bias in that

$$E\Big[L_{u,f,t}|\nu_{u,f,t}\Big] \neq 0$$

To overcome this endogeneity I use a shift-share instrument as is standard in the immigration literature. My instrument for hours worked by each unskilled type $u \in U$ as described in table 1 (and analogously skilled $s \in S$) uses the predicted number of total unskilled workers in a year based upon the migration patterns of 1980. For this to be a valid instrument the instrument must be uncorrelated with demand shocks for specific skill types. My justification is the same as Card (2001) in that the actual inflow of immigrants from a given source country moving to the U.S. can be decomposed into an exogenous supply-push component and an endogenous demand pull component.

The exogenous supply push component uses the fraction of immigrants from a country of a certain skill level in 1980 who have settled in the U.S. to predict future patterns of migration. The immigrants who are predicted to come can be thought of as the immigrants joining family members already here or of those who want to migrate due to circumstances in their home country and want to come where other former immigrants of have come. In either scenario these immigrants come not because of demand factors but because of other reasons which implies this instrument should satisfy the exclusion restriction. The endogenous demand pull components is the difference between the predicted flows and actual flows. Formally the supply push component is

$$m_{u\in U\setminus A,f,t} = \sum_{g} \tau^{80}_{u\in U\setminus A,g} \lambda^{80}_{g,f} M_{g,t}$$

Where $\tau^{80}_{U,g}$ is the fraction of workers from country g who are of unskilled type $u \in U$ in 1980, $\lambda^{80}_{g,c}$ is the fraction of immigrants from country g who work in metroarea f in 1980 and $M_{g,t}$ is the number of new arrivals from country g in year t. Therefore, the first stage regression for the unskilled workers is as follows

$$\log L_{u\in U\setminus A,f,t} = \gamma_f + \gamma_{u\in U\setminus A} + \gamma_1 \log m_{u\in U\setminus A,f,t} + \varphi_{u\in U\setminus A,f,t}$$

Figures XI and XII displays the results of the first stage of the regression. Figure XI shows the results of the first stage of the regression when considering workers with college education from a low transferability country as unskilled labor inputs. Figure XI shows that the coefficient on the instrument for both unskilled and skilled inputs is significant and the specification results in an F-value of 30.84 and 5.72. Both values indicating that the instrument used is valid. Figure XII shows the results of the first stage regression when considering workers with college education from a low transferability country as skilled labor inputs. As in figure XI the F-values of 17.84 and 11.25 are reasonable implying that the instrument is still valid under this alternate specification.

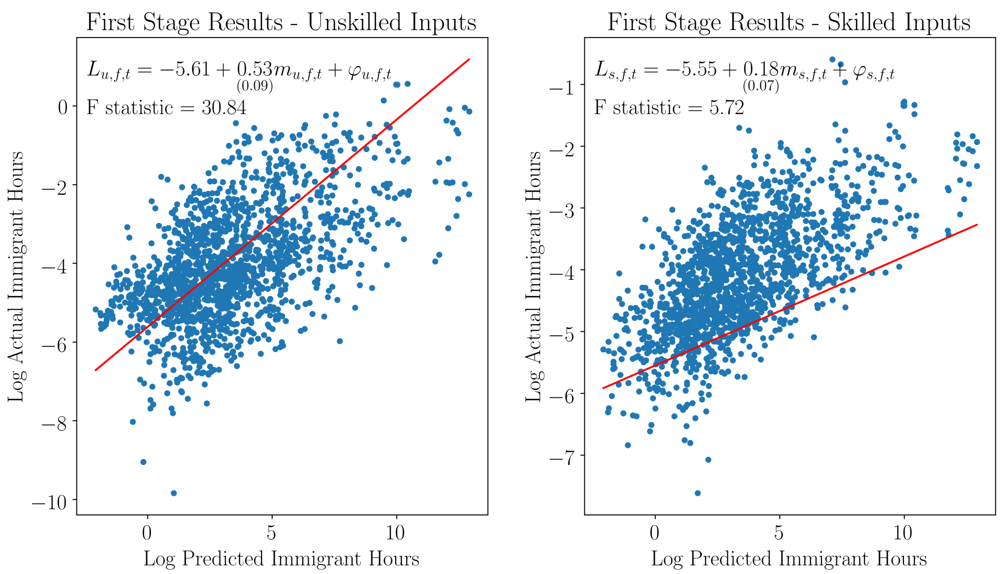


Figure XI: First Stage Results - Low Transferability with College As Unskilled

2.8 Estimates of σ_U and σ_S Low Transferability with College Education as Unskilled

Table XII shows the estimation of $-\frac{1}{\sigma_U}$. The values imply a value of σ_U that is the elasticity of substitution between different unskilled labor inputs of between 4.5 and 20.4 with the results under most specifications being close to 11. By including fixed effects for time I am allowing for productivity to vary over time and including fixed effects for each skill group it allows for different forces to affect different skill groups. This can be thought of as different immigration policies or technological change that might affect one group more than another. Including fixed effects for different metro areas allows for similar affects. The main assumption that I am making is there is no metroarea time fixed effects interactions.

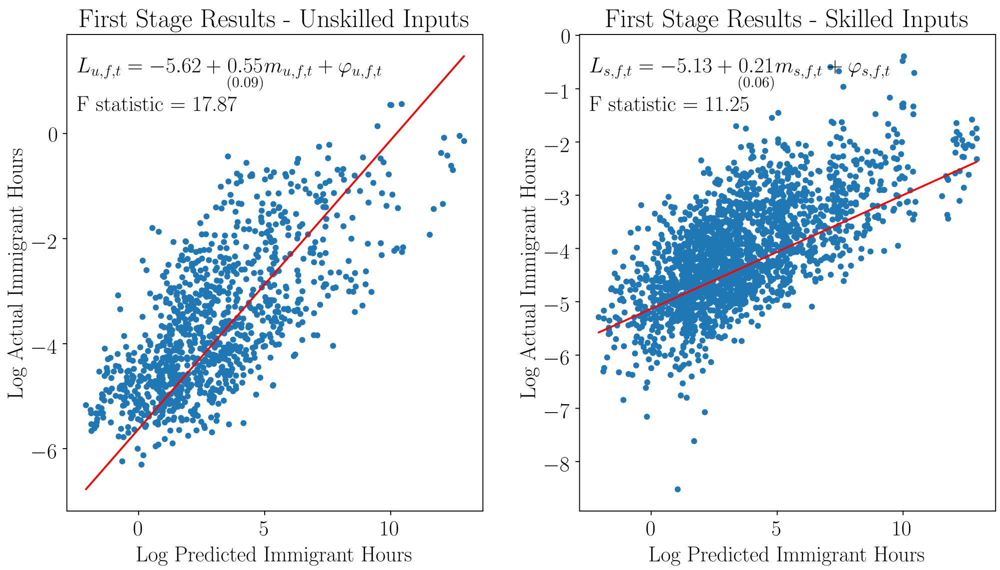


Figure XII: First Stage Results - Low Transferability with College As Skilled

Table XII: Estimates of $-1/\sigma_U$

	No FE	Skill FE	Year FE	Metro FE	All FE
Pooled	-0.073***	-0.049***	-0.073***	-0.182	-0.086***
	(0.020)	(0.007)	(0.020)	(0.051)	(0.012)
Men	-0.085**	-0.056***	-0.085**	-0.217***	-0.086***
	(0.027)	(0.005)	(0.027)	(0.021)	(0.012)
Women	-0.056***	-0.039***	-0.057***	-0.137***	-0.084***
	(0.017)	(0.010)	(0.017)	(0.015)	(0.017)
2000-2011	-0.074**	-0.053***	-0.075**	-0.244***	-0.076***
	(0.025)	(0.005)	(0.025)	(0.023)	(0.015)
Full time	-0.088**	-0.059***	-0.088***	-0.222***	-0.091***
	(0.027)	(0.005)	(0.026)	(0.020)	(0.012)
Observations	1571	1571	1571	1571	1571

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

The estimates are also robust to changing of the sample composition. If we restrict the sample to just men or women the estimates change very little and when considering all fixed effects the estimates are identical. If the timer period is changed to only include the 2000 Census and 2011 ACS data imply a higher elasticity of substitution of 13.85 compared to 11.65 when considering the entire time period of the analysis. Finally when considering only those who are full time workers in the estimation I obtain an elasticity of substitution of 10.98.

These values are lower than those estimated in Ottaviano and Peri (2012) who estimate a value of ∞ implying that unskilled labor inputs are perfect substitutes. Peri and Sparber (2009) estimate a similar parameter by dis-aggregating unskilled labor supply into the cognitive and manual tasks and estimating the elasticity of substitution for these two task inputs. They find that these tasks are complimentary i.e. elasticity of substitution less than 1. They also show that immigrants enter into manually intensive tasks whereas U.S. natives perform more cognitive tasks. Given the evidence in table X showing that many immigrants with less than college are in much different occupations than their U.S. native counterparts the parameter estimated in table XII can be thought of as somewhat analogous to Peri and Sparber (2009) and why I obtain an elasticity of substitution between their paper and that of Ottaviano and Peri (2012).

Ultimately this imperfect substitution will imply that effects on wages of immigration will be lower than if perfect substitution is assumed as in **?**. This imperfect substitution could be because immigrants are choosing different occupations to their U.S. born counterparts as documented in **??** and Peri and Sparber (2009).

A clear result emerges in table XII that shows the estimation of $-\frac{1}{\sigma_S}$. Under most specifications and samples the estimates vary between -0.14 and -0.25 implying an elasticity of substitution of between 7 and 4. These estimates are statistically significant at the 5% level and many at the 1% level. The only sample that produces any statistically significant difference is when using the wages of women as the dependent variable. Using this sample I find an elasticity of substitution varying between 50 and 6.7. This imperfect substitution likely comes from the different occupational choices by immigrants with a college education compared to those who are U.S. born. For example 80% of immigrants with a STEM degree work in STEM occupations defined by the BLS the corresponding number for those who are U.S. born is around 25%.

Attempts to estimate a parameter similar to σ_S have been undertaken in Ottaviano and Peri (2012) and Turner (2017). In the former they dis-aggregate the skilled labor supply by college graduates and

Table XII: Estimates of $-1/\sigma_S$

	No FE	Skill FE	Year FE	Metro FE	All FE
Pooled	-0.131***	-0.112*	-0.130***	-0.152*	-0.226***
	(0.029)	(0.051)	(0.026)	(0.069)	(0.062)
Men	-0.137***	-0.107	-0.135***	-0.212	-0.247***
	(0.028)	(0.055)	(0.027)	(0.078)	(0.064)
Women	-0.074*	-0.082*	-0.072*	0.019	-0.154**
	(0.036)	(0.038)	(0.035)	(0.058)	(0.050)
2000-2011	-0.139***	-0.107	-0.136***	-0.241***	-0.280***
	(0.032)	(0.059)	(0.029)	(0.072)	(0.073)
Full time	-0.140***	-0.112*	-0.139***	-0.211***	-0.247***
	(0.030)	(0.056)	(0.028)	(0.064)	(0.061)
Observations	1571	1571	1571	1571	1571

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

some college and obtain an elasticity of substitution of around 10. In Turner (2017) he dis-aggregates skilled labor inputs by degree field of college STEM vs non-STEM. Using this dis-aggregation he obtains an elasticity of substitution between 2 and 6.7. What distinguishes this paper from Turner (2017) is that he disaggregates only by college major I also disaggregate by an immigrant's country of origin.

2.9 Estimates of σ_U and σ_S Low Transferability with College Education as Skilled

In this subsection I repeat the exercise of subsection 2.8 in estimating values of $-\frac{1}{\sigma_S}$ and $-\frac{1}{\sigma_U}$ to obtain a value of the elasticity of substitution between unskilled labor inputs, σ_U and the elasticity of substitution between unskilled labor inputs σ_S. However, the key difference is I include those who are from countries with low transferability and a college education in the skilled labor inputs rather than the unskilled labor inputs. Doing this gives the following expressions for total unskilled and skilled labor.

$$L_U = \left(\theta_{H,LQ} L_{H,LQ}^{\frac{\sigma_U - 1}{\sigma_U}} + \theta_{H,HQ} L_{H,HQ}^{\frac{\sigma_U - 1}{\sigma_U}} + \theta_{H,A} L_{H,A}^{\frac{\sigma_U - 1}{\sigma_U}}\right)^{\frac{\sigma_U}{\sigma_U - 1}}$$

$$L_S = \left(\theta_{C,LQ} L_{C,LQ}^{\frac{\sigma_S - 1}{\sigma_S}} + \theta_{C,HQ} L_{C,HQ}^{\frac{\sigma_S - 1}{\sigma_S}} + \theta_{C,AI} L_{C,AI}^{\frac{\sigma_S - 1}{\sigma_S}} + \theta_{C,ST} L_{C,ST}^{\frac{\sigma_S - 1}{\sigma_S}} + \theta_{C,A} L_{C,A}^{\frac{\sigma_S - 1}{\sigma_S}}\right)^{\frac{\sigma_S}{\sigma_S - 1}}$$

Table XII: Estimates of $-1/\sigma_U$

	No FE	Skill FE	Year FE	Metro FE	All FE
Pooled	-0.085***	-0.055***	-0.087***	-0.193***	-0.095***
	(0.009)	(0.009)	(0.008)	(0.007)	(0.012)
Men	-0.098***	-0.061***	-0.099***	-0.228***	-0.095***
	(0.011)	(0.010)	(0.010)	(0.008)	(0.014)
Women	-0.070***	-0.047***	-0.072***	-0.150***	-0.097***
	(0.008)	(0.009)	(0.007)	(0.005)	(0.011)
2000-2011	-0.086***	-0.057***	-0.090***	-0.243***	-0.090**
	(0.015)	(0.014)	(0.014)	(0.009)	(0.028)
Full time	-0.101***	-0.064***	-0.102***	-0.233***	-0.100***
	(0.011)	(0.010)	(0.010)	(0.008)	(0.014)
Observations	1571	1571	1571	1571	1571

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table XII shows the results of this second exercise when estimating $-\frac{1}{\sigma_U}$. Table XII shows that the estimates are similar to when those from a lower transferability country with a college education are considered as unskilled inputs. Table XII implies that elasticity of substitution between unskilled inputs is between 10 and 12. Further table XII shows that the estimates are all significant at the 1% level. These results imply that this exercise's definition of unskilled labor inputs are closer to perfect substitutes than in the first exercise. Thus when considering the effect of immigration on wages this would predict a larger negative own group effect than in the first exercise.

Table XII shows the results of this second exercise when estimating $-\frac{1}{\sigma_S}$. Unlike the estimates of $-\frac{1}{\sigma_U}$ under this second exercise the estimates of $-\frac{1}{\sigma_S}$ are different at the 5% significance level. The estimates of $-\frac{1}{\sigma_S}$ in table XII imply an elasticity of substitution of between 6.7 and 9.2.

Table XII: Estimates of $-1/\sigma_S$

	No FE	Skill FE	Year FE	Metro FE	All FE
Pooled	-0.131***	-0.085*	-0.129***	-0.223*	-0.116*
	(0.029)	(0.037)	(0.028)	(0.091)	(0.047)
Men	-0.140***	-0.088*	-0.138***	-0.280**	-0.138**
	(0.030)	(0.036)	(0.030)	(0.089)	(0.048)
Women	-0.080***	-0.055	-0.078***	-0.186***	-0.087***
	(0.024)	(0.030)	(0.023)	(0.081)	(0.039)
2000-2011	-0.143***	-0.092*	-0.141***	-0.331**	-0.151**
	(0.033)	(0.037)	(0.032)	(0.106)	(0.048)
Full time	-0.144***	-0.093**	-0.142***	-0.279**	-0.132**
	(0.030)	(0.036)	(0.030)	(0.089)	(0.048)
Observations	1571	1571	1571	1571	1571

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

2.10 Elasticity estimates for high and low skilled

With the estimates of σ_U and σ_S to be able to estimate σ_{SU} I need to calculate the individual productivity terms for each skill type $\theta_{u,f,t}$. Given that

$$\log\left(\frac{w_{u,t}}{w_{H,A}}\right) = -\frac{1}{\sigma_U}\log\left(\frac{L_u}{L_{H,A}}\right) + \log\left(\frac{\theta_u}{\theta_{H,A}}\right)$$

is estimated using the following regression

$$\log\left(\frac{w_{u,f,t}}{w_{(H,A),f,t}}\right) = \rho_{u,f,t} + \rho_1 \log\left(\frac{L_{u,f,t}}{L_{(H,A),f,t}}\right) + \nu_{u,f,t}$$

I can use the error terms and value of the coefficients on the skill dummies to back out the following:

$$\nu_{u,f,t} + \rho_u = \log\left(\frac{\theta_u}{\theta_{H,A}}\right)$$

This equation combined with the restriction that $\sum_{u \in U} \theta_{u \in U} = 1$ I can identify the full set of $\theta_{u,f,t}$'s given that I have 4 equations and 4 unknowns for each time, t and metroarea, f. In this subsection I show the procedure for backing the θ's for unskilled inputs, the procedure is identical for the skilled inputs. Further, the procedure is the same regardless of the how those from low transferable countries with college education are classified.

With θ's and σ_U and σ_S and hours data from the Census and ACS as described earlier I can construct measures of $L^U_{f,t}$ and $L^S_{u,f,t}$. To construct the measures of labor supply I choose an elasticity of substitution for unskilled workers of $\sigma_U = 11$ and elasticity of substitution for unskilled workers of $\sigma_S = 4$.

To back out σ_{SU} I can combine the first order conditions that describe the relationship between wages and the constructed labor supply measures for skilled and unskilled inputs then use the following regression to back out σ_{SU}, which yields the following regression equation. This equation will identify $-\frac{1}{\sigma_{SU}}$ using β_1.

$$\log\left(\frac{w^U_{f,t}}{w^S_{f,t}}\right) = \beta_{f,t} + \beta_1 \log\left(\frac{L^U_{f,t}}{L^S_{f,t}}\right) + \epsilon_{f,t}$$

Including fixed effects $\beta_{f,t}$ such that

$$\beta_{f,t} = \beta_f F + \beta_t T$$

will control for any metro area and time effects. The results of the regression are in table XII.

Table XII shows the estimates of $-\frac{1}{\sigma_{SU}}$ that is the elasticity of substitution between skilled and unskilled workers. The first takeaway from this table is that whether those who are from low transferability countries with a college education are treated as high or low skill does not appear to have a significant impact on the result. With estimates of $-\frac{1}{\sigma_{SU}}$ almost identical and not statistically different from each other regardless of specification. The most significant difference in the estimate of $-\frac{1}{\sigma_{SU}}$ comes when restricting the sample to only full time workers. The estimate $-\frac{1}{\sigma_{SU}}$ with the full sample is -0.43 compared to -0.57 if restricting the sample. These estimates imply an upper bound of the elasticity of substitution to be 2.34 and the lower bound 1.75. Estimates which are significant at the 5% level regardless of the sample specification.

These estimates of the elasticity of substitution are well within the range as estimated in the literature. Ottaviano and Peri (2012) estimate a value between 1.67 and 3.3, Colas (2016) estimates

Table XII: Estimates of $-1/\sigma_{SU}$

	Low Transferability College Educated as Unskilled	Low Transferability College Educated as Skilled
Full Sample	-0.426*	-0.428*
	(0.168)	(0.177)
2000-2011	-0.463***	0.444
	(0.063)	(0.318)
Full-Time	-0.579	-0.569*
	(2.869)	(0.272)
Observations	1571	1571

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

a value of 2.4, Katz and Murphy (1992) estimate a value of 1.7. Obtaining a value that is similar to the literature may not seem particularly interesting. However, as far as I know I am the first to estimate parameters of the lower level of my CES production function and then use these parameters to generate measures of the labor supply that are directly used in the estimation of the top of the nested CES production function. For example Ottaviano and Peri (2012) have 4 level nested CES skilled-unskilled at the top, dropout-graduate at the next level, experience at the third level and nativity at the bottom. While they estimate the relevant elasticities of substitution for the bottom two levels and construct the corresponding measures of labor supply they are unable to do so for the top two levels. When estimating the elasticities of substitution for the top two levels they are implicitly assuming all inputs in the lower levels are perfect substitutes. Turner (2017) again estimates what would be σ_S in this paper but does not estimate the top level parameter of σ_{SU}. Instead he tests with different values of this parameter from the literature and unsurprisingly it has significant implications for the size of the effect of immigration on wages.

2.11 Effects of Immigration on Wages

With the estimates of σ_{SU}, σ_S and σ_U I can simulate the effects of immigration on wages in the U.S. for different groups. With the nested CES framework I can provide an assessment of the total effect of immigration on wages as in Ottaviano and Peri (2012). By manipulating the first order conditions, plugging in the estimates of each elasticity of substitution as well the percentage change

Table XII: Effects of Immigration on Wages

[ht]

	This Paper		OP 2012		Borjas 2003	
Classification of Low Transferability	Unskilled	Skilled	Unskilled	Skilled	Unskilled	Skilled
Unskilled	-0.37	0.13	-2.42	-2.38	-3.19	-3.27
	(0.86)	(1.21)	(0.71)	(0.33)	(0.39)	(0.21)
Skilled	3.68	3.06	4.18	4.02	3.48	3.57
	(1.13)	(1.15)	(0.62)	(0.4)	(0.42)	(0.23)
Unskilled	-0.25	0.03	-0.59	-0.48	-0.65	-0.65
	(0.19)	(0.21)	(0.11)	(0.15)	(0.06)	(0.09)
Skilled	1.02	0.61	0.97	0.92	0.71	0.71
	(0.25)	(0.26)	(0.13)	(0.14)	(0.07)	(0.1)
σ_{SU}	2.4	2.4	1.7	1.7	1.7	1.7
σ_U	11.6	10.4	34.5	34.5	∞	∞
σ_S	4.0	7.2	6.3	6.3	∞	∞

Standard deviation in parenthesis

of each hours worked by each immigrant group I can calculate the effects of immigration on wages of different worker types.

I perform the simulation over the period of 1990 to 2011 as well as 2000 to 2011. Given that this is a partial equilibrium setting by using a long time period this goes someway to eliminating the effects of wages because of capital adjustment.

I run 10,000 simulations from a joint normal parameter distribution with the average and standard deviation being the elasticity of substitution estimate and it's standard errors. Each time plugging in the simulated value into the first order conditions I can calculate the wage effect for each skill-metroarea group. I then average over simulation results by skill levels using the metroarea wage share in 1990 as the weight. I also calculate the standard deviation over each skill-metro area and then average using the wage share of each metro area as the weighting scheme.

Each of the columns show the results of the simulation taking into account whether low transferability with a college education are treated as unskilled or skilled inputs. Further how the results change depending upon different parameters estimated in the literature. Using the elasticities estimated table XII shows that immigration between 1990 and 2011 likely resulted in either no effect or a small negative effect on wages for those who are U.S. born with less than a college education. Whereas their college educated counterparts experienced an increase of above 3%. However, restricting the sample from 2000-2011 we do see a significant change for those with a college education. With a much lower increase in wages, this is consistent with the fact that without a direct policy change the composition of immigrants arriving in the U.S. over the past 20 years has been better educated than previous cohorts.

In comparison to the rest of the literature table XII shows that the effect on those without a college education has been overstated. This is largely due to the much lower within group elasticity of substitution for unskilled inputs than comparable models.

Finally in each simulation there is very little difference in result depending upon where those with low transferability college education are treated. With no statistically significant difference in any of the specifications.

2.12 Conclusion

In this chapter I establish that the occupation and wages of immigrants differ from those not only born in the U.S. but also from immigrants from other countries. For example, those with a college education from a low income country work in occupations and having earning patterns that are more similar to those who are U.S. born with less than a college education. This is significant because traditional models that disaggregate labor supply along the lines of skills would usually put this immigrant group as skilled rather than unskilled with the U.S. born with less college who they resemble in terms of occupation and earnings.

Given these differences I explore the implications for the effects of immigration on wages when we disaggregate the labor supply not only by educational attainment but also by country of educational attainment and field of educational attainment.

To do this I estimate the relevant elasticities of substitution for nested CES production function and simulate the effects in a partial equilibrium model if no immigrants came between 1990 and 2011.

Using this nested CES framework I estimate elasticities of substitution within skill groups that are a lower than traditional estimates and importantly that input within a skill group when we consider country of education and field of education are not perfect substitutes. Further, unlike previous work I can use my framework to estimate the elasticity of substitution between skilled and unskilled workers and obtain values that are similar to the literature.

With these parameter estimates I find that immigration between 1990 and 2011 likely lead to 0.4% decline in wages for those without a college education ad an increase of 3.6% for those with a college education.

The framework presented in this chapter shows the partial equilibrium effects of immigration on wages. However, as wages change so do net tax receipts and the funding of the government budget. To fully understand how immigration policy interacts with public finances we need a general equilibrium model which I present in chapter 3.

3 Immigration Reform and Fiscal Policy

3.1 Introduction

The facts established in chapter 1 relating to the changing profile of immigrants and the outcomes of their children leads to the following questions: Can changing to a Canadian or UK style policy based up on educational attainment and skills lead to welfare gains for the U.S.-born population? How do the outcomes of immigrant children affect these results? Finally, how will changing immigrant profiles interact with public finances when considering the aging of the U.S. population?

To address these questions I build a general equilibrium, overlapping generations model which incorporates heterogeneity in the agent's fertility by country of origin and education as well as heterogeneity in the education of their children. In addition I also incorporate the intergenerational transmission of skills. This model and its general equilibrium properties allow me to assess fully how the design of immigration policy affects wages, which in turn affects tax revenues and benefit receipts. This framework gives me the flexibility to run a number of policy counterfactuals, allowing me to change immigration policy design according to educational attainment and by number of immigrants admitted.

Using this model I find that moving to a immigration policy in which potential immigrants with greater skills are given priority can be welfare improving for both workers with and without a college education. Further, I show that the design of fiscal policy has an affect on the size of the welfare gains. The U.S. population with U.S. born parents without a college education experience lifetime welfare gains of 1.0% while their skilled counterparts experience lifetime welfare gains of 0.2%. These welfare changes come from two forces: wage effects and fiscal externalities. As the labor force becomes more skilled through the addition of more skilled immigrant workers, the wages of similarly skilled workers decrease. With complimentarities in the production function between different labor types, wages of less skilled workers increase. Increased wages for less skilled workers combined with additional skilled workers paying taxes leads to an increase in overall tax receipts. This generates positive fiscal externalities for both types of workers. These positive fiscal externalities outweigh the loss in wages for skilled workers, resulting in net welfare gains.

In contrast to Storesletten (2000) I find that the children of immigrants help the solvency of public finances rather than hinder it. Further, I find that including the intergenerational transmission of skills from immigrant parents to immigrant children is quantitatively important to the results of any immigration policy analysis.

Finally I find that the changing profile of immigrants is important when considering the long term effects of immigration on public finances. Given the forecasts for the decrease in the worker retiree ratio, I find that in order to make the government budget balance, social security transfers would have to decrease by 19% given previous patterns of immigration. However, if we consider the change to the composition of immigration arrivals, transfers would only need to decrease 14%.

3.2 Literature Review

This paper considers the effects of different immigration policy design on wages in the U.S. as well as the welfare and fiscal effects of any policy changes. This paper is most closely related to the literature on the effects of immigration on government finances and on immigration policy and the labor market outcomes of immigrants and their descendants.

A number of papers estimate the effect on wages of previous waves of migration to the U.S. Borjas (2003) finds that immigrants during the 1990s have decreased the wages of low-educated U.S. natives by a maximum of 9%. By considering immigrants and natives as imperfect substitutes, Ottaviano and Peri (2012), find that immigration between 1990 and 2006 actually had an effect on wages between -2.2% and +1.7%, depending on the nesting structure and parameterization of the model. Another related approach has been to consider the tasks that immigrants perform when working. Schoellman (2010) considers an occupation as a set of skills, for example cognitive, manual or interpersonal and he differentiates occupations by how extensively each occupation uses each skill. Using the aforementioned framework, he estimates the skills of immigrants from different countries by observing which occupations they choose. With this model, Schoellman (2010) finds that immigration to the U.S. decreases wages of U.S. native workers by at most 5% and that the effect varies largely by occupation. This paper furthers the contributions of those papers, not only by analyzing the effect of past immigration policy on wages, but also the effect on lifetime welfare and fiscal contributions of immigrants.

Calculating the fiscal contribution of immigrants has been done most notably by Lee and Miller (2000) and Storesletten (2000). The former takes public use microdata from the 1994 CPS (Current Population Survey) to build up a profile of taxes paid and benefits received, over the lifecycle for immigrants and natives. Lee and Miller (2000) then use these profiles while making assumptions related to productivity, discount rates, health spending and immigrants' fertility, to calculate the net present value of an immigrant, i.e. the present value of net tax revenues from an immigrant. While this approach provides an informative analysis of the fiscal contributions of immigrants, it misses any general equilibrium effects if immigration were increased a substantial amount. Further, their results mask a great deal of heterogeneity of outcomes by educational attainment, as established later in this paper and in Orrenius (2017).

Storesletten (2000) addresses the partial equilibrium nature of Lee and Miller (2000) by using an overlapping generations model in the style of Auerbach et al. (1987), allowing immigrants' fertility to differ by education and country of origin. Storesletten's paper is the closest to this one. The central aim of Storesletten (2000) is to find which immigration policies will balance the U.S. government budget. Storesletten (2000) has two main findings, first the policy with the lowest number of college educated immigrants that will balance the budget is 1.5 million, assuming they arrive between the ages of of 41 and 45 i.e. those unlikely to have children. This number would have implied an 11 fold increase in arrivals (compared with 1990). The second is that children of immigrants largely erase any benefits to the government budget balance that their parents provided. The negative impact of children comes from the fact that Storesletten (2000) assumes that there is no correlation between the skills of immigrants and their children. Storesletten does not consider heterogenity in U.S. born workers and when calibrating, Storesletten finds that they are a burden on public finances. Given that the children of immigrants are not separated from other U.S. born workers this drives the negative findings of his paper.

This paper builds upon the approach taken by Storesletten (2000) by incorporating heterogeneity in immigrants in both fertility, education and country of origin and also considering heterogeneity in the skills of children of immigrants. However, this paper will focus as well on the question of whether any immigration policy is welfare-improving to different groups of U.S. natives.

The fertility of immigrants is a key component of the interaction between immigration policy, demographics and therefore public finances. Council et al. (1997) find an average fertility rate of 2.7 children per female immigrant compared to 2.0 for a native. Using data from the 1970 and 1980s U.S. Censuses, Blau (1992) finds that immigrants have higher fertility rates than natives. However, after controlling for age and rates of marriage, immigrant and native fertility rates are similar. Storesletten (2000) uses the 1980 and 1990 Censuses to estimate the fertility rate of immigrants. Storesletten (2000) finds that for those with high school or less the fertility rate is close to 3.4 children per woman and for those with college is closer to 1.8 per woman; this compares to 2.25 for the U.S. native in the same time period. More recently Swicegood et al. (2006) use data from the 2004 American Communities Survey and find that fertility, varies widely by country of origin, with immigrants from Nigeria having 3.1 children compared to Japanese immigrants who have 1.5. This paper performs a similar analysis using the 2015 American Communities Survey 5 year sample and finds that it is not only the country of origin that matters for fertility, but also education. In relation to the fertility of second generation immigrants, Fernandez and Fogli (2009) find a positive correlation between the average fertility of the parent's country and the second generation immigrants' fertility. This implies that those with immigrant parents continue to have more children than their counterparts with U.S. born parents.

While immigrants having more children is a facet of the interaction between immigration and fiscal policy, we must also consider the varying outcomes of the second generation immigrants. One of the most comprehensive analyses of second generation immigrants is by Card et al. (2000) who uses synthetic cohort methods to look at the levels of education and earnings of immigrants and their children by country of origin between 1940 and 1999. Card et al. (2000) finds that immigrant children tend to be better educated and earn more than their parents, the exception being those from wealthier countries such as the U.K. and Germany. He also finds that on average immigrant children tend to out-earn and be better educated than children with two U.S. parents. Borjas (2006) uses the same method as Card et al. (2000) using updated data from the 2002-2004 CPS and comes to a similar conclusion. He does however, note that the gap between first and second generation immigrants in terms of earnings and educational attainment has been falling over time.

This paper explores the consequences of continuing the current U.S. immigration system, which is based largely around family preferences. Many of the aforementioned papers are based upon immigration patterns from the 1990s. However, the profile of immigration during the past 20 years has changed, as documented primarily by Borjas (2015) who finds that immigrants who come to the U.S. today are older and better educated than the immigrants of the 1980s and 1990s. Further, the source countries of immigrants have changed; while immigration in the 1980s and 1990s was largely from Central and South America, more recently a greater number of Chinese and Indian immigrants have arrived as documented by the Department of Homeland Security (2016). Given that Lagakos et al. (2018) establish that the returns to experience are highly heterogeneous for immigrants from different countries, this will be important to consider when changing immigration policy as it relates to taxes paid and benefits received.

3.3 Model

I use an overlapping generations model to analyze the fiscal and welfare effects of changing the design of U.S. immigration policy to allow for both more immigrants and different compositions of immigrant populations.

3.3.1 Agents

Each agent is born with type $h \in \{U, S\}$ either unskilled or skilled and this type remains constant over their lifetime. Each agent has an origin g which is a tuple of the agent's country of birth as well as the agent's parents' country of birth and can take the following values $\{L, M, H, A\}$ either low, middle, high income or the U.S. For all immigrants their parent country will be the same as their country of origin. For children of immigrants their country of origin will be A with parents country of origin differing. I denote age as j and a corresponding probability of survival between j and $j+1$ is element j of the $J \times 1$ vector of γ^g. Agents have a $J \times 1$ vector of fertility rates $\eta^{h,g}$ and productivity $\epsilon^{h,g}$. If $j < J$, before this age they die with probability $1 - \gamma^g$ as described above. In addition, they choose retirement at age $\chi < J$.

3.3.2 Population Evolution

The path of population over time will depend upon the fertility rates η, inter generational transmission of skills π from parents to children, survival rates γ and immigration policy ς. At time t for each skill $h \in \{U, S\}$ the following will have their own separate laws of motion.

- $I_{j,t}^{h,g}$: Immigrant population with origin g
- $E_{j,t}^{h,g}$: Population with immigrant parents with origin g
- $N_{j,t}^{h}$: Population with U.S. born parents

Therefore for any age j for an immigrant from country g of skill h

$$I_{j,t}^{h,g} = \underbrace{I_{j,t-1}^{h,g} \times \gamma_j^g}_{\text{Surviving population}} + \underbrace{\varsigma_{j,t}^{h,g}}_{\text{New immigrant arrivals}}$$

The population of age 0 of skill h who have immigrant parents from country g is

$$E_{0,t}^{h,g} = \underbrace{\big(I_t^{U,g} \cdot \eta^{U,g}\big) \times \pi^{U,g}(h|parent = U)}_{\text{Children of skill h born to unskilled parents}} + \underbrace{\big(I_t^{U,g} \cdot \eta^{U,g}\big) \times \pi^{S,g}(h|parent = S)}_{\text{Children of skill h born to skilled parents}}$$

For any $j > 0$

$$E_{j,t}^{h,g} = E_{j-1,t-1}^{h,g} \times \gamma_j^g + \varsigma_{j,t}^{h,g}$$

Finally the population of the U.S. born population with U.S. born parents population of age 0 is

$$\begin{aligned} N_{0,t}^h = &\big(\big(\sum_g E_t^{U,g} + N_t^U\big) \cdot \eta^{U,A}\big) \times \pi^{U,A}(h|parent = U) \\ &+\big(\big(\sum_g E_t^{S,g} + N_t^S\big) \cdot \eta^{S,A}\big) \times \pi^{S,A}(h|parent = S) \end{aligned}$$

and therefore for $j > 0$

$$N_{j,t}^h = N_{j-1,t-1}^h \times \gamma_j^g$$

This aggregates together to give the following measure of skill h at age j at time t

$$\psi_{j,t}^h = \begin{bmatrix} I_{j,t}^{h,L} \\ I_{j,t}^{h,M} \\ I_{j,t}^{h,H} \\ E_{j,t}^{h,L} \\ E_{j,t}^{h,M} \\ E_{j,t}^{h,H} \\ N_{j,t}^h \end{bmatrix}$$

In section 3.3.7 I will use similar notation for hours worked $l_t^{h,j}$, consumption $c_t^{h,j}$ and assets $a_t^{h,j}$

3.3.3 States

The state vector of the economy can be defined as follows

- t: time period
- $a^{h,j}$ and $\psi^{h,j}$: assets and measure of each agent of age j with type h
- B government debt owned by households
- K aggregate stock of capital

For ease of notation I define $\Lambda_t = (K_t, B_t)$

3.3.4 Agent's problem

In each period each agent of solves the following recursive problem. Entering the period with savings a, each agent chooses consumption c as well as labor l savings for tomorrow a' and retirement χ.

$$V_j^{h,g}(a, \chi, \mathit{\Lambda}) = \max_{c,l,a',\chi'} u(c,l) + \beta(1-\gamma^g)V_{j+1}^{h,g}(a, \chi', \mathit{\Lambda}')$$

They choose consumption, labor and savings according to the budget constraint in equation 9. Labor income is dictated by hours worked, productivity and the hourly wage w. Agents incur taxes τ_l on any labor income they earn and receive transfers according to the transfer function $T^h(\chi)$ which is dependent on the agent's type, age and retirement status.

If an agent chooses retirement I they can no longer work and simply receive income from transfers and their savings. In addition, agents pay a tax on consumption τ_c and agents receive a return $R(1-\tau_k)$ on their savings and bequests from those in their generation who die that period.

$$c(1+\tau_c) + (1-\gamma_j^g)a \leq wl\epsilon^{h,g}(1-\tau_l) + T_j^{h,g}(\chi) + (1+R(1-\tau_k))a \tag{8}$$

$$\tag{9}$$

$$\mathit{\Lambda}' = F(\mathit{\Lambda}) \tag{10}$$

3.3.5 Firms

Firms maximize profits and choose capital K, unskilled labor L^U and skilled labor L^S and solve the following[11]

$$\max_{K,L^U,L^S} Y - w^U L^U - w^S L^S - rK \tag{12}$$

$$Y_t = AK^\theta \left(\lambda L^{U\rho} + (1-\lambda)\, L^{S\rho}\right)^{\frac{1-\theta}{\rho}} \tag{13}$$

3.3.6 Government

The government budget constraint is as follows:

$$G + (1+R)B + \sum_{h,j} \psi^{h,j} \cdot T^{h,j} = \tau_k A + \tau_l w^U L^U + \tau_l w^S L^S + B' + \tau_c C \tag{14}$$

where B is aggregate government debt, G is government consumption, C is aggregate household consumption and A is aggregate household saving.

3.3.7 Equilibrium

To close the model, given the population evolution I define a steady state equilibrium as:

- Prices $\{w^U, w^S, r\}$
- Policy functions for consumption, labor and savings $f_c^h(a_t)$, $f_l^{h,g}(a)$, $f_{a'}^{h,g}(a)$ and $f_\chi^{h,g}(a)$
- Value functions $V_j^{h,g}(a, \epsilon, \Lambda)$

[11] λ incorporates a level and a skill specific labor-augmenting technology Ω^h. Ω_U and Ω_S are calibrated to ensure the existence of a steady state equilibrium. The condition that any calibration must satisfy as shown in in Maliar and Maliar (2011) is as follows:

$$\mu = \frac{\Omega^U}{\omega^U} = \frac{\Omega^S}{\omega^S} \tag{11}$$

where μ is the growth rate of the economy due to population growth.

That solve the agent's problem, the firm's problem and markets clear, such that

$$L^U = \sum_j \psi_j^U \cdot l^{U,j} \cdot \epsilon^U$$

$$L^S = \sum_j \psi_j^S \cdot l^{S,j} \cdot \epsilon^S$$

$$K = \sum_{h,j} \psi_j^h \cdot a_j^h - B$$

$$C + X + G = Y$$

$$r = MP_K$$

$$R = r - \delta$$

$$w_u = MPL_u$$

$$w_s = MPL_s$$

3.4 Parameterization

3.4.1 Demographics

Agents are born age 0, start work at age 18 and die with certainty at age 90; each period is 1 year. Before the age of 90 at age j they can die with probability γ^g as described in 3.3. To calculate their survival probabilities I use the Vital Statistics NCHS Multiple Cause of Death Data for 1999-2001 and the 2000 U.S. Census. The NCHS data has data on the number of deaths in the U.S. by year as well as by immigration status. The 2000 Census gives the population of both immigrants and natives, with the number of births and deaths in any given year. There are more recent versions of this survey available, however, after 2004 the NCHS removed the immigrant variable from the public use file. With this data I can calculate the survival probabilities according to the life tables. I perform this exercise for those over the age of 18. For those under the age of 18 I assume the survival probability for each period is 1. Using this data, I find that immigrants have an average life expectancy of 79. This compares to 78 for U.S. natives. This is in line with a study by Singh and Miller (2004) who uses confidential data from the US National Vital Statistics System and finds immigrants have an average life expectancy of 80 compared to 76.6 for natives. The survival rates, the fertility rates estimated in section **??**, as well as population shares from the CPS 2011-2015 (IPUMS CPS) and assuming that future immigrant arrivals are of the same composition as those already here imply values for ψ both in the steady state and for any change in policy. These parameters imply a worker-retiree ratio of 3.9. To calibrate π the conditional intergenerational education transmission matrix I use the data from the GSS and results of the exercise that generate Table VIII.

3.4.2 NIPA Accounts

Table XII displays the annual averages from NIPA (National Income and Product Accounts), taking into account adjustments to NIPA's measure of GNP (Gross National Product). The adjusted GNP is the NIPA measure of GNP, arrived at by adding in the services from consumer durables and government fixed capital, then subtracting sales taxes and excise taxes. Consumption is the private consumption of non-durable goods and of services in addition to government expenditure excluding spending on defense. Investment is defined as gross private domestic investment, consumer durables and the non-defense portion of government investment.Defined this way, consumption comprises 76% of adjusted GNP while investment accounts for 19% of adjusted GNP.

In this model I treat government expenditures on non-defense items as lump sum transfers to agents. This assumes that government spending on public services such as education, law and order and transportation services is perfectly substitutable with cash.

3.4.3 Fixed Asset Tables

To calculate the model equivalent of A_t I sum private fixed assets, stock of consumer durables and privately held inventories from the BEA fixed asset tables. In addition I add the value of land from the U.S. flow of funds data. Fixed assets and consumer durables are approximately 3.07 times adjusted GNP, inventories are are 0.12 and land 0.61 giving a capital output ratio of 3.8.

Table XII: Fiscal Policy Parameters: All are Percentage of adjusted GNP

Moment	Value	Source
Government debt	97.0%	Flow of funds
Defense spending	4.6%	NIPA : Federal defense expenditures
Non-defense spending (excluding education)	11.4%	NIPA : Government consumption expenditures
Education spending	4.6%	National Transfer Accounts
Social Security and Medicare transfers	8.1%	NIPA
Other transfers	6.3%	NIPA : Total transfers - Social Security - medicare
τ_l	39.5%	CPS 2011, 2013, 2015
τ_k	30.1%	Flow of Funds - Taxes on Domestic Corporate Profits

3.4.4 Parameters based on Macro Data

The utility function is specified as follows

$$u\left(c,l\right)=\log c+\alpha\log\left(1-l\right) \tag{15}$$

The preference parameters α and β are set to match the total hours of work relative to the working age population and the capital output ratio respectively. The average annual hours worked in the U.S. according to the CPS are 1350; thus with a potential 100 hour work week this implies that the fraction of time spent working is 0.247. I set the depreciation rate to match investment to adjusted GNP ratio of 0.21. The income share parameter, θ, is set to match the labor share of adjusted GNP to be equal to 0.54, that is the total value of compensation and 70% of proprietor's income. This latter parameter, while lower than traditional estimates, is in line with recent findings by Karabarbounis and Neiman (2013).

Using NIPA data I set policy parameters so that the model matches the following data: defense spending is 4.6% of adjusted GNP, combined Social Security and Medicare spending is 8.1%, non-defense spending excluding education expenditures is 11.4% and education expenditures amount

Table XII: Internally Calibrated Parameters

Parameter	Parameter Value	Moment	Model	Data	Source
β	0.964	K/Y	3.8	3.8	BEA 2010-2016
α	1.76	Average hours	0.247	0.247	CPS 2011, 2013, 2015
δ	0.053	X/Y	0.21	0.21	BEA 2010-2016
$1-\theta$	0.54	Labor share of income	0.54	0.54	BEA 2010-2016
λ	0.39	w^S/w^U	2.00	2.00	CPS 2011, 2013, 2015
ρ	0.29	-	-	-	Katz and Murphy (1992)
$\epsilon^{i,g,p}$	-	$w^i\epsilon^{i,g,p}/w^i\epsilon^{i,A,A}$	-	-	CPS 2011, 2013, 2015

to 4.6%. To calculate the ratio of other transfer programs to adjusted GNP programs, I use total government spending on social benefits, subtracting Social Security and medicare, which gives a value of 6.1%. With flow of funds data summing total federal and state debt, I find that government debt as fraction of adjusted GNP is 97%. All of these numbers are averages between 2010 and 2016.

I set λ, the share of labor income accruing to unskilled workers such that in the model the skill premium i.e. the ratio of hourly wages is 2.0. This matches the ratio from the CPS 2011-2015 (IPUMS CPS).For both skilled and unskilled U.S. native workers I set the efficiency units $\epsilon = 1.0$. As with λ I set the efficiency units of each of the other types, to match the differences in hourly wages according to the CPS 2011-2015 (IPUMS CPS). I set the parameter dictating the elasticity of substitution between skilled and unskilled inputs, $\rho = 0.28$ as estimated in Katz and Murphy (1992). Further I keep the efficiency units constant over the life cycle.

3.4.5 Taxes and Transfer Distribution

The transfer function $T^{h,j}(\chi)$ can be broken down into 3 parts: (i) common transfers from government consumption expenditures other than defense spending (ii) means-tested transfers based upon income such as Medicaid, the Earned Income Tax Credit and supplemental Social Security benefits and (iii) transfers in retirement which are Social Security and Medicaid.

The transfers from government consumption excluding education are divided pro-rata between all agents and ages. The education budget is divided up pro-rata between those aged between 4 and 18. The means tested transfers that I consider are workers' compensation, Supplemental Social Security Income, Temporary Assistance for Needy Families, unemployment benefits, veterans' benefits, Child Tax Credit, Earned Income Tax Credit and Medicaid. To match the distribution of these benefits from the CPS 2011 - 2015 (IPUMS CPS) I distribute benefits in the following way. I distribute 78% of means tested transfers to unskilled workers who are of working age and 12% to skilled workers of working age. The other 10% of these transfers go to the retired population; 6% to those who were unskilled workers and 4% who were skilled workers. The transfers within each group are given out equally across ages.

Agents have three choices of retirement age; 62, 66 and 70. If they retire at age 66 they will receive full retirement benefits. If they retire at 62 they will receive for life 75% of the benefits they would have received had they retired at age 66. All agents must retire by the age of 70 and if they chose the latest date they will receive for life 137% of the retirement benefits they'd have received at the age of 66. Once an agent has chosen to retire, they cannot go back to work. These numbers are chosen to match the current U.S. Social Security payment policy. I omit an additional state variable from the model that would track the contributions to Social Security by individuals and then link it to their retirement benefits. While higher incomes imply higher Social Security payments in retirement, they also imply higher taxes, which is why Steuerle and Quakenbush (2012) find that there is only an 18% lifetime difference between a worker who has earned 60% above the average wage and one who earns the average wage.

The transfer function is the same regardless of nativity. Using the 2015 ACS 5 year sample (IPUMS USA) figure II I test, using a linear probability model for participation in a variety of government transfer programs. I restrict the sample to any immigrant who has been here for more than 5 years, given that is when they are eligible for most programs. I find that while immigrants do have higher rates of participation in these programs, after controlling for income, region and age the differences are negligible.

Finally I paramaterize the tax on labor income using the CPS 2011-2015 (IPUMS CPS). To do this, I divide each family up into bins based on their AGI (Adjusted Gross Income). I then calculate the average marginal rate for each bracket using data on federal and state marginal rates. These rates are calculated by the CPS as well as payments to FICA. Taking an average using the total AGI of each bracket as in Barro and Redlich (2013), I find an average marginal rate of 39.5%. Breaking this down by educational attainment, I find an average marginal rate of 35.2% for those with less than college and 40.3% for more than college. The reason for such little dispersion is as follows. Those with low income who will predominantly be those with less than college will pay low marginal federal rates. However, all face a rate of 14.7% for FICA payments. For those who are high income, who will largely be the college educated they face federal marginal rates but much lower marginal rates on their FICA.

I use the average tax rate on domestic corporate profits from the flow of funds data to parameterize τ_k. Averaging over 2010-2016 I find the average rate to be 30.1%. The tax on consumption τ_c is set to 12.8% to ensure that the government budget balances, given its debt levels, expenditures and tax revenue collected.

3.5 Evaluation of Alternative Immigration Policies

In this section I evaluate a number of different immigration policies and compare them to the status quo, i.e. the current U.S. immigration policy which is based primarily upon family ties and which allows for 700,000 adult immigrants to enter the U.S. annually. I analyze the changes in welfare of continuing the current U.S. immigration policy, but increasing the number of immigrants admitted. I also analyze the welfare changes upon moving to a system closer to those of the U.K. and Canada, in which immigrants with higher levels of education and experience are given preference for entry. Finally, I consider how recent changes in the composition of immigrants to the U.S. can affect public finances when we also consider the demographic changes that are predicted to occur over the next 60 years.

The baseline policy assumes that the immigrant arrivals match the distribution of immigrant population in the 2015 ACS (IPUMS USA) figure II and that 700,000 adults arrive each year. Under each policy scenario I keep the ratio of government debt and defense spending to adjusted GNP the same, at 97% and 4.5% respectively. In addition, I keep the value of per-capita transfers for non-defense government expenditures, education spending, means-tested transfers and retirement the same as the steady state. Under each policy change I analyze the welfare changes for cohorts born before and after the change. Further, all welfare changes are analyzed from the perspective of U.S. born workers. [12]The migration decision is a feature that has been abstracted from in this framework.[13]

[12]I omit the analysis of immigrant welfare changes; to fully quantify these welfare changes, the initial decision to migrate must be taken into account.

[13]Adding a migration decision would change little in this model. Given the set up of the model, to match immigrant inflows would require calibrating some form of preference shock. This would add an additional state variable to the model and result in the same arrival origin distribution as established exogenously in the data

3.5.1 Continue Current U.S. Policy at Increased Levels

The first policy counterfactual I run is to continue with the current family-ties-based immigration policy, but increasing the number of adult immigrants allowed in, from 700,000 per year up to 1.4 million per year.

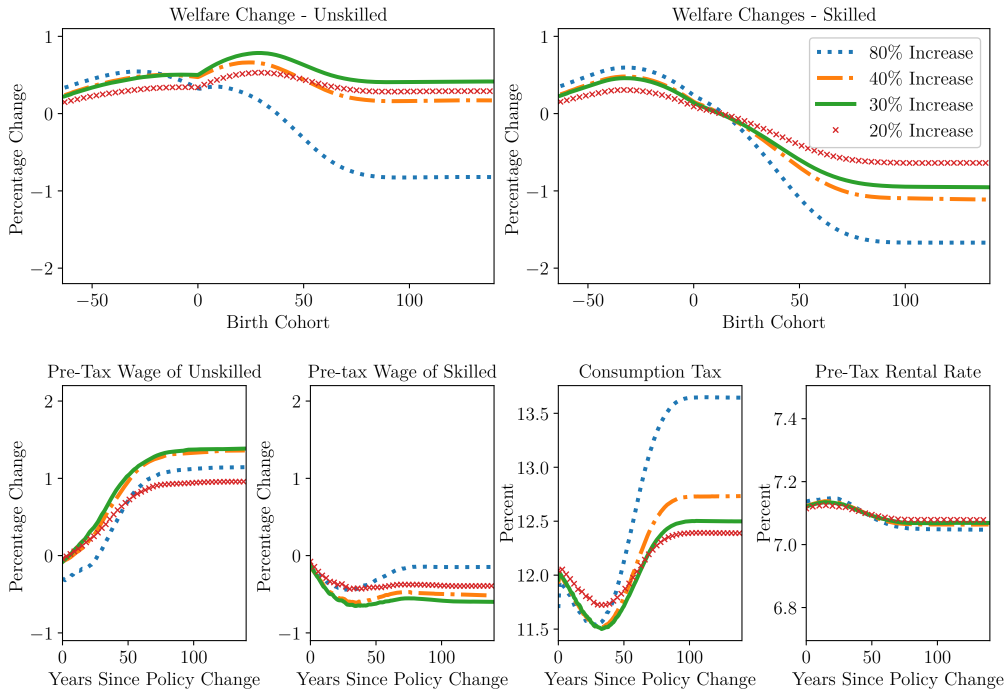
When performing the policy counterfactual of expanded immigration, I increase overall immigration between 10 and 100%. However, I cap the increase in skilled workers that come, to 180,000. The upper-bound is chosen to match the number of applicants who are rejected from the H1B skilled visa lottery in the U.S. These applicants are not rejected due to lack of skills, but rather because of the arbitrary cap on the number of H1B visas that are distributed. An alternative parameterization of this could be the number of immigrants who meet the criteria for a merit based visa to Canada, but don't receive it because of cap limits. However, I calculate this number to be close to 30,000. [14]. Figure XIII shows the result of this counterfactual:

Under this policy counterfactual I find that increases in immigration of up to about 40% are welfare improving for the unskilled workers. Under each policy counterfactual the wages of the unskilled workers go up. Even as the new immigrant population becomes less skilled relative to the existing working age population, the effective labor supply of skilled inputs still increases. Given the complimentarity in the production function, this increases the wages of unskilled workers while decreasing the wages of skilled workers.

As wages change, the taxes needed to make the government budget constraint bind also change. Immediately after the policy the working age population increases, increasing tax receipts and therefore lowering the level of τ_c needed. As the new immigrants retire this effect is diminished and τ_c increases again. For high levels of immigration, as the population of immigrants becomes more unskilled, government transfers also therefore increase. This leads to higher levels than the original steady state level of τ_c. The negative effects on wages for skilled workers combined with the increases in τ_c leads to welfare losses for skilled workers of most cohorts. Unskilled workers experience increased wages, but the increases in consumption taxes offset these gains at high levels of immigration.

[14]Given the potentially large wages gains for many immigrants - especially those from low and middle income countries - by moving to the U.S., putting a limit on the number of skilled immigrants may seem strange. However, we must also consider that while people may be allowed to move and receive higher wages as a result, they may chose not to. For example, after the expansion of the E.U. to include Poland in 2004, although many skilled immigrants did move to the U.K. and other countries, far more remained in Poland. Further, upon entry to the E.U., close to 50% of migrants had a college degree, but by 2008 this had dropped to 25%

Figure XIII: Results of Expanding Status Quo Immigration Policy



(a) All welfare changes are from the perspective of a U.S. born worker with U.S. born parents

3.5.2 Alternative Fiscal Instruments

In this section I also evaluate the same policy counterfactuals as in section 3.5.1, keeping τ_c fixed at the initial level of 12.1% and using τ_k, τ_l to make the government budget constraint bind. The results of these exercises are in Table XIII. While the choice of policy instrument will affect the magnitudes of the welfare changes resulting from policy changes, it does not change the result that for modest expansions of the current U.S. immigration policy, unskilled workers would experience small lifetime welfare gains while the skilled workers would see their welfare decrease.

Table XIII: Comparison of Policy Counterfactuals 100 Years After Policy Change Takes Place

		40% Increase in Immigration			80% Increase in Immigration		
		τ_c	τ_l	τ_k	τ_c	τ_l	τ_k
Baseline (%)		12.10	39.50	31.0	12.10	39.50	31.0
After Policy Change (%)		12.50	39.80	31.50	13.50	41.50	34.50
Welfare Change (% Change)	Unskilled	0.15	0.25	0.22	-0.93	-1.70	-1.65
	Skilled	-1.00	-0.80	-0.91	-1.80	-3.50	-2.50
Pre-tax Wage Changes (% Change)	Unskilled	1.15	1.10	1.02	1.38	1.46	1.11
	Skilled	-0.15	-0.70	-0.52	-0.40	-0.85	-0.21
Pre-tax Rental Rate of Capital Changes (% Point Change)		0.00	0.00	-0.05	0.00	0.00	0.11

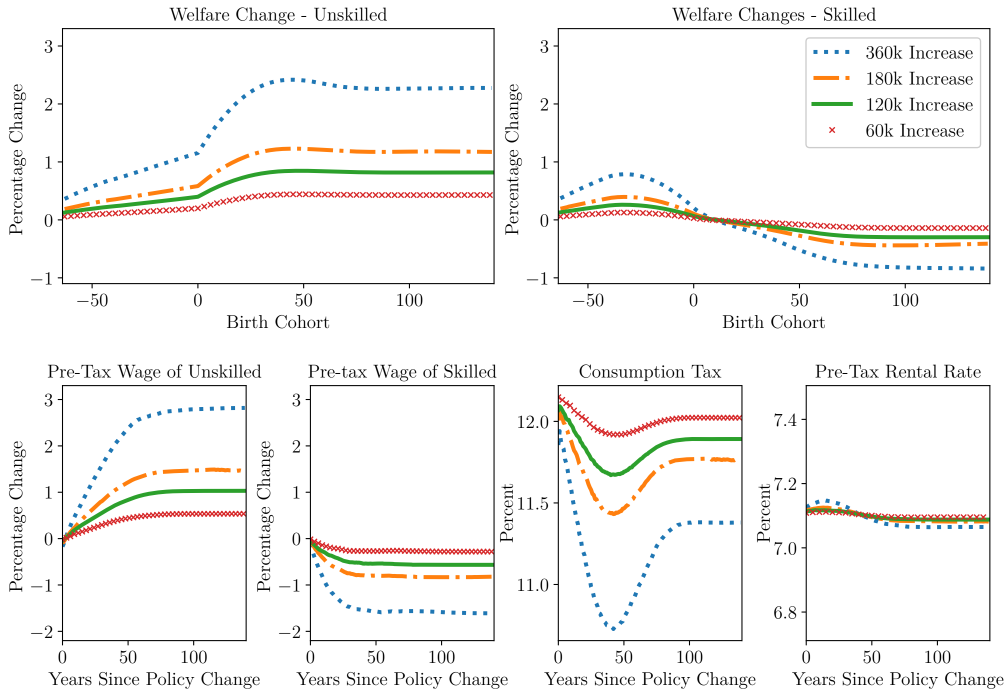
3.5.3 Increase Skilled Immigration

The second counterfactual I run is to move the U.S. to a immigration policy similar to those in the U.K. and Canada. Much of the political debate has indeed focused on crafting a high skill immigration policy for the U.S. If the goal of policy makers is to ensure that those at the bottom of the income distribution are not hurt by any immigration policy a skilled immigration policy seems the natural option.

To test the implications of this policy change on welfare and prices, I allow for an overall increase in immigration of between 60,000 and 360,000 skilled workers between ages 30 and 50 only.

In Figure XIV we can see that increasing skilled immigration is welfare increasing for unskilled workers and is strictly increasing in the number of additional skilled immigrants allowed in. This is driven primarily by the increases in wages due to the complimentarity with skilled workers. In each policy experiment a secondary force is at work: as the wages of unskilled workers increase, so do their overall tax receipts; in addition, while the wages of skilled workers decrease, their overall tax receipts increase due to the increase in the number of skilled workers, these two results allow for a drop in the consumption tax. This decrease in consumption tax lowers the relative price of consumption leading to increased welfare gains. Skilled workers' experience welfare losses for any expansions over 60,000 skilled immigrant workers. While skilled workers receive the positive fiscal externality described, the decrease in wages dominates.

Figure XIV: Results of an Increase in Skilled Immigration



3.5.4 Alternative Fiscal Instruments

Under the counterfactual of increasing skilled immigration - unlike expanding the status quo - the fiscal instrument used to make the government budget balance is important, not only for the magnitude, but also as an indicator of welfare changes for the skilled workers. Figure XV shows the effects when, instead of using the consumption tax to make the government budget constraint bind after a change in immigration policy, changes in the labor tax, tax on savings and increases to government consumption that are not returned to the population.[15]. The latter counterfactual provides insight into when any benefits from an improved fiscal environment as a result of change in immigration policy are not given back to the population and gives an idea of the importance of the positive fiscal externalities from increasing skilled immigration. From Figure XV it is evident that even large increases in skilled immigration to the U.S. can results in welfare gains for skilled workers. The mechanism behind this is as follows : with a greater effective supply of skilled labor, the wage rate of unskilled workers increases. As the wage rate of unskilled workers increases, so do their tax receipts. This increase in tax receipts allows for the τ_l required to make the government budget balance decrease. This decrease is enough to offset the wage decrease for skilled U.S. natives as a result of increased

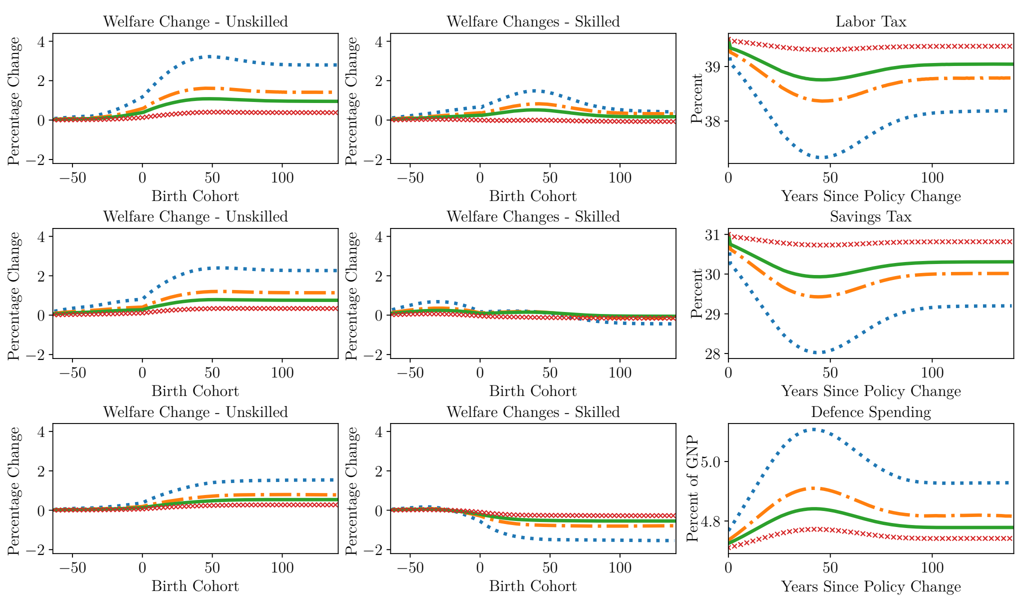
[15] This could be thought of as an increase in defense spending

skilled immigration.

In the scenario whereby the tax on savings is changed to make the government budget balance, skilled workers also experience welfare gains as a result of increases in skilled immigration of up to 180,000 per year. Again, the wages of unskilled workers increases and so do their tax receipts, allowing for the decreasing of τ_k. However, as the unskilled workers earn more, they save more, thus reducing the rental rate of capital and decreasing tax receipts to the government. While these two forces work in opposite directions the decrease in τ_k is just enough to offset the wage losses for skilled workers.

The bottom row of Figure XV displays the results of the government using any additional tax revenues resulting from skilled immigration to fund additional spending on goods that the population does not benefit from.[16] This counterfactual is the most closely comparable to what the current immigration literature studies as, in it, the only changes the agents face when making decisions are changes in wages and returns to saving. Therefore, the changes in welfare are driven primarily by changes in wages and given that unskilled wages go up and skilled wages go down, unskilled workers still experience welfare gains. However, these gains are lower compared to the other counterfactuals displayed in Figure XV given that they do not receive the positive fiscal externality. This is the same reason why skilled workers' welfare losses are amplified.

Figure XV: Results of an Increase in Skilled Immigration Using Different Fiscal Instruments to Make Government Budget Constraint Bind



[16]In the data this would be treated as an increase in defense spending

3.5.5 Removing Correlation Between Skills of the Parents and Children

To highlight the role correlation between the skill of parents and children, I run the policy experiment of allowing for an additional 180,000 skilled immigrants setting the education transmission matrix π using the unconditional probability of a child with U.S. born parents going to college. The new matrix is displayed in Table XV. I run this counterfactual comparing the welfare effects and changes in public finances using both the consumption tax and labor tax to ensure the government budget constraint binds. The results of this exercise are displayed in Figure XVI. From Figure XVI it is evident that the role of correlation between parental and child skill is quantitatively important. Ignoring correlation between generations would likely underestimate the welfare gains accruing to unskilled workers as a result of immigration policy change. As Figure XVI shows the welfare gains increase around 0.4 percentage points. For the skilled U.S. workers, when using a consumption tax to make the government budget constraint bind, the additional welfare gains when modelling correlation are close to 0. If instead the labor tax is adjusted, welfare gains are close to 0.2 percentage points. Further, Figure XVI shows that modelling for the correlation between parents and children does lead to an improvement in public finances, as judged by the additional decrease of 0.1 percentage points in the consumption tax and 0.85 percentage points in the labor tax.

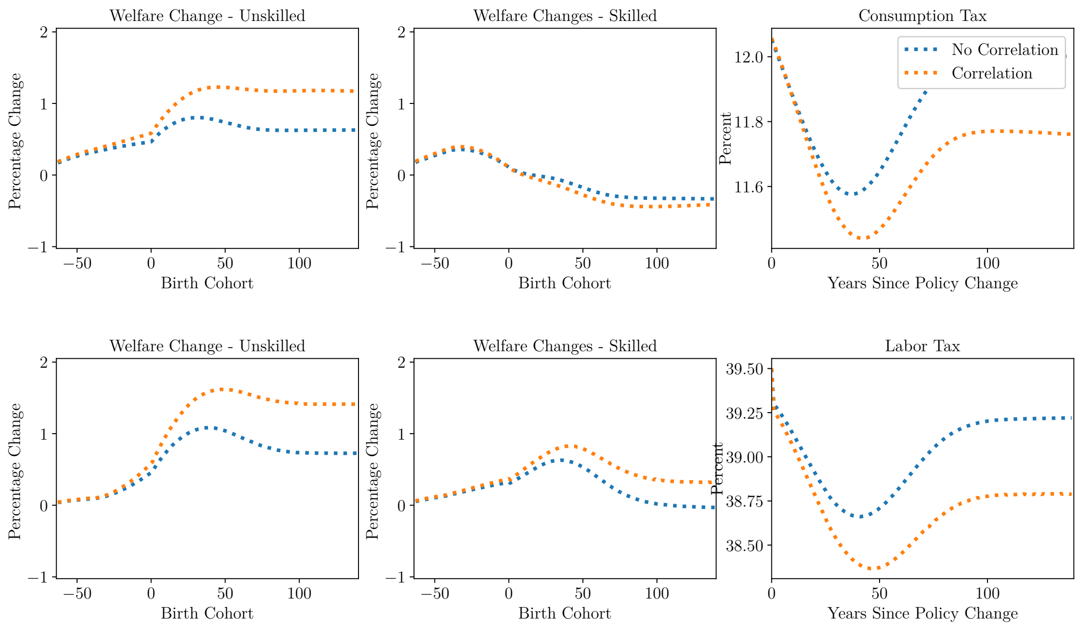
Table XV: Intergenerational Education Transmission Matrices Unconditional on Parents' Skills

		Children	
		LC	C
Parents	LC	0.70	0.30
	C	0.70	0.30

(a) LC indicates less than college, C indicates college or more

(b) Data taken from 2015 ACS 5 year sample (IPUMS USA) figure II

Figure XVI: Welfare and Fiscal Effects when Turning off Correlation Between Parents and Children Skill's



3.5.6 Dropping Assumption of Perfect Substitutes Within Skill Types

In chapter 2 I establish that within skilled and unskilled worker groups there is a degree of imperfect substitutability. Given that the setup of the production function in this chapter is nested in the production function used in chapter 2 I can use the elasticities of substitution to run the same policy experiments from previous sections of this chapter. Therefore labor demand can be written as

$$L_U = \left(\sum_g \theta_g^U L_g^{U\,\sigma_U} \right)^{\frac{1}{\sigma_U}}$$

$$L_S = \left(\sum_g \theta_g^S L_g^{S\,\sigma_S} \right)^{\frac{1}{\sigma_S}}$$

Where g is a tuple consisting of a source country (or parent's source country) $\in \{Low, Middle, High, U.S.Born\}$ and generational status $\in \{First, Second\}$

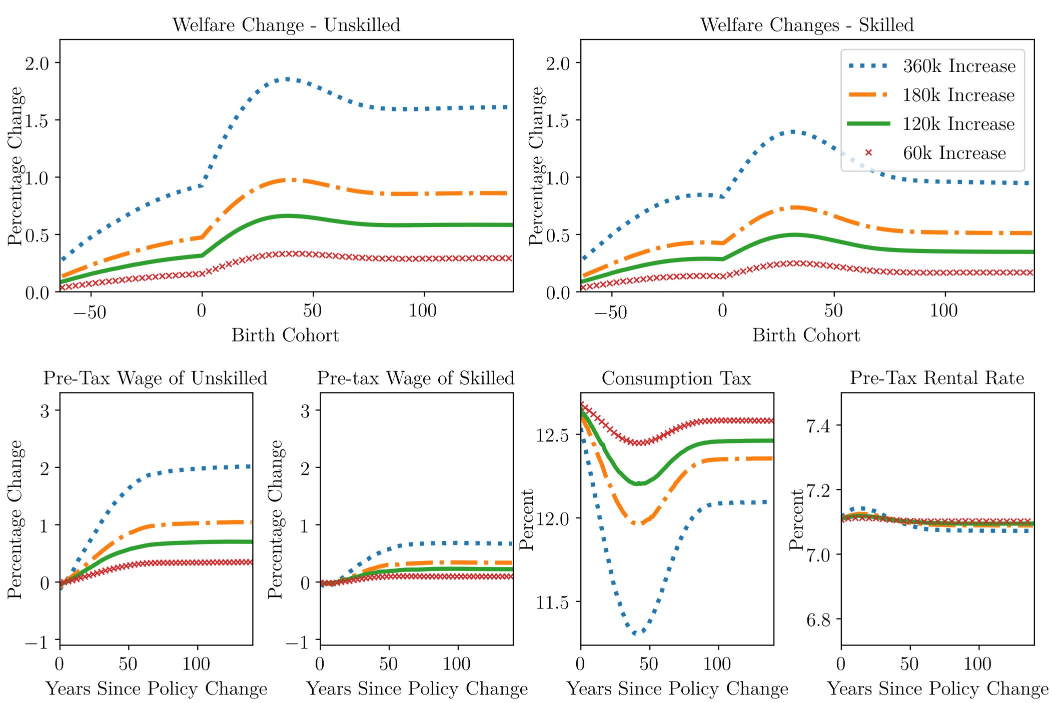
Table **??** displays the change in parameter values for the next exercise.

Table XVI: Caption

Parameter	Parameters from this paper	Parameters from chapter 2
Elasticity of substitution between skilled and unskilled	1.4	2.4
Elasticity of substitution between skilled workers	∞	10.0
Elasticity of substitution between unskilled workers	∞	4.0

With the new parameter values I perform the exact same exercise as in 3.5.3 and the results are in XVII

Figure XVII: Results of Increasing Skilled Immigration Using Estimates of Parameters from 2



While the changes on prices and welfare follow similar patterns along the transition path as in 3.5.3 the magnitudes differ. Allowing for imperfect substitutability within types we see that the wages for U.S. born workers go up both in the case of skilled and unskilled workers. The mechanism behind the wage increase for skilled workers is the same as before given that the number of skilled workers increases their wages go up. However, this induces unskilled workers to work more hours. This increased supply dampens the initial effect on wages from having more skilled workers. While the number of skilled workers increases this lowers the wage of skilled workers born in the U.S. However, the effect is smaller than when I assume that all skilled workers are perfect substitutes. The effect is so much smaller that the increased hours worked by unskilled workers dominates the downward effect of having more skilled workers in the economy. With increased wages for both sets of workers to make the government budget constraint bind τ_c can be lowered further than in 3.5.3 for realistic levels of increased skilled immigration. This results in overall welfare gains for both skilled and unskilled workers. Albeit the welfare gains are smaller for unskilled workers.

3.5.7 Immigration and Demographic Change

It is well established that the U.S. has a population that is living longer and having fewer children. This is projected to play a substantial role in the future funding of current retirement programs, namely social security, given that the system depends on the worker to retiree ratio. In this section, I simulate fiscal outcomes incorporating the forecast that the worker retiree ratio will fall from around 3.9 to 2.6 over the next 60 years. [17]. Further, I evaluate the effects when assuming that immigrant arrivals resemble the composition of more recent arrivals to the U.S. as a pose to those who arrived during the 1990s. In addition, to highlight the role of correlation between parents and children, I set the education transmission matrix as in 3.5.5

As a with each previous exercise, I attempt to use different fiscal instruments when comparing the world with a worker retiree ratio of 2.6 to that of 3.9. In this exercise I also test the effects of decreasing retirement transfers. However, like McGrattan and Prescott (2017) I find that changing the labor tax or tax on capital is unable to make the government budget constraint balance. Table XVII shows the results of this exercise.

Table XVII: The Effects of Changing Immigrant Composition 100 Years On

	Immigrant arrivals based on 2005-2015	Immigrant arrivals based on 1990-2000	Immigrant arrivals based on 2005-2015 with no intergenerational correlation
Consumption Tax Change	3.1%	4.3%	3.8%
Using retirement transfer to balance government budget	-14.0%	-19.0%	-16.0%
Output per capita	-3.9%	-5.6%	- 4.5%

(a) Change in consumption tax is in percentage points with a baseline of 12.1%

From Table XVII it is evident that if current trends in immigrant arrivals continue, it will help

[17] To do this I assume that fertility rates drop 12.5% over the next 70 years

to alleviate some of the pressure on public finances that the U.S. will face over the next 70 years. In addition, it shows again that considering correlation between the skills of immigrant parents and their children is quantitatively important for any immigration-related policy analysis.

3.6 Conclusion

Immigration reform and its consequences have been a central part of policymakers' agendas for the past three decades. The question of which combinations of skills are crucial and how many immigrants to let in, has been at the heart of this debate. This chapter goes some way to answering the question : what are the welfare effects of expanding immigration to the U.S.?

With the facts established in chapter 1 in mind and using a general equilibrium, life-cycle model allowing for correlation between the skills of immigrants and their children's, I find that moving the U.S. to an immigration policy whereby priority is given to those with a college degree can be welfare-improving for those with and without a college degree. Moving to such a policy with a realistic expectation of how many skilled immigrants would come to the U.S. can result in welfare gains of up to 0.8% for U.S. natives without a college education and 0.2% for those with a college degree. This result is driven, by not only the positive fiscal externalities that skilled immigrants generate, but also by the correlation between their skills and their children's achievements, which leads to a more skilled labor force.

Finally I show that if the composition of more recent immigrant arrivals continues, it can go some way to alleviating pressures on social security funding. Projecting future U.S. demographic changes with an aging population and on the basis that the composition of the most recent immigrant arrivals continuing to be the norm results in social security payments only need only be reduced 14.0%. This is compared to 19.0% if the composition of immigrant arrivals of the 1990s and early 2000s were the norm. In addition, if policy-makers do not consider the correlation between skills of immigrant parents and their children, they would underestimate the benefits of the change in the composition of immigrant cohorts.

4 Conclusion

In chapter 1 I establish that there is a great deal of heterogeneity immigrant's fertility, educational attainment and income of the first and second generations, and fiscal participation. Namely along the lines of first generation source country and education. Further, I establish that the arrival distribution of immigrants has changed quite significantly over time. Putting these analyses together it motivates the re-examining of how immigration and fiscal policy interact especially given the projected issues with the funding of social security in the U.S.

To fully understand how immigration and fiscal policy interact, understanding the effects of immigration on policy which will ultimately determine tax receipts is important and the subject of chapter 2. In this chapter I show that the occupations chosen by immigrants differ from comparatively qualified U.S. born workers which motivates the idea that they may not be perfect substitutes in production. In chapter 2 I construct a nested CES production function that allows for labor input to differ not only education but by source country and field of education. With this framework I estimate the relevant elasticities of substitution and find lower estimates than the previous literature which in turn implies a much greater degree of imperfect substitutability. With lower levels of imperfect substitutability this implies that the effect on wages for U.S. born workers with less than a college degree is close to 0, whereas comparable studies would put the estimate at between -3% and -8%.

In chapter 3 I construct a general equilibrium, overlapping generations model incorporating the observations of chapters 1 and 2. With this model I can run a number of policy experiments and find that expanding the status-quo immigration policy up to 20% can be welfare improving for U.S. born workers with and without a college degree. Further, I find that expanding skilled immigration only would be welfare improving. Increasing lifetime welfare by around 1% for those without a college education and 0.2% for those with a college education. An important contribution in this chapter is to show that the choice of which fiscal policy instrument is used to make the government budget constraint balance after an immigration policy change is quantitatively important. In addition, any analysis that omits the second generation of immigrants and the correlation between their education and their parents will understate the effects of any immigration policy change on welfare.

This dissertation lays out a quantitative framework for immigration policy analysis and shows that any policy analysis that treats immigrants and their children as a homogeneous group will likely miss key effects of any immigration policy change.

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Appendix

A List of Countries Used for International Fertility Comparison

Below is a list of the countries and their Censuses used to create III from (IPUMS International)

Argentina 2010,2001,1991,1980,1970

Armenia 2011,2001

Austria 2011,2001,1991,1981,1971

Bangladesh 2011,2001,1991

Belarus 2009,1999

Benin 2013,2002,1992,1979

Bolivia 2001,1992,1976

Botswana 2011,2001,1991,1981

Brazil 2010,2000,1991,1980,1970,1960

Burkina Faso,2006,1996,1985

Cambodia 2008,1998

Cameroon 2005,1987,1976

Canada 2011,2001,1991,1981,1971

Chile 2002,1992,1982,1970,1960

China 2000,1990,1982

Colombia 2005,1993,1985,1973,1964

Costa Rica 2011,2000,1984,1973,1963

Cuba 2002

Dominican Republic 2010,2002,1981,1970,1960

Ecuador 2010,2001,1990,1982,1974,1962

Egypt 2006,1996,1986

El Salvador 2007,1992

Ethiopia 2007,1994,1984

Fiji 2007,1996,1986,1976,1966

France 2011,2006,1999,1982,1975,1968,1990,1962

Germany 1987,1971,1981,1970

Ghana 2010,2000,1984

Greece 2011,2001,1991,1981,1971

Guinea 1996,1983

Haiti 2003,1982,1971

Honduras 2001,1988,1974,1961

Hungary 2011,2001,1990,1980,1970

India 2009,1999,1987,2004,1993,1983

Indonesia 2010,2005,2000,1995,1990,1985,1980,1976,1971

Iran 2011,2006

Iraq 1997

Ireland 2011,2006,2002,1996,1991,1986,1981,1979,1971

Israel 1995,1983,1972

Italy 2011,2001

Jamaica 2001,1991,1982

Jordan 2004

Kenya 2009,1999,1989,1979,1969

Kyrgyz Republic 2009,1999

Lesotho 2006,1996

Liberia 2008,1974

Malawi 2008,1998,1987

Malaysia 2000,1991,1980,1970

Mali 2009,1998,1987

Mexico 2015,2010,2005,2000,1995,1990,1970,1960

Mongolia 2000,1989

Morocco 2004,1994,1982

Mozambique 2007,1997

Netherlands 2011,2001,1971,1960

Nicaragua 2005,1995,1971

Nigeria 2010,2009,2008,2007,2006

Pakistan 1998,1981,1973

Palestine 2007,1997

Panama 2010,2000,1990,1980,1970,1960

Papua New Guinea,2000,1990,1980

Paraguay 2002,1992,1982,1972,1962

Peru 2007,1993

Philippines 2010,2000,1995,1990

Poland 2011,2002,1988,1978

Portugal 2011,2001,1991,1981

Puerto Rico 2010,2005,2000,1990,1980,1970

Romania 2011,2002,1992,1977

Rwanda 2012,2002,1991

Saint Lucia,1991,1980

Senegal 2002,1988

Sierra Leone,2004

Slovenia 2002

South Africa,2011,2007,1996,2001

South Sudan 2008

Spain 2011,2001,1991,1981

Sudan 2008

Switzerland 2000,1990,1980,1970

Tanzania 2012,2002,1988

Thailand 2000,1990,1980,1970

Trinidad and Tobago 2011,2000,1990,1980,1970

Turkey 2000,1990,1985

Uganda 2002,1991

Ukraine 2001

United Kingdom,2001,1991

Uruguay 2011,2006,1996,1985,1975,1963

Venezuela 2001,1990,1981,1971

Vietnam 2009,1999,1989

Zambia 2010,2000,1990

Zimbabwe 2012

B Occupational Similarity By Experience Group

Table XVII: High transferablility Education Occupation Similarity Index

Education	0-5	5-10	10-15	15-20	20-25	25-30
American High School						
High transferablility College	0.23	0.28	0.35	0.32	0.27	0.18
High transferablility College STEM	0.19	0.22	0.24	0.26	0.23	0.16
High transferablility Child Education, U.S. College	0.33	0.34	0.34	0.35	0.37	0.39
High transferablility Child Education, U.S. College STEM	0.22	0.22	0.26	0.26	0.26	0.28
American College						
High transferablility College	0.51	0.56	0.61	0.57	0.53	0.44
High transferablility College STEM	0.34	0.40	0.41	0.45	0.41	0.30
High transferablility Child Education, U.S. College	0.65	0.70	0.68	0.73	0.74	0.75
High transferablility Child Education, U.S. College STEM	0.39	0.41	0.46	0.49	0.51	0.53
American College STEM						
High transferablility College	0.47	0.51	0.54	0.54	0.48	0.38
High transferablility College STEM	0.57	0.56	0.62	0.66	0.57	0.45
High transferablility Child Education, U.S. College	0.52	0.58	0.60	0.62	0.61	0.61
High transferablility Child Education, U.S. College STEM	0.60	0.66	0.68	0.71	0.72	0.73
American High School						
American College	0.46	0.44	0.44	0.44	0.45	0.45
American College STEM	0.39	0.37	0.37	0.38	0.39	0.38
American College						
American College STEM	0.62	0.64	0.67	0.69	0.68	0.68