DEUNIONIZATION AND IMMIGRANT ENTRY

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Abstract

From the late 1960s, the U.S. economy has seen a rapid decline in labour union membership and coverage. This paper argues that the entry of immigrants into the U.S. economy has significantly altered the incentives of native-born workers to join labour unions and firms to hire unionized workers, prompting a fall in unionization. High-skilled workers find their efforts better rewarded in the non-union sector once immigrants enter the workforce thus, leaving the union. On the other hand, low-skilled native workers who face competition from immigrant workers are now less valued by firms if unionized and cannot demand a union wage. I present evidence that the entry of low skilled immigrants drives down union rates across geographical regions using an instrumental variable approach. The relationship is robust to controlling for other potential causes proposed to explain a decline of union density. I develop a search-theoretic framework to bear out the mechanism and empirically test predictions derived from the model. The model is further calibrated to fit the data in 1980 and used to predict union density in 2000. This exercise finds that low skilled immigrant entry can explain 48-55% of the total fall in union density.

JEL Classification: J15, J31, J51, J61, J64
Keywords: Immigrant entry, unionization, wage inequality, labour skills

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1 Introduction

The U.S. economy witnessed a significant and steady decline in union membership starting from the late 1960s. From 40% at its peak in the 1950s, union density reached 9% by the end of the century (Figure 1). This fact coincided with an epochal wave of low skilled immigrants entering the U.S. Share of total immigrants as a part of the U.S. population increased from 3% in the 1960s to around 12% in the last decade (Figure 1).[1] These immigrants, especially those entering between the 1970s and 2000s, were low skilled, with the majority without a high school degree, Hanson et al. (2017).

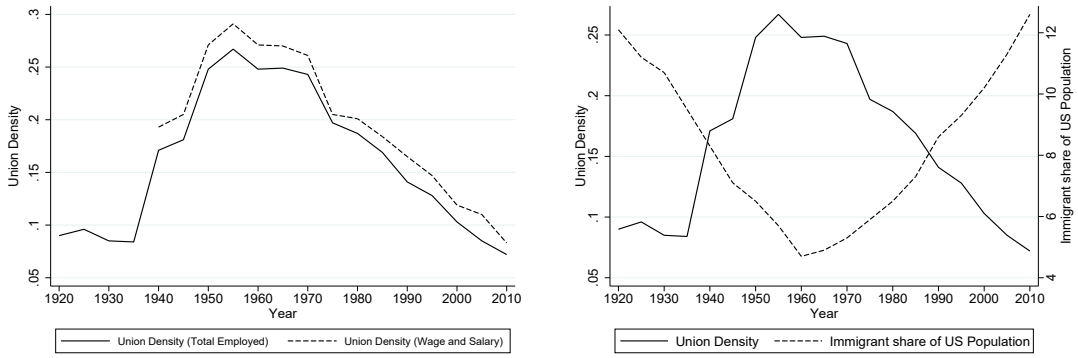


Figure 1: Left panel: Private Sector Union Rate in the US. Right panel: Immigrant share in the total U.S. population and private sector union rates.

The trends observed in Figure 1 point to how the timing of immigrant entry and the fall in union rates coincided in U.S. history. A natural question arising from observing these trends will be to see if they translate to a more granular level. Therefore, to further evaluate these seemingly related phenomena and allay scepticism naturally occurring from observing time trends, I look at cross-sectional variation across U.S. states. I look at heat maps of U.S. States, and in the top panel of figure 2 plot the fall in union rates between 1980 and 1990, and the bottom panel shows the immigrant entry in different U.S.

[1] Using historical data from the U.S. Census, it is also true that immigrant entry has followed broadly 'U-shaped' trend with immigrants as a percentage of the U.S. population decreasing from 14.8% in the early 1900s and declining steadily during and after the World Wars and reaching the lowest at 4.7% in the 1960s. This share has then increased steadily and is at 13.7% in recent years.

states at the same time. The strong negative correlation of -0.45, as seen in Figure 2 immediately raises the possibility of a causal link with immigration being a factor that drove down unionization. My goal in this paper is to investigate that possibility.

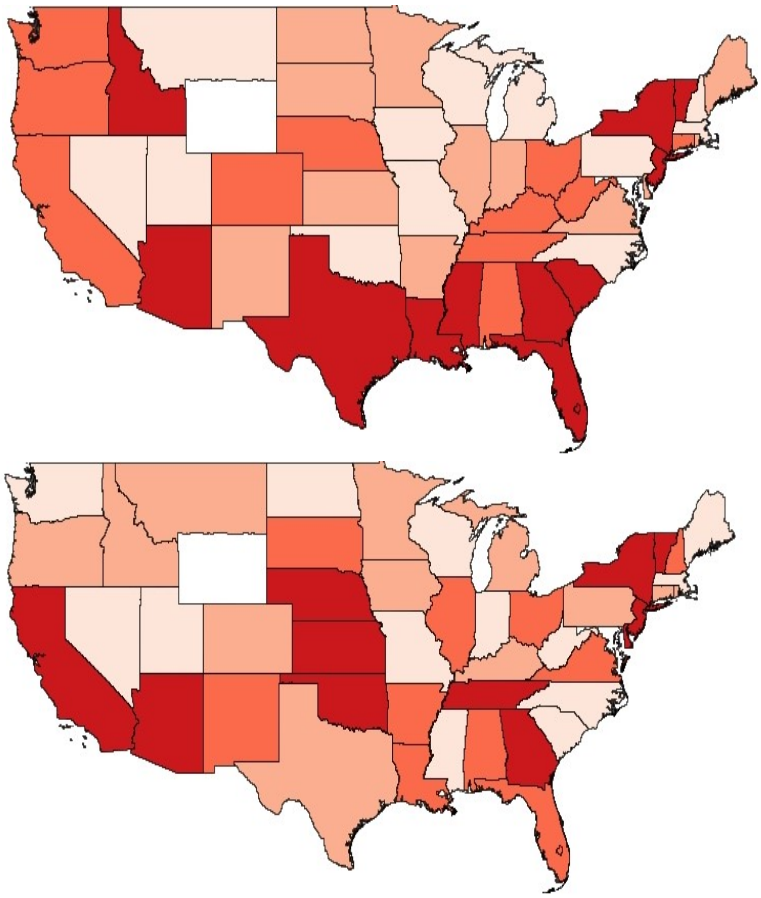


Figure 2: Top panel: Union Rate changes in the U.S. states, 1980-1990. Bottom panel: Immigrant population change in U.S. states, 1980-1990. Darker red colours show larger fall in union rates in top panel and higher entry of low skilled immigrants in the bottom panel.

To understand if there is a causal link between increased immigration and unionization rate, it is essential to think of how immigrant entry affects the local labour market and, at the same time, understand the implications brought in by market structures like unions. Immigrant workers entering a region affects the region in two crucial ways.

Firstly, they change the skill mix of the region as they are mainly low skilled; this is especially so the case for the U.S. between 1970-2000, Butcher and Card (1991). Secondly, they seek lower wages than similarly skilled native-born workers because of their lower outside options. They have lower outside options as they often lack access to unemployment benefits and do not value leisure in a foreign setting as much as natives, thus, improving the outside option for firms, Albert (2021) and Amior and Manning (2020). These two effects of immigrant entry can lead to a fall in union rates because of how unions are set up. Unions value an egalitarian approach and flatten skill differentials, with a strong tendency to pay similar wages to all their members. In this equilibrium with a certain amount of union membership, a sizeable entry of low-skilled immigrants in the U.S. affects the incentives of native-born workers to join the union and firms to hire unionized workers. High skilled workers get better pay in the non-union sector and prefer not to join the union. Low skilled workers are now not hired at union wage and would be better off by taking a non-union job as firms can now choose from a larger pool of immigrant workers.

I aim to evaluate this causal mechanism in the data, and for that, I use the following empirical strategy. I start by examining correlations and find a significant negative correlation between immigrant entry and union membership across U.S. MSAs, industries, and occupations, showing the correlation seen in figure 2 is also present in other cross-sectional variations. I also find the correlation holding in a broader context at the international level, suggesting that this causal mechanism can be generalized to more diverse settings. I show why this phenomenon is not the result of a mechanical shift because one might expect immigrants to be less unionized. Thus, as immigrants become a larger share of the workforce, we might expect lower unionization rates. I see that unionization rates among native-born workers have decreased.

To make a causal statement- immigrant entry leading to a fall in union rates, I need to be mindful of two potential issues to the identification strategy. Firstly, there are endogeneity issues as omitted variables may be driving both immigrant entry and union rate decline. Secondly, spillover effects caused by the migration of native-born workers and firms across regions violate the closed geographical region assumption, potentially bias-

ing my estimates from the correlation analyses. I follow the literature by using the famous 'ethnic enclaves' instrumental variable (IV) approach to tackle the endogeneity issue. This IV approach uses past immigrant stocks as predictors for future immigrant shocks in a region. It is based on the crucial assumption that these immigrant stocks are not correlated with current economic conditions. However, despite dealing with the endogeneity issue, the IV often fails to account for spillover effects of migration, especially over longer time horizons. As pointed out by Jaeger et al. (2018), the ethnic enclaves IV conflates the short and long-run impact of immigrant entry in a region when immigrant inflows and stocks become serially correlated.[2] Since most of the analysis is at the long-run level; I use the IV approach suggested by Jaeger et al. (2018) that accounts for this adjustment by using an even more lagged instrument. Using both methods, I find that low-skilled immigrant entry can explain 48% of the total union fall between 1980 and 2000.[3]

My IV estimates point to a substantial fall in union rates caused by the low skilled immigrant entry. To check for robustness, and specifically, if I am picking up effects from alternate forces, I look at other possible reasons for a fall in union rates. Specifically, I evaluate the introduction of the right to work, the growing importance of the service sector and skill-biased technical change, as suggested by the literature behind the fall in unionization rates in the U.S. I find a measure for each of these reasons and see that they alone cannot explain the entirety of the fall in unionization. When used as additional checks in my preferred specification, these channels do not undermine the significant importance of the immigrant channel in explaining the fall in union density.

Next, I develop a model to capture the causal mechanism I discussed earlier more formally. The model uses a standard search-theoretic setting to formalize the arguments put forth and shows the mechanism qualitatively and intuitively and, in turn, is useful for two main reasons. Firstly, it provides me over-identifying predictions that I can take to the data, which serve to be both novel and prove model validity. Secondly, it allows

[2] A good summary of this IV and debate surrounding it can be found in the likes of but not confined to Borjas (1995) and Card and Peri (2016)

[3] In the main text, I discuss why my ethnic enclaves and Jaeger et al. (2018) IV approaches provide similar results. In short, it is because serial correlations between immigrant entry become a concern only after 1980, and my IV uses the 1970 stock of immigrants in the U.S.

me to calibrate the environment to explain how much of the fall in union rate can be explained by the channel. I do this by allowing workers to differ in their observable skills as either high or low, and an unobservable efficiency parameter that directly affects their productivity when matched to a firm. Unions take the non-union wages as given and set a uniform wage for all the members to maximize total union membership. The value functions of the workers and firms decide the efficiency levels at which a worker chooses to join the union and the firms to hire a unionized worker. The general equilibrium framework finds that when low-skilled immigrants enter the labour market, unionization tends to shrink from the two ends of the skill distribution and gets more concentrated towards the middle. High-skilled native-born are better off not joining the union as they become more productive due to the complementarity of skills in the production function. More firms are now ready to hire these high-skilled workers given their better productivities, further pushing up their non-union wages. On the other hand, low-skilled native-born workers at union wage are now less desirable by firms for two reasons. The first is due to diminishing returns in the production function as more low-skilled workers are in the market. Second is a better outside option for firms in terms of low-wage seeking immigrants due to their lower outside options. Firms would prefer to hire immigrant workers, thus reducing their probability of hiring a unionized low skilled native-born worker. These workers, therefore, leave the union and are better off taking a non-union wage.

My model has three main over-identifying predictions which hold in the data: Firstly, I find an inverted 'U' shape relationship when plotting unionization rate across skill deciles. Secondly, I see that low-skilled immigrant entry in a region increases the wage gap between high and low skilled non-union native-born workers. Finally, I find that immigrant entry in a region reduces the mean union wage. I calibrate the model to the U.S. setting between 1980-2000 to see the impact immigrants have had on wages of native-born workers of different skills and how that translates into a fall in union density. Using estimates both established in the literature and targeting moments based on union rates in 1980, I find that the model can predict about 48-55% of the total fall in union rates. The model does better in predicting union rate changes towards the two ends of the skill distribution than in the middle. I re-do this calibration exercise but now for the period between 2000 and 2017, a period characterized by high skilled immigrant entry and find

that the model does similarly well in predicting the changes in these decades.

The paper contributes to three strands of the literature in labour economics and macroeconomics. Firstly, it contributes to the literature trying to determine the cause behind falling union rates in the U.S. Acemoglu et al. (2001) considers skill-biased technical change (SBTC) to be the leading cause and argues that with SBTC, highly skilled workers prefer leaving the union. The model presented in this paper can generate similar findings but is different in two crucial aspects. Firstly, this paper predicts that both high and low skilled workers leave the union, which is supported by my empirical findings. Secondly, this paper differs by highlighting the contributions of both native-born workers and firms in reducing union rates. MacDonald and Robinson (1992) analyze unionization using firm's cost function in a partial equilibrium setting. However, their analysis omits the strategic interaction between workers and firms in reducing union rates. Dinlersoz and Greenwood (2016) again argue for SBTC as the driving force behind falling union rates in a theoretical setting. However, they do not provide empirical evidence to back their causal story. Finally, this paper is closest to the approach of Açıkgöz and Kaymak (2014) from a theoretical standpoint. They assume an exogenous increase in productivity which prompts deunionization when unions follow an egalitarian approach as shown by Freeman and Medoff (1984) and Card (1996). This paper goes beyond their contribution in two major ways: Firstly, this paper highlights in the model the critical determinant-low-skilled immigrant entry and how that affects productivities and incentives to unionize and backs it up with calibrating the identifying changes. Secondly, I deploy a rigorous empirical investigation into how immigrant entry leads to a fall in union rates, thus making a causal claim.

The second strand of literature this paper contributes to studies the impact of immigrant entry into the labour market on native earnings and other outcomes. There are two approaches used in this literature. The first method explored in Card (2001a), Altonji and Card (2007) and Card (2009) looks to compare labour market outcomes or changes in labour market outcomes in response to local immigrant inflows across locations. To account for the endogenous sorting of migrants, they use what is known as the ethnic enclave instrument. In the same vein, Card (1990) reports that the large inflow of Cubans

to Miami in 1980 (during the Mariel Boatlift) had a minimal effect on the Miami labour market. Some other papers that make use of natural experiments to analyze the effect of immigrant entry are Friedberg (2001), Glitz (2012), and Angrist and Kugler (2003). On the other hand, Borjas (2003) argues for comparing labour market outcomes across education and experience groups at the national level. However, the identification strategy in Borjas (2003) relies on the exogeneity of immigrant flows into skill-experience cells.[4] This paper takes the first approach and evaluates the impact of immigrant entry on unionization rates across geographical regions but looks closely at low skilled immigrants and how they affect unionization rates of low skilled and high skilled natives.

From a more modelling standpoint, papers have tried to analyze the effect of immigrants on the local labour market. Ottaviano and Peri (2012) in a structural production function approach, introduce substitutability between natives and immigrants of similar education and experience levels and take that to data to find immigrant entry has a more severe impact in terms of wage reduction on previous immigrants than low-skilled natives. Chassamboulli and Palivos (2014) use a search and matching framework to analyze immigrant entry on native-born wages and find it to be substantial after a calibration exercise. Amior and Manning (2020) looks at wage effects of immigration in the presence of a monopsonistic labour market. Albert (2021) find undocumented immigrants have a high job creation effect on natives and thus increase their employment and wages. In this paper, I also employ a search and matching framework but look at how the impact of immigrant entry in general equilibrium distorts the incentives of native workers to join the union and for firms to hire unionized workers.[5] This paper captures the dual-sided incentives of workers and firms alike through a change in wage, leading to a decline in union densities.

Finally, there are concerns about growing income inequality in the U.S. a fall in the union rate has also been proposed to have caused an increase in wage inequality, Card (1996), DiNardo et al. (1996), Fortin and Lemieux (1997). Card (2001b) finds 15-20% of the

[4] Ottaviano and Peri (2012) and Monras (2020) for a more careful evaluation of the issues surrounding the Borjas (2003) method.

[5] This paper, therefore, in a similar contribution to the likes of Lewis (2011) in looking at how immigrant entry can incentivize firms and impact their hiring process.

rise in male wage inequality in the U.S. between 1973-1993 can be accounted for falling union rates. A recent paper by Farber et al. (2021) using new survey data before 1973 points to how U.S. income inequality has varied inversely with union density over the past 100 years. Lemieux (1998) argues that this is because unions compress the returns to a time-invariant unobservable measure of skill. At the same time, studies like Card (2009) have linked an increase in wage inequality to higher low skilled immigrant entry. By analyzing how the entry of low skilled immigrants leads to the fall in union rates, this paper contributes by tying the two important strands of the literature on income inequality together and, in my knowledge, is the first to do so. Besides inequality, the decline in unions is a major factor behind job polarization, Tüzemen and Willis (2013), Föll and Hartmann (2019) and jobless recoveries, Berger et al. (2012), and the vanishing procyclicality of productivity in the U.S., Mitra (2021). Given how many countries, especially in Europe, continue to have higher union density and have recently established more welcoming immigration policies, it is crucial to understand how the entry of immigrants can affect union density and, in turn, other macroeconomic areas of concern.[6]

The rest of the paper proceeds as follows: Section 2 describes the data and motivating trends. Section 3 describes the specifications, identification and estimation strategies used in the main empirical results. Section 4 tries to hold other possible reasons for falling union rates in the U.S. to closer scrutiny and conducts robustness checks. Section 5 examines a search and matching model to analyze the general equilibrium effects of immigrant entry on unionization rates. Section 6 looks at specific model predictions and evaluates them in the data. Section 7 provides model calibrations and evaluates how well the model can capture the change in union density in the U.S. Finally, section 8 concludes and offers potential avenues for further research.

[6]For job polarization and union presence in Europe, Goos et al. (2009).

2 Empirical Evidence

2.1 Data

I base the empirical analysis on two primary data sources. Firstly, I use the U.S. Census data for the years 1960, 1970, 1980, 1990, and 2000, combined with pooled observations from the American Community Survey (ACS) for the years 2009-2011 and 2016-2018. The Census provides details of immigrant entry in the U.S. across State and MSAs, besides providing much-needed information on worker characteristics like industry and occupation, which is crucial for the analysis I undertake. However, the Census does not provide information on union status. For all union and union-related information, I use the Current Population Survey (CPS). I use data from the May supplements from the NBER website to get union information in the 1970s and monthly files in the later years after 1983.[7,8] To achieve time consistency on union rates across states, I follow Hirsch et al. (2001).[9] For other non-union information from the CPS, I use the March files of the CPS, which contains more detailed information on location, country of birth, union status and other variables that I need; I use it to construct yearly data. This data on immigrants in the CPS is available only from 1994, and thus, I use the CPS from 1994-2017, where I need information on the union status of immigrants. All data are from the Integrated Public Use Microdata Series.[10] The main sample consistent across the CPS and Census includes workers, aged 18 to 64 who are not self-employed and work for wages and salaries, not enrolled in school, and report positive hours of work and earnings. I drop immigrants with no information on their country of birth or year of arrival in the United States.

[7] Papers which use the same are Hirsch and Macpherson (1993) and Mayer (2004)

[8] The estimates of union membership and the total number of persons employed for 1994-2003 were calculated from the monthly Current Population Survey (CPS). Estimates of union membership for 1973-1993 are from Barry T. Hirsch and David A. Macpherson, Union Membership and Earnings Data Book: Compilations from the Current Population Survey, Washington, Bureau of National Affairs, 2003, p. 11. Union membership data for 1930-1972 are from: U.S. Department of Labor, Bureau of Labor Statistics, Handbook of Labor Statistics, Bulletin 1865, U.S. Govt. Print. Off., 1975, p. 389.

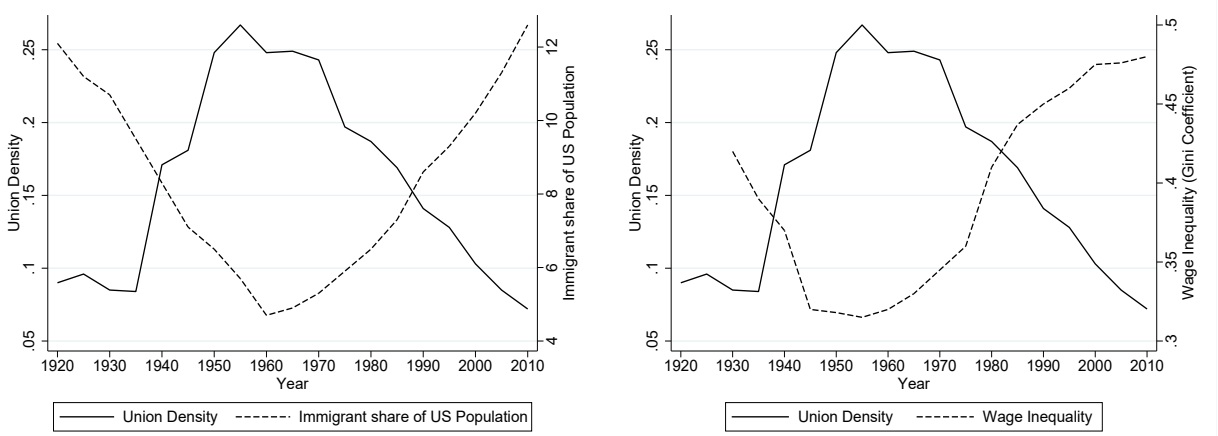
[9] The paper Hirsch et al. (2001) corrects for the measurement errors introduced in the CPS when measuring union rates due to a change in the questions asked concerning union status. It is crucial to make this assessment to correctly quantify the drop-in union rates, which started in the late 1960s.

[10] (IPUMS-USA, Ruggles, Flood, Goeken, Grover, Meyer, Pacas and Sobek, 2018)

2.2 Long Run Trends

I start the analysis by evaluating long-run trends in unionization rates and immigration inflows in the U.S. Particularly of fundamental interest is to assess the general timing of these changes and see if they point to certain conjectures. As shown in the left panel in figure 3, the fall in unionization rate was contained to about three per cent in the 60s, seven per cent in the 1970s but showed significant decline later starting in the 1980s. To illustrate the immigration channel in falling union rates, I look at how the entry of immigrants into the U.S. has changed over the years. The rise in the immigrant population especially starting in the 1960s, suggests that an increase in immigrants and a decline in union rates occurred in a very similar time frame. Further, between the 1920s and 1960s, immigrants as a percentage of the U.S. population declined steadily while union rates increased.[11] The implementation of the Immigration and Nationality Act of 1965 lead to a substantial increase in the number of immigrants in the U.S. and altered the immigration demographics in the U.S. As seen in figure 3 union rates started falling steadily since the late 1960s. An emerging trend in the U.S., especially in the late 1980s and 1990s, was the increase in the size of undocumented immigrants, Monras (2020). Neither the CPS nor the Census allows for the direct identification of undocumented immigrants. However, the surveys conducted by the U.S. Census Bureau for the Census and CPS are address-based and designed to be representative of the whole population; they also include undocumented respondents. The Department of Homeland Security (DHS) uses the CPS and ACS surveys as the primary source to estimate the size of the undocumented immigrant population, Albert (2021). Therefore, I acknowledge the presence of undocumented immigrants in my sample, but I do not make distinctions between them and documented ones as that is not crucial to the analysis. As will be later established in the empirical discussions, the critical area of focus is the period in the 1980s to 2000s where unionization rates fell by about 9%. I use the period between 1980-2000 for evaluating the impact of immigrant entry on the union rate for two primary reasons. Firstly, the period between the 1980s to 2000s saw a significant fall in the union rate. After the 2000s, the union rates were already at historically low levels of under 10% and primarily confined to the public

[11]The Nationals Origins Formula was a basis of the U.S. Immigration policy between 1921 and 1965, which strategically discriminated against the entry of Southern and Eastern Europeans, South American, Asians, as well as other non-Northwestern European ethnic groups from the American Immigration policy



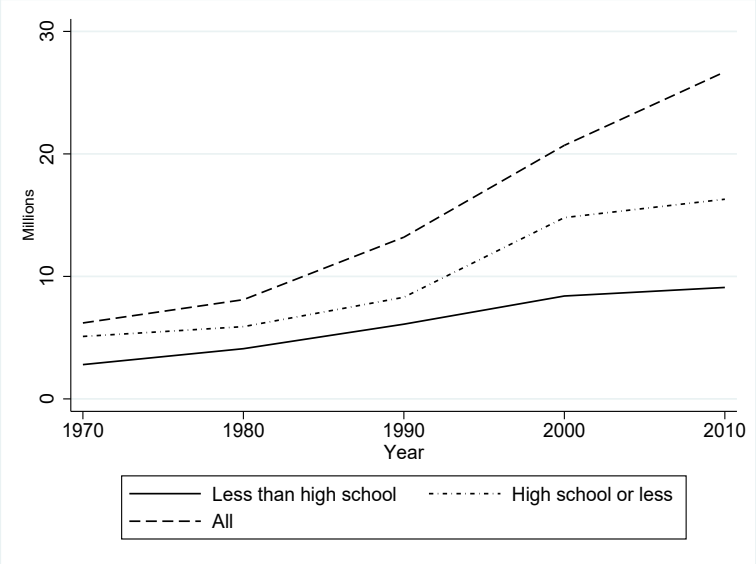
Note: Left panel: Unionization is measured as fraction of all employed workers and Immigrant population change in the US. Right panel: Wage inequality is measured by Gini Coefficient. Sources: Kopczuk et al. (2010).

Figure 3: Deunionization, wage inequality and immigrant entry in the US

sector, so to expect them to fall further would be a stretch.[12] Also, starting my analysis allows me to use the 1970s and 1960s Census data later for IV estimation and will enable me to use the 2017 years for the calibration and model predictions. The right-hand panel of Figure 3 plots the change in union membership rates and wage inequality in the United States.[13]

[12]This is also consistent with the literature, Açıkgöz and Kaymak (2014).

[13]Here, I evaluate inequality using the Gini coefficient; other alternate methods have found similar changes. Yun (2006) evaluates this using a variety of techniques.



Note: Data based on the US Census 1970,80,90,2000 and ACS (2009-11). Additional source: Hanson et al. (2017)

Figure 4: Education Level of Immigrant Population in the US

In figure 4, I graph the education level of the immigrants entering the U.S. starting in the 1970s based on the Census. As the graph suggests, a substantial portion of the immigrant population entering the U.S. were either high school educated or less, indicating that they were low skilled. The percentage of high skilled immigrants started to increase from the late 1990s as is also suggested by Peri et al. (2015).[14] Starting in the 1990s, as identified by the Pew Research Center, undocumented immigrants who are essentially less educated and without high school diplomas increased steadily and decreased only after 2007, Passel and Cohn (2016). The characteristics of incoming immigrant cohorts are provided in Table 1. As less-educated, foreign-born labour supplies increased sharply after 1970, their predominant national origins shifted from Europe to Latin America. Cohorts' sizes increased steadily over the time considered, with the 1960s cohort comprising around 1200 thousand individuals, the 1980s cohort 4.2 million individuals and the 2000s cohort 5.5 million individuals. This substantial increase in the size of the immigrant in-

[14]This is especially so after Since the Great Recession, after which the U.S. border became a less active place when it comes to net inflows of low-skilled labour from abroad, Hanson et al. (2017).

flows was accompanied by an essential shift in their ethnic and educational composition. In the 1960s, most immigrants originated from Western source countries and relatively few from Mexico and Asia. Over the following decades, this pattern reversed, with the share of migrants from Western countries decreasing and the percentage from Mexico and Asia increasing. The level of formal education of the new cohorts of immigrants improved since the late 1980s, with the share of high school dropouts decreasing from 51.1 per cent in the 1960s to 33.6 per cent in the 2000s. The percentage of college-educated immigrants increasing from 21.6 per cent in the 1960s to 31.3 per cent in the 2000s. However, age and average wage profiles have remained similar.[15]

In figure 5, I compare the education levels of native and foreign-born in the U.S. over the last 50 years. As seen in the left panel of the figure, consistently amongst all foreign-born working workers in the U.S., a very high portion have only 0-8 years of education. 9-11 years of schooling, more recently is more similar among the two groups but again the percentage of native-born with 12 or more years of education far outnumber the foreign-born. This figure decreases over the decades but consistently remains significantly higher than that of natives.[16] This evidence again underlines that immigrants, especially in the 70s, 80s and 90s, were predominantly low skilled when referenced against natives.

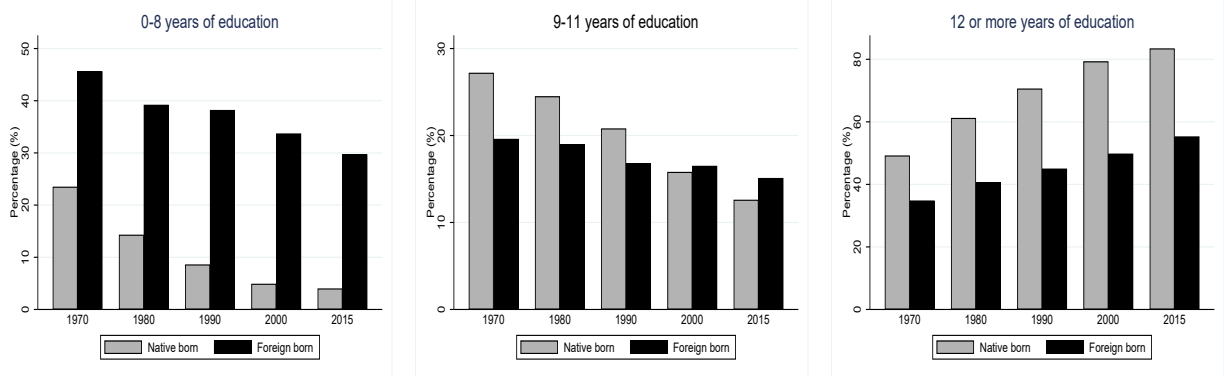
[15]Data source from the Census, using appropriate individual weights obtained from IPUMS and Albert et al. (2020)

[16]Also essential to remember here is that the education received by most foreign-born is in their home country, and as the literature suggests, foreign education is less valued and often even discriminated against. Oreopoulos (2011) besides pointing to the vast literature on this issue, looks at discrimination among highly skilled workers in the Canadian context.

Table 1: Descriptive Statistics of Immigrant Cohorts

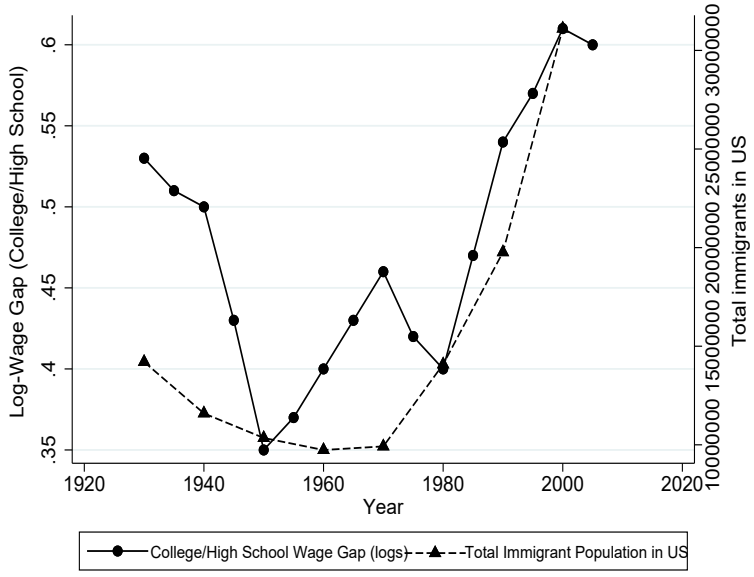
	Entry Decade:			
	1960-69	1970-79	1980-89	1990-99
Share of population (%)	1.2	2.9	4.2	5.5
Cohort Size (millions)	0.9	1.6	2.7	3.8
Age	35.3	33.6	33.2	33.1
Hourly Wage ($ adjusted)	18.6	17.8	15.7	17.1
HS dropouts (%)	51.1	46.1	36.1	33.6
HS graduates (%)	18.1	18.2	22.6	26.8
Some College (%)	9.1	10.1	15.8	9.5
College graduates (%)	21.6	23.5	25.6	31.3
Mexico (%)	9.6	23.5	21.5	29.5
Other Latin America (%)	27.8	19.4	25.2	20.5
Europe(%)	37.8	17.8	11.1	9.8
Asia (%)	14.9	31.4	33.9	27.6
Other (%)	9.9	7.9	8.2	12.6

Note: The statistics are based on the sample of male immigrants aged 18-64 reporting positive income, that entered the United States during the respective time intervals, measured in the first Census year following the arrival. Observations are weighted by the personal weights obtained from IPUMS, rescaled by annual hours worked.



Note: Left panel shows percentage of foreign and native born with 0-8 years of education. Middle panel shows percentage of foreign and native born with 8-11 years of education. Right panel shows percentage of foreign and native born with 12 or more years of education. Data sourced from the Census, Hanson et al. (2017).

Figure 5: Native born versus Foreign born Education over the years

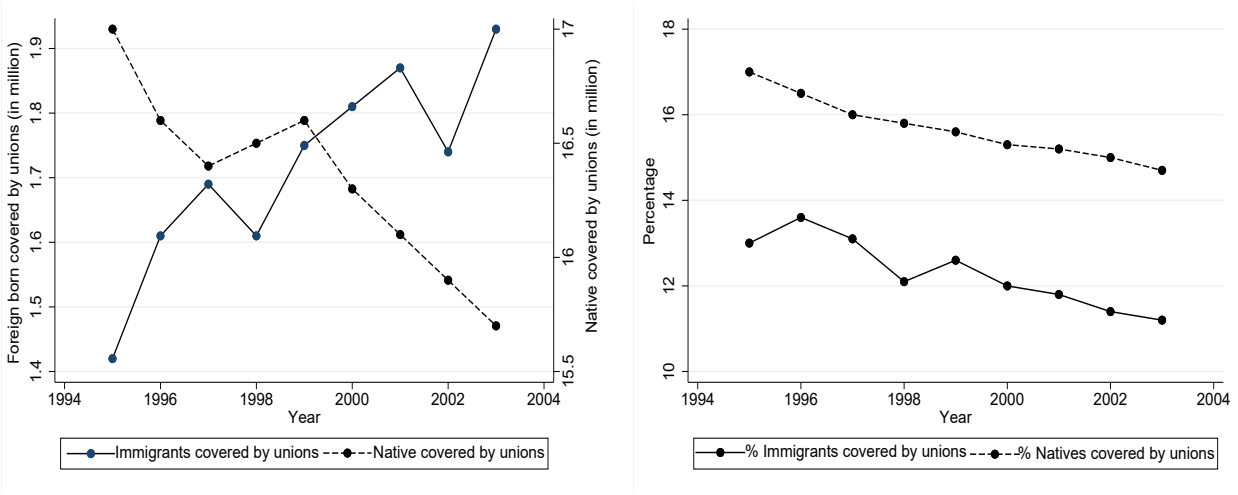


Note: College wage premium in US sourced from Goldin and Katz (2008) and immigrant % sources from 2010-19 American Community Surveys (ACS), and 1970, 1990, and 2000 decennial census. All other data are from Gibson and Lennon (1999).

Figure 6: College Wage premium and immigrant entry in the US.

Finally, figure 6 plots the logs of the wage gap between college and high school graduates in the U.S. along with total immigrants entering the U.S. Consistent with previous long-run trends, the slight growth in the immigrant population in the 1960s followed by a more substantial increase in the 80s and 90s, closely followed by a similar rise in the wage gap amongst college and high school graduates in the U.S. With the significant rise of the immigrant workforce as a part of the total workforce of the U.S. especially in post-1965, a reasonable doubt might be that the fall in union rates can be simply a compositional shift as immigrants are significantly less likely to unionized. Using the CPS data, I find that this is not true.[17] Even though the total number of immigrants joining the unions as documented in the left panel of figure 7 is increasing, but this does not keep up with the existing increase in the share of immigrants leading to an overall fall in the total percentage of immigrants being unionized in the U.S. as shown in the right panel of figure 7. Starting from around 13% in 1994, it had gone below 10% in 2003. On the other hand, native-born decreased their union participation in absolute numbers and as a percentage of the workforce. The unionization for native-born came down from around 16% covered in 1994 to 13% in 2003 among all 16-65 aged, wage and salaried workers.

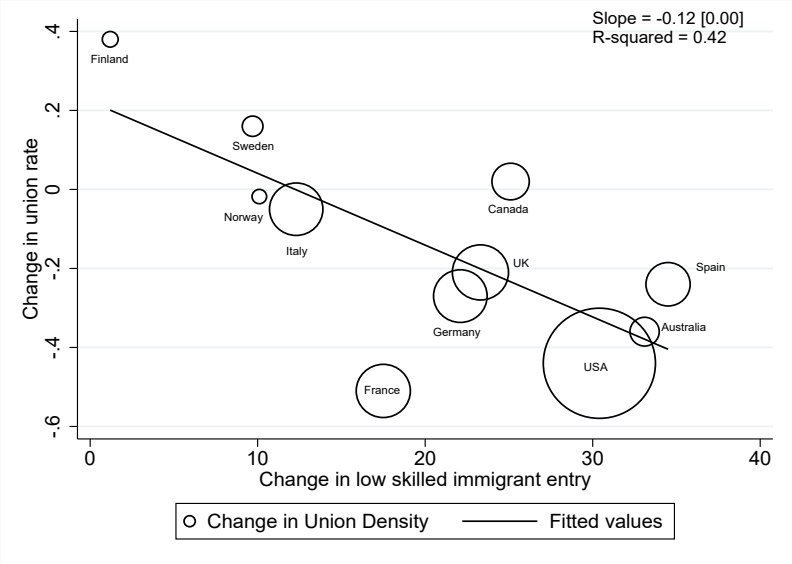
[17] Ideally, the task would be to see these rates and numbers are changing from the start of the 1980s, but unfortunately, data pertaining to immigrants as part of unions starts from 1994.



Note: In figure on the left: Union Affiliation of Employed Foreign-Born Wage and Salary Workers and Native Wage and Salary Workers, Age 16 Years and Over, 1996 to 2003. In the figure on the right: Percentage of total wage and salaried immigrant and native workers as part of unions, 1996 to 2003. Data Source: Current Population Survey, 1995 to 2003 (annual averages)

Figure 7: Immigrant and Native Union Rates in the US

Besides concentrating on the U.S. and evaluating how union rates have changed with immigrant entry, I also study the correlations between the two in an international context. I do this to understand how union rates and immigrant entries have evolved worldwide and check if my findings for the U.S. can be corroborated in other settings. The countries considered are essentially developed economies with well-defined labour markets but differ regard immigrant penetration of the labour market, political institutions, and skill composition. Figure 8 shows these correlations and finds a significant positive relationship between a change in low skilled immigrant entry and a change in union density. Most countries that have increased the low skilled immigrant entry have also seen a fall in union density, including Australia, Spain, UK, France, and Germany, with the notable exception being Canada. As seen in the figure, most Nordic countries have very low immigrant entry and high union rates.



Note: Union density data for all countries concerned are sourced from OECD Annual Trade Union Density Dataset. Estimates on immigrant entry derived from various sources including StatsCan, Census, Migration Policy institute document, country specific press release and World Bank.

Figure 8: International Evidence for De-unionization and Immigrant Entry

3 Specification and Results

3.1 Correlation Analysis

In the previous section, we observe the long-run patterns in the data and consistencies in the timing of the two events, namely, a decline in unions and an increase in the low-skilled immigrant entry. However, given the bi-causal nature of the relationship concerned, it is essential to consider this relationship in far greater depth. Therefore, this section presents a framework to study the relationship between the concerned variables using both correlations across sectors and an instrumental variable approach. I first undertake the analysis in a difference-in-difference approach, where I analyze how immigrant entry and union decline has changed across states, industries, and occupations. This multi-dimensional approach is vital to avoid any possibilities of spurious correlations that might be possible in a single sector. I use the following specification:

$$\Delta\ Union_c = \alpha + \beta\,\Delta\ (\frac{I}{N})_c + \gamma\, X_{c,1980} + \epsilon_c \tag{3.1}$$

Here, ΔU_c is the change in the union rates in the concerned time horizon in sector c. $\Delta(\frac{I}{N})_c$ is the change in immigrant to the native-born population between the years in labour marker of interest. γ controls state-level variables like log population, region dummy, average income, and population share in different industries.[18] I have used both union membership and percentage of workers covered under collective bargaining agreement which show similar results. I start my analysis first with some basic correlation analysis across states between 1980-1990 (left panel) and 1980-2000 (right panel) in figure 9.[19] Both figures highlight the significant negative correlation between the degree of unionization and the magnitude of the increase in immigration across US states. The results with weighted observations where weights are the average employment levels in each state bear similar patterns.[20][21]

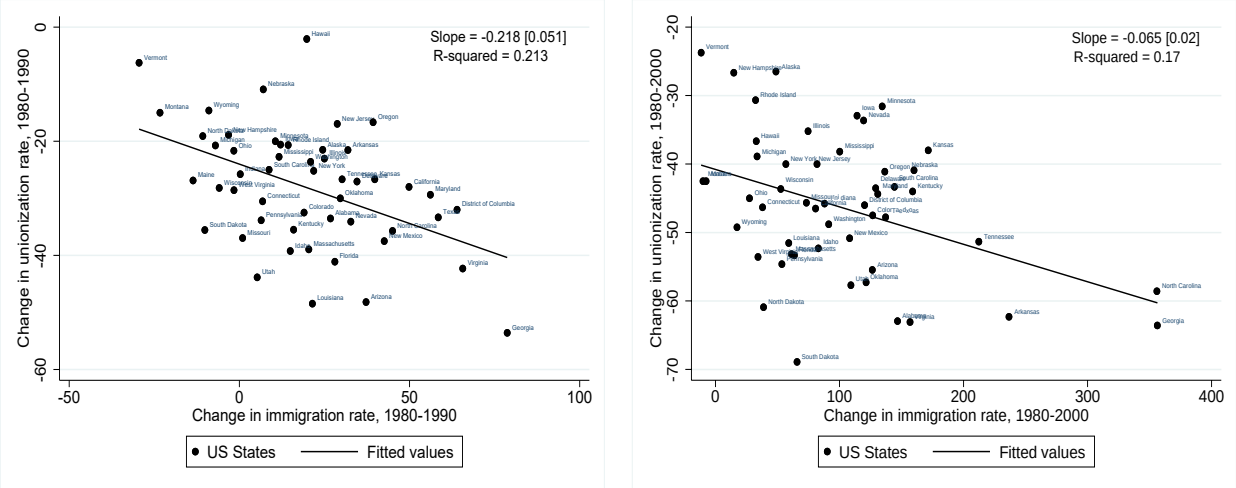
A concern with the regression would be that the fall in unionization rates and the rise in the immigrant population might be compositional. The fall might be driven by employment shifts towards less unionized states rather than changes within each region. This would be undesirable to give any causal interpretations to the coefficient. However, a simple decomposition exercise helps us find that about 89% of the fall in union rates within 1981-1990 took place within states and not through employment shifts to less

[18] I use 19 broad industry classifications. Results are very similar with narrower (14) or broader (31) classifications.

[19] On careful evaluation, it is plausible that places that undergo higher growth can attract both immigrants and make it easier for unions to start. This leads to a positive relationship between the two variables. However, this is not the case, as we see in the results.

[20] I run the same correlation graphs with state weights, and the results are not different. I try different weights, but the most logical seems to be employment share. These graphs are a part of the Appendix, figure 20

[21] I also run correlations between 1990-2000, the results are still significant, although the coefficients are slightly smaller. Results in Appendix, figure 21.



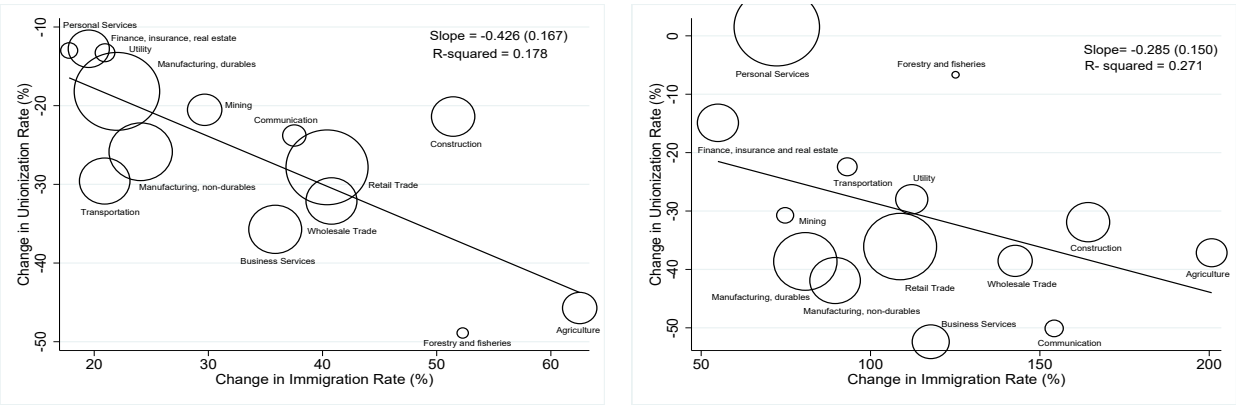
Note: In the left panel: Change in union rates and immigrant population shares across states between 1980 and 1990. In the right panel: Change in union rates and immigrant population shares across states between 1980 and 2000. Data on state level unionization rates comes from CPS and Hirsch and Macpherson (1993). The p-value of the slope coefficient using robust standard errors in reported in parentheses.

Figure 9: Cross-State Evidence on De-unionization and Immigrant entry

unionized states.[22] Next, I look at similar correlations but across industries in figure 10.[23] The figure shows a significant negative correlation between the degree of unionization and immigrant entry into industries. Thus, the relationship holds not only across states but also across industries.

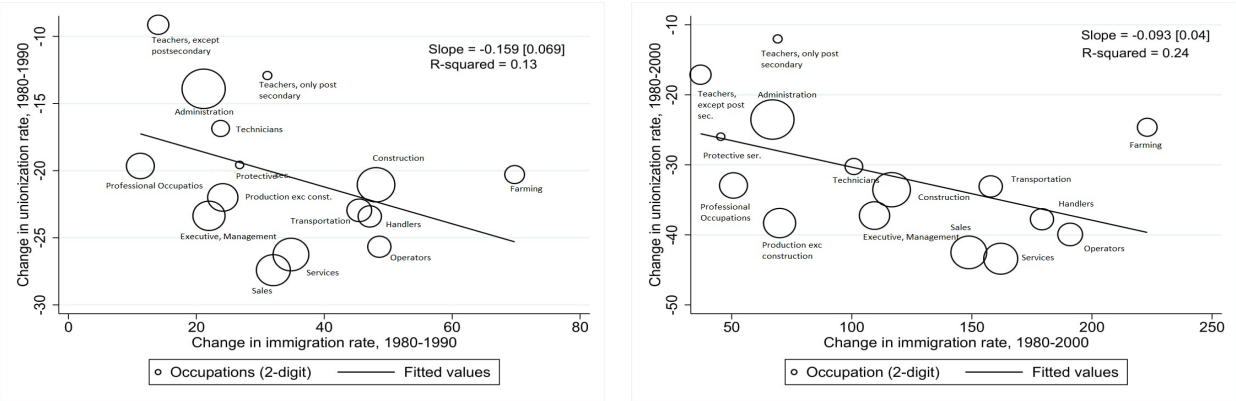
[22]change in union density across states can be decomposed as = Within$-s$ changes, $\sum_{i=1}^{S} e_s \delta u_s$ + Between$-s$ change, $\sum_{i=1}^{S} e_s \delta u_s$, where e_s is the average employment share and u_s is the average union density in state s.

[23]Unweighted correlation graphs are shown in Appendix as figure 22.



Note: In the left panel: Change in union rates and immigrant population shares across industries between 1980 and 1990. In the right panel: Change in union rates and immigrant population shares industries states between 1980 and 1998. Data on industry level unionization rates comes from CPS. Size of the bubbles represent rolling average industry employment level. Slope coefficient and robust standard errors are reported in parentheses.

Figure 10: Cross-Industry Evidence on De-unionization and Immigrant entry



Note: In the left panel: Change in union rates and immigrant population shares across occupations between 1980 and 1990. In the right panel: Change in union rates and immigrant population shares across occupations between 1980 and 2000. Data on occupation level unionization rates comes from CPS. Size of the bubbles represent rolling average occupation employment level. Slope coefficient and robust standard errors are reported in parentheses.

Figure 11: Cross-Occupation Evidence on De-unionization and Immigrant entry

Finally, in Figure 11, I look at unionization rates across occupations and immigrant entry in these specific occupations. I again see a significant negative relation between union rates and immigrant entry. The relationship is stronger for the 1980-1990 decade and even after accounting for employment under each occupation as weights.[24] In the following sections, I carefully lay out the identification strategy and analyze in detail the instrument variable technique undertaken to investigate these robust correlations further.

3.2 Instrument Variable

A potential channel of endogeneity that might threaten the causal interpretation of the OLS estimates is reverse causality. An argument can be made that the fall in unionization in certain specific areas prompted the entry of immigrants. This is so that they could take advantage of the fewer restrictions afforded to firms in their hiring practices in areas with fewer unions, which would mean less competition for immigrant workers from natives. In other words, immigrants were strategically located in areas where there was a higher level of de-unionization. To overcome this issue, I use an instrumental variable technique familiar in the literature. My study here, like others in past (Altonji and Card (2007), Card (2001b), Bartel (1989)) will rely on spatial variation in immigrant inflows for identification. To address the endogeneity of the location choices of new immigrants, inflows at an aggregate level will be combined with the lagged geographic distribution of immigrants to create an instrument. The argument for this type of instrument's validity is that the persistence of regional immigration patterns derives from new immigrants' preference to resettle with family—and much of U.S. immigration is "family-based" or to be in a culturally familiar environment.[25] Often referred to as a 'shift share' instrument; I instrument for immigrant entry in different U.S. states by their share in 1970.

Since the regressions are at the geographic level, I can predict the regional flows of immigrants to this region using the initial geographic distribution in the base year. National

[24]Current Population Survey (CPS) Outgoing Rotation Group (ORG) Earnings Files are used from 1983. The sample includes employed wage and salary workers, ages 16 and over. For the pre-1983 figure, monthly files of the CPS are used. Source: Hirsch and Macpherson (1993)

[25]Shown in many papers but not restricted to the likes of Munshi (2003), Bertrand et al. (2000).

inflow of immigrants $I_{c,e,t}$ are defined as the difference in the number of immigrants from origin country c with education e between time period t and $t-1$. Let $\pi_{c,e,r,t}$ denote share of immigrants from country c with education e who live in region r at time t. The inflows used to compute the instruments are given by the sum over these immigrant inflows to a specific region:

$$I^z_{e,r,t} = \sum_c I^z_{c,e,r,t} = \sum_c \pi_{c,e,r,t-1} I_{c,e,t} \tag{3.2}$$

The predicted population levels of immigrants at time t are then:

$$P^Z_{e,r,t} = P_{e,r,t-1} + I^Z_{e,r,t} \tag{3.3}$$

And predicted population shares are

$$N^Z_{e,r,t} = P^Z_{e,r,t} / (P^Z_{E,r,t} + \sum_e P^Z_{e,r,t}) \tag{3.4}$$

where $(P^Z_{E,r,t} + \sum_e P^Z_{e,r,t})$ is the total imputed population (natives and predicted number of immigrants) in a time-region cell. The final instrument are the changes in the above shares between two consecutive periods of consideration given as $N^Z_{e,r,t} - N^Z_{e,r,t-1} = \Delta N^Z_{e,r,t}$, which is used to predict the variation in the true change, $\Delta N_{e,r,t}$ that is exogenous to the current labour market conditions.

Finally, it is important to consider the region or geographic level at which the analysis runs. By choosing MSA, city or state, the assumption is that these regions are closed economies, and there are no spillover effects through internal migration of workers or firm relocation. However, U.S. workers are knowns to be geographically mobile, and an immigrant shock might be dampened over the long run by these migrations. This is especially true because I look at changes in unionization rates over the long run. There are two approaches; firstly, by using a broader geographic region of consideration to evaluate these changes, I do so by considering my analysis at the state levels besides the MSA analysis. Most U.S. migrations are within states and especially so in earlier decades when migrations were less frequent. Therefore, this can partly address the issue at hand. Secondly, I substantiate my result with another IV technique as suggested by Jaeger et al.

(2018). Consider if immigrants join the pool of the unemployed upon arrival, their initial impact on vacancy creation will be much larger than their long-run impact as the probability to match with a cheaper worker will be very high in the beginning and subsequently decrease to its new steady-state level as the initially unemployed immigrants are matched to firms. Suppose there are long-lasting adjustment or transition processes and the original composition and immigrant settlement patterns are correlated over time. In that case, the coefficients of the above-outlined IV estimation are biased. This is because the short- and long-run responses to local immigration shocks would be conflated. Therefore, I use the approach laid out in their paper to account for the long-run adjustment process by also including the first leg of the immigrant shares in the model. The results from Jaeger et al. (2018) suggest that periods with substantial changes in the country of origin composition may provide variation that can be exploited with a variant of the shift-share strategy. By instrumenting both current and past immigrant inflows with versions of the past settlement instrument that vary only in their national components, it is possible to isolate the variation in inflows that are uncorrelated with current local demand shocks and the process of adjustment to past supply shocks. Their results also suggest that the 1970s are the best time to consider the use of this procedure.[26] Therefore, for evaluation, I consider the following OLS model first:

$$\Delta log\, U_{r,t} = \alpha + \beta \Delta log\, N_{r,t} + \gamma X_{r,t} + \epsilon_{r,t} \tag{3.5}$$

where $log\, U_{r,t}$ is the union rate in region (MSA, state) r at time t. $N_{r,t}$ is the immigrant share and X are region level controls. The first stage regression for the standard IV approach would then be given as:

$$\Delta\, N_{r,t} = \delta_{10} + \delta_{11} \Delta\, N^{Z}_{r,t} + \epsilon_{r,t} \tag{3.6}$$

Next using Jaeger et al. (2018), from now referred to as JRS-IV, the first stage additionally includes the first lag of the immigrant shares in the model. Thus, the first stage would

[26] In their paper Jaeger et al. (2018) show that a high degree of correlations in immigrant entry post-1980 lead to serial correlations issues, thus making the "ethnic-enclaves" instrument biased. Using their methodology, they find their instrument leads to a more negative impact of immigrant entry on native wages.

be written as:

$$\begin{aligned} \Delta\, N_{r,t} &= \delta_{10} + \delta_{11}\Delta\, N^{Z}_{r,t} + \delta_{12}\Delta\, N^{Z}_{r,t-1} + \epsilon_{r,t} \\ \Delta\, N_{r,t-1} &= \delta_{20} + \delta_{21}\Delta\, N^{Z}_{r,t} + \delta_{22}\Delta\, N^{Z}_{r,t-1} + \epsilon_{r,t} \end{aligned} \tag{3.7}$$

In the table below, I present, the first stage results for both the standard IV model and JRS-IV.[27] This allows me to write the second state estimation equation as follows.

$$\Delta log\, U_{r,t} = \alpha + \hat{\beta}_1 \Delta log\, \hat{N}_{r,t} + \hat{\beta}_2 \Delta log\, \hat{N}_{r,t-1} + \gamma X_{r,t} + \epsilon_{r,t} \tag{3.8}$$

In both the models, the instruments have positive and significant effects on the shares they predict, as shown in Table 2.

[27] Albert (2021) finds similar results.

Table 2: First Stage Results

State	IV	JRS-IV	
	$Imm.Share$	$Imm.Share$	$(Imm.Share)_{t-1}$
$(Imm.Share)^Z$	0.698	0.578	0.535
	(0.072)	(0.093)	(0.098)
$(Imm.Share)^Z_{t-1}$		0.073	0.518
		(0.061)	(0.048)
R^2	0.715	0.756	0.801
MSA	$Imm.Share$	$Imm.Share$	$(Imm.Share)_{t-1}$
$(Imm.Share)^Z$	0.613	0.498	0.411
	(0.101)	(0.115)	(0.131)
$(Imm.Share)^Z_{t-1}$		0.061	0.498
		(0.049)	(0.015)
R^2	0.657	0.677	0.689

Note: Population data are from the US Census 1960-2000. The sample consists of 51 states and MSAs, for which data are available. Standard errors are clustered at the Stae/MSA level. The observations are weighted by State/MSA population.

As reported in table 3, the results for the OLS and second stage results for the IV and JRS-IV technique are presented with different specifications for state and Table 4 provides the same for MSAs. The table below shows the first regressions between immigrant population growth and unionization rates across states between 1980 and 1990. Column (1) highlights the correlation results along with an additional check by including log population. Column (2) controls for the region, and columns (3) and (4) control for other different state-level variables of interest: average income and education. In column (5), I show IV results where I instrument immigrant population shares in 1980 with the stock of immigrants in 1970 and finally, in column (6), I look at results from the JRS-IV technique.

Table 3: Estimates of the impact of low-skilled immigrant entry on union rates, 1980-90, (States)

			Full Sample		IV-1970	JRS-IV
	(1)	(2)	(3)	(4)	(5)	(6)
(Immigrant/Native) Ratio	-0.358***	-0.271**	-0.315**	-0.329***	-0.452***	-0.477***
	(0.095)	(0.131)	(0.150)	(0.151)	(0.106)	(0.151)
Log Population	x	x	x	x	x	x
Region Dummy	-	x	x	x	x	x
Average Income	-	-	x	x	x	x
Average Education	-	-	-	x	x	x
R^2	0.21	0.59	0.594	0.597		
N	51	51	51	51	51	51

Note: The results are obtained from the decennial Census, 1970, 1980 and 1990. Robust standard errors are in parentheses, adjusted for clustering at state level. $^{*}p < 0.10$; $^{**}p < 0.05$; $^{***}p < 0.01$.

Both the state and MSA level regressions indicate a significant negative relationship between immigrant entry and unionization. Controls for the region, population, average income, and education do not change the relationship.[28] For both States and MSAs, the effect is less when all controls are introduced in column (4) as compared to estimates in column (1). Finally, the IV results in column (5) and JRS-IV results in (6) point to causality such that entry of low skilled immigrants leads to a fall in union rates across states and MSAs. Given the log-log specification of the regression equations, the coefficients under consideration have an easy translatable form.

[28] Albert and Monras (2018), and Monras (2020) have shown immigrant locations prefer settling in areas with higher wages and more population. Therefore, it is important to control for these variables when looking at immigrant entry impact on unions

Table 4: Estimates of the impact of low-skilled immigrant entry on union rates, 1980-90, (MSAs)

			Full Sample		IV-1970	JRS-IV
	(1)	(2)	(3)	(4)	(5)	(6)
(Immigrant/Native) Ratio	-0.328***	-0.241**	-0.245**	-0.290***	-0.422***	-0.434***
	(0.101)	(0.119)	(0.12)	(0.141)	(0.116)	(0.171)
Log Population	x	x	x	x	x	x
Region Dummy	-	x	x	x	x	x
Average Income	-	-	x	x	x	x
Average Education	-	-	-	x	x	x
R^2	0.18	0.47	0.48	0.49		
N	183	183	183	183	183	183

Note: The results are obtained from the decennial Census, 1970, 1980 and 1990. Robust standard errors are in parentheses, adjusted for clustering at MSA level. $^{*}p < 0.10$; $^{**}p < 0.05$; $^{***}p < 0.01$.

In Table 3, the central coefficient of interest in column (5) shows that a 1% increase in immigrant to native population ratio leads to a 0.45% fall in union rates. The standard IV approach has a higher estimate than the OLS result. The JRS-IV result in (6) shows a similar effect of a 1% increase in immigrant to native population leading to a 0.47% fall in union density. Between 1980 and 1990, a low-skilled immigrant to native population rose by about 28%, indicating a 13% fall in union density. Union coverage and membership decreased by about 27% between 1980-1990. Therefore, the results suggest that low skilled immigrant entry can account for about 47% of the total fall in union density in this period. The reasonably high values of R^2 in the OLS specifications show that the regressions are well explained.[29] The coefficients of interest for both OLS and IV for state-level specification in Table (5) between 1980-2000 and MSAs in Table (14) in Appendix are also significant but smaller, but this is because there is a higher immigrant entry between

[29]Results are similar for union membership versus people covered under union bargaining agreement. The coefficients are higher for the latter.

these years due to a longer time horizon. As was the case, with the specification between 1980-1990, the results for the IV specification are higher than the OLS. Similar controls for state/MSA characteristics and other factors that have had a negative impact on union rates have also been controlled for as previously. In Table (5), a 1% increase in low skilled immigrants to the native-born ratio in a state leads to a 0.24% fall in union density. Union density fell by about 42% between 1980 and 2000, where the low skilled immigrant to population ratio increased by 85%. Therefore, the results indicate that a rise in immigrant entry predicts a 20.4% fall in union rates. Therefore, it predicts about 48.5% of the total fall in union density.

Table 5: Estimates of the impact of low-skilled immigrant entry on union rates, 1980-2000, (States)

			Full Sample		IV-1970	JRS-IV
	(1)	(2)	(3)	(4)	(5)	(6)
(Immigrant/Native) Ratio	-0.228***	-0.195**	-0.201**	-0.219***	-0.242***	-0.247***
	(0.066)	(0.092)	(0.095)	(0.071)	(0.102)	(0.101)
Log Population	x	x	x	x	x	x
Region Dummy	-	x	x	x	x	x
Average Income	-	-	x	x	x	x
Average Education	-	-	-	x	x	x
R^2	0.21	0.59	0.594	0.597		
N	51	51	51	51	51	51

Note: The results are obtained from the decennial Census, 1970, 1980 and 1990. Robust standard errors are in parentheses, adjusted for clustering at state level. $^{*}p < 0.10$; $^{**}p < 0.05$; $^{***}p < 0.01$.

4 Other Plausible Reasons

This paper projects the entry of low skilled immigrants as one of the primary proponents for the fall in union rates across the U.S. It puts forward a coherent empirical analysis to back the claim. The literature has argued for other plausible reasons. In this section, I will try to analyze different conceivable channels explored in the literature as potential explanations for the falling union rates and hold these to closer empirical scrutiny.

4.1 Political Reasons- Right-to-Work Law and Anti-Union Politics

"Right-to-work" laws generally refer to laws initiated in the different U.S. States that prohibit union security agreements between employers and labour unions. This law acts as a government ban on contractual agreements between employers and union employees requiring workers to pay for the costs of union representation, Baird (1998). It has been passed in 27 U.S. states thus far and has led to earnings inequality across states, Nieswiadomy et al. (1991). A recent study by Kogan (2017) and backed by similar findings from Feigenbaum et al. (2018) points to how right-to-work laws lead to greater economic inequality by indirectly reducing the power of labour unions. A concern with the analysis so far can be that immigrants chose to locate in states where "Right-to-Work" was in place, thus, contributing to the reduction in union rates. I have two plausible reasons that go against this theory. First, right-to-work laws were adopted in different states at very different times. A lot of the states adopted it in the late 40s, and early 50s and some others like Michigan (2012), Missouri (2017), Kentucky(2017), Wisconsin(2015) and Indiana (2012) have adopted it much more recently. As shown in the long-run trends, union rates did not decline during the 1940s ad 1950s and, in fact, increased in many states during the period. Also, these periods do not line up with immigrant entry, i.e., immigrants started entering the U.S. in the mid to late 1960s after the Immigration and Nativity Act. I present a timeline of U.S. states and when they adopted right-to-work laws in table 15 in the Appendix. I re-run the correlation graphs from figure 9 but now separately for right-to-work states and states without right-to-work regulations.[30] The coefficients are significant for both; it is more significant for the states with the 'right to work' legislation.

[30] A method also employed in Mitra (2021).

Appendix, figure 23 and 24 presents the graphs. The result shows that despite controlling for 'right-to-work' regulations, immigrant entry can still explain falling union density, but political institutions surely aid the decline. .

Next, I perform a simple regression analysis to see if immigrants have settled more in states with right-to-work laws. I run the following specification:

$$\Delta(\frac{Imm}{Pop})_{Z,t} = \beta D.State_Z + \alpha X_{Z,t} + \epsilon_{Z,t} \tag{4.1}$$

The variable $\Delta(\frac{Imm}{Pop})_{Z,t}$ is the period change in immigrant population shares. The analysis spans from 1970-2000, and I choose to partition these into three time periods, 70-80s, 80-90s and 90-2000s. The main coefficient of interest being β which evaluates the significance and magnitude on the dummy if the state has right-to-work laws. $X_{Z,t}$ controls for state characteristics in state Z in decade t. Results are provided in table 6. Right-to-work adoption has not differentially affected immigrant entry.

Table 6: Estimates of 'Right-to-Work' Legislation on Immigrant Entry

	Dependant Variable: Change in Immigrant to total Population		
	(1) 1970-80	(2) 1980-90	(3) 1990-2000
Dummy for Right-to-work State	-2.75	1.56	3.45
	(7.48)	(6.60)	(22.55)
Average Income	x	x	x
Average Education	x	x	x
Average Age	x	x	x

Note: The results are obtained from the (Census, 1970-2000). Average income is the mean of all income earned in the state. Average education is the percentage of people in the state who have more than a high school diploma. Average age of the state is the mean of the age of the working population of the state. Robust $P > |t|$ values are in parentheses.

The other argument put forward is the anti-union efforts of the Reagan administration in the U.S. and the Thatcher government in the UK, Howard (1995). Although these policies effectively put pressure on the reduction of union activities, the timing of the deunionization events suggests that forces that started to push unionization down were already in play before these Reagan's presidency. Farber and Western (2001) points to how the number of union elections began to decline in the early 70s, was much ahead of the Reagan Labor Board in 1983. Unionization declined in the U.S. from the late 1960s, in the 70s and well up to the 2000s. They also claim that union membership and other activities started to fall from 1974, before which public and private union rates were similar, but private union rates fell drastically post that year.

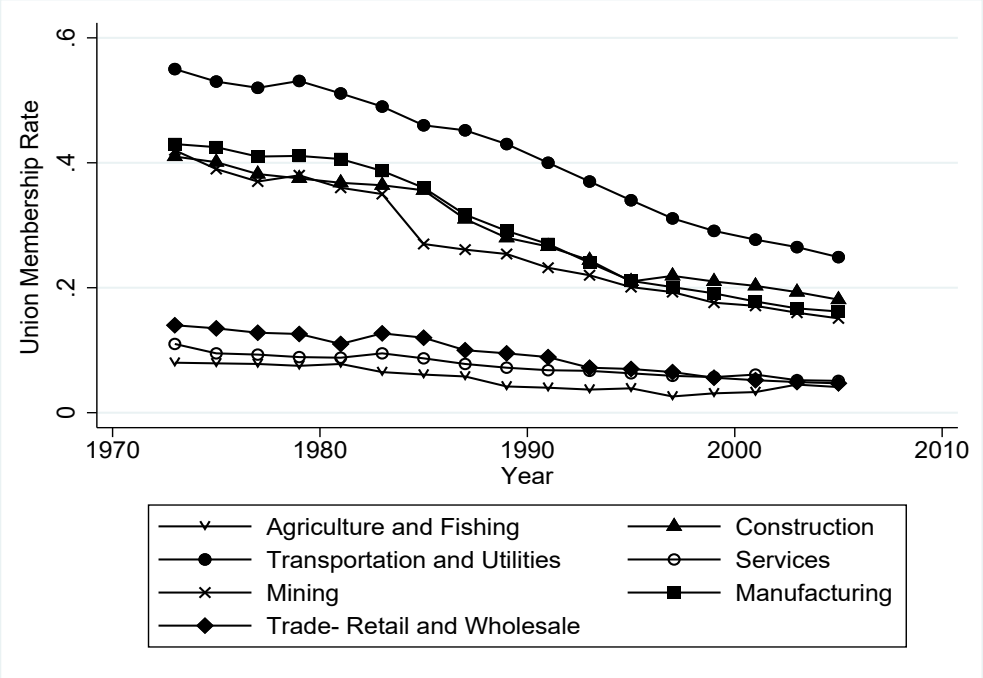
4.2 Composition of Industries

It might be that the decline in union rates is not a result of the entry of low skilled immigrants entering the workforce but of a change in the relative employment of the different

industries. Industries like services are a lot less unionized than manufacturing, and thus, as more people work in these non-unionized sectors, the overall percentage of unionized workers has decreased. This argument lends credibility because, in the U.S., employment share has shifted away from sectors where unions have been traditionally strong, like manufacturing and construction, to services. Although the output share of the services sector has increased from about 74% in 1965 to about 80% in 2005 and share in total hours worked has increased by about 20 percentage points, the fall in union rates has occurred in this sector. [31] In figure 12, I graph the unionization rates across major industries between 1973 to 2005. Union rates across all sectors have declined, and this substantial decline within each industry points to deunionization in the U.S. is solely not due to a compositional shift. Further, following Farber (1990) and Farber and Krueger (1992), I estimate the union membership rate changes within and between industries. I estimate the industry composition effect at the two-digit industry level, keeping constant the employment share at the 1978 levels and updating only the industry-wise union coverage rates.[32] This is done for between 1978 and 1999, and I find that 13.6% decline in union rates is within industries, and about 3.2% is between industries. In a similar vein, Baldwin (2003) argues that trade and the possibility of out-sourcing by specific industries have to lead to a fall in union rates. However, the decline in the unionization rate was not confined to the tradable goods sector and has been almost uniform across industries. Furthermore, as seen in the data and from union elections, the union wage premium has been stable for 40 years. Thus, any theory based on depletion of economic rents available to unions must adhere to a union strategy that trades size for more significant wage premiums.

[31] Data on service sector output and total hours share taken from KLEMS annual dataset.

[32] I map the 3-digit census coding to the 2-digit classification, as defined by the NBER. Due to the change in the census industrial classification system in 2000, I confine the compositional analysis to 1978-1999. As the rate of unionization declined by 4% after 1999, this would not alter the composition analysis much by including the period after 1999



Note: Union Membership and Coverage by Industry in the US (1973-2007) – Percent of workers. The sample consists of male, private wage, and salary workers over the age of 16 from in the CPS May supplements (1973-1981) and the monthly ORG files (1983-2007).

Figure 12: Industry wise Union Membership Rate

Next, I try to see if falling union rates across industries correlate with an immigrant entry into those industries. To check for this, I look at across 19 broad industry classifications and regress difference in union rates across sectors on the difference in the immigrant share of the labour share in those industries over time by using the specification as follows:

$$\Delta \, ln \, Union_i = \alpha + \beta \, ln \, \Delta(\frac{Immigrant}{Native})_i + \gamma X_{i,1980} + \epsilon_i \tag{4.2}$$

I present the results for 1980-1990 in Table 7 and the results for 1980-2000 are in the Appendix as Table 16. As the results show and further encourages the correlation graphs earlier, industries saw higher growth in the immigrant population and a higher fall in union rates. Although the IV argument as for the state or region level exercise is not as

valid for industries because past immigrant inflows in a specific industry may not predict future immigrant inflows, but the IV estimates also point to a similar outcome.

Table 7: Estimates of the impact of low-skilled entry on union/coverage rates-CPS (1980-1990), industry level

	Union Rates (1)	Coverage Rates (2)	IV-1970 (3)	IV-1960 (4)
(Immigrant/Native)	-0.416***	-0.425***	-0.476***	-0.531***
	(0.152)	(0.167)	(0.142)	(0.162)
Average Income	x	x	x	x
Employment Shares	x	x	x	x
R^2	0.231	0.234		
N	16	16	16	16

Note: The results are obtained from the decennial Census, 1960, 1970, 1980, 1990 and CPS (March files). Robust standard errors are in parentheses, adjusted for clustering at state level. $^{*}p < 0.10$; $^{**}p < 0.05$; $^{***}p < 0.01$.

4.3 Technology Improvements- Skill Biased Technical Change (SBTC)

Most studies that have argued for skill-biased technical change to be the driver of de-unionization in the U.S. have not presented adequate empirical evidence to back their claims. Recent work by Dinlersoz and Greenwood (2016) puts forward SBTC has the primary component behind falling union rates but mainly from a theoretical standpoint. Acemoglu et al. (2001) also provides theoretical justification behind SBTC leading to a fall in unionization. Their model predicts that skilled workers leave unions and enter the non-union sector to get a higher wage due to the introduction of skill-biased technology. I

can replicate this with my model; crucially, their analysis claims that low-skilled workers do not leave the union. Their model is silent on the firm's role behind deunionization. Thus, it contradicts data facts based on Farber (1983) and Açıkgöz and Kaymak (2014) who find unions concentrated towards the middle of the skill distribution. Also, Acemoglu et al. (2001) does not provide any empirical support behind SBTC leading to a fall in union rates. Finally, SBTC also cannot explain the lack of deunionization in countries with similar episodes of SBTC. Most countries, especially in Europe, have seen technology adoption in production but still maintain high union rates. The primary reason behind this could be that technological change is difficult to measure quantitatively. However, I test the hypothesis using recent automation data if an increase in automation take-up has changed unionization rates in different U.S. Metropolitan Statistical Area (MSAs). I proxy automation technology by relying on data from Leigh and Kraft (2018) based on the location of robot integrators, a strategy used by Acemoglu and Restrepo (2020).[33] Table 8 offers estimates for the following model

$$\Delta Union_z = \beta\ D.Integrators_z + \alpha X_{z,1990} + \epsilon_z \tag{4.3}$$

$Integrator_z$ for if an MSA has an integrator between 1990-2015. Here, z denotes an MSA with a dummy $D\Delta Union$ indicates the change in union rates between 1990 and 2015. Here robotic integrators are used only to proxy for skill-biased technical change as it is difficult to measure. Given the scope of robots and their penetration in the U.S. economy, to the extent to which it can proxy SBTC, I find no evidence pointing to a relationship between it and union rates as is seen in Table 8. Papers like Krueger (1993) and Beaudry et al. (2010) have tried to reason if the introduction to computers should proxy SBTC. In contrast, recent papers like Rubinton (2020) have reasoned for a more general definition, where the investment in Information and Communication Technologies (ICT) should be considered SBTC. It is hard to argue ultimately against SBTC not impacting union rates even remotely. Still, I am not aware of any papers trying to empirically show

[33] A map outlining the data is provided in Appendix as figure 25

the relationship between the two, which is beyond the scope of this paper.

Table 8: Estimates of the impact of location of robot integrators in the US on unionization rates, 1990-2015

	Dependant Variable: Change in union rates		
	(1)	(2)	(3)
Dummy for Robot Integrator in MSA	2.038	1.556	1.221
	(0.765)	(0.677)	(0.419)
Average Income	x	x	x
Average Education	-	x	x
Right-to-Work	-	-	x
N	161	161	161

Note: Union and other MSA level data from Census and American Community Survey, 2015. Robotic integrator data from Leigh and Kraft (2018) and Acemoglu and Restrepo (2018). $P > |t|$ values are in parentheses and have been clustered at MSA level.

Finally, considering alternative explanations to the fall in union density in the U.S., I analyze all the options together in a specification as considered in Eq.3.6 and Eq.3.8. I bring the controls from Table3 and, in addition to those, look at how right-to-work, industry composition and SBTC as measured by robotic integrators compares to when evaluated against low skilled immigrant entry. In Table 9, column (1) is the OLS result from Table 3. In Column (2), I additionally control for right-to-work states and the interaction with immigrant entry, Column (3) controls for service sector population share.[34,35]. In Column (4) and Column (5), I consider the standard IV estimates and JRS-IV estimates. Finally, in Columns (6) and (7), I bring in an SBTC variable and analyze it in the IV setting but between the years 1990-2015 as this is for when the SBTC data is available for as

[34]Removing the interaction term between right-to-work states and immigrant entry also does not change the significance of the results.

[35]Controlling instead for a share of the population in manufacturing has similar results. Interaction terms also do not change the results

discussed in the previous section. Table 10 analyzes at the MSA level between 1980-1990. Additionally, Table 17 in the Appendix looks at the same specification across states between 1980-2000. The tables below show that there is still a robust negative relationship between immigrant entry and unions after controlling for the previously mentioned variables. Columns (6) and (7) have a much smaller coefficient on the immigrant to native-born ratio term because of the period considered. The rate of decline in unions decreased post-2000s because the immigrant population that came into the U.S. post-2007 was a lot more skilled.

Table 9: Estimates of the impact of low-skilled immigrant entry on union rates, 1980-90, (States)

		Full Sample		IV-1970	JRS-IV	IV-1970 (1990-15)	JRS-IV (1990-15)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(Immigrant/Native) Ratio	-0.329***	-0.312***	-0.319**	-0.424***	-0.431***	-0.101*	-0.098**
	(0.151)	(0.113)	(0.158)	(0.124)	(0.131)	(0.050)	(0.048)
Right-to-Work	-	-0.024	-0.026	-0.05	-0.01	-0.04	-0.04
		(0.05)	(0.13)	(0.04)	(0.11)	(0.13)	(0.12)
Right-to-Work X (I/N) Ratio	-	-0.192	-0.20	-0.09	0.00	0.00	0.00
		(0.17)	(0.18)	(0.12)	(0.39)	(0.7)	(0.8)
% Services	-	-	-0.109	-0.05	-0.03	-0.02	-0.03
			(0.12)	(0.13)	(0.21)	(0.04)	(0.05)
SBTC	-	-	-	-	-	-0.19	-0.18
						(0.91)	(0.93)
R^2	0.597	0.61	0.65				
N	51	51	51	51	51	51	51

Note: The results are obtained from the decennial Census, 1970, 1980 and 1990 and ACS (2014-16). Robust standard errors are in parentheses, adjusted for clustering at state level. $^{*}p < 0.10$; $^{**}p < 0.05$; $^{***}p < 0.01$. Specification(6) and (7) does not have region dummy

Table 10: Estimates of the impact of low-skilled immigrant entry on union rates, 1980-90, (MSAs)

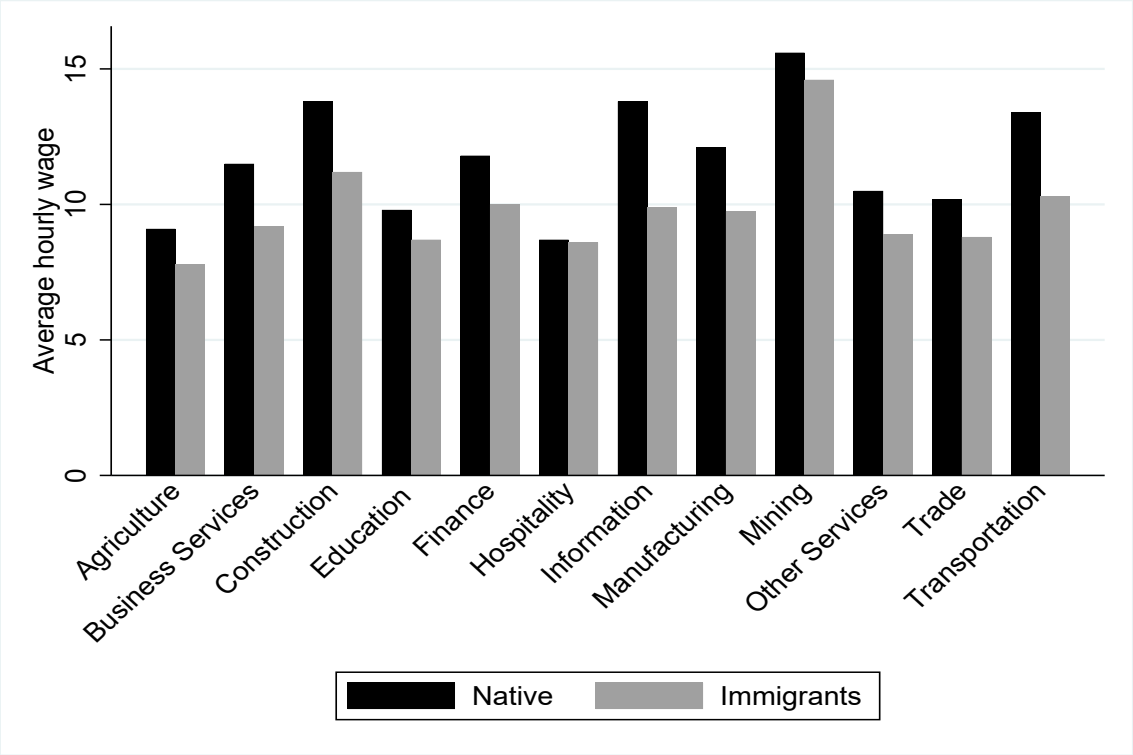
		Full Sample		IV-1970	JRS-IV	IV-1970 (1990-15)	JRS-IV (1990-15)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(Immigrant/Native) Ratio	-0.290***	-0.295***	-0.261**	-0.341***	-0.351***	-0.089**	-0.092*
	(0.141)	(0.076)	(0.13)	(0.128)	(0.132)	(0.04)	(0.046)
Right-to-Work	-	-0.013	-0.016	-0.03	-0.02	-0.15	-0.14
		(0.04)	(0.15)	(0.04)	(0.04)	(0.2)	(0.2)
Right-to-Work X (I/N) Ratio	-	-0.132	-0.120	-0.17	-0.14	-0.02	-0.01
		(0.19)	(0.11)	(0.17)	(0.19)	(0.7)	(0.8)
% Services	-	-	-0.109	-0.03	-0.04	-0.02	-0.03
			(0.12)	(0.13)	(0.22)	(0.04)	(0.05)
SBTC	-	-	-	-	-	-0.22	0.28
						(0.41)	(0.43)
R^2	0.49	0.52	0.65				
N	162	162	162	162	162	162	162

Note: The results are obtained from the decennial Census, 1970, 1980 and 1990 and ACS (2014-16). Robust standard errors are in parentheses, adjusted for clustering at MSA level. $^{*}p < 0.10$; $^{**}p < 0.05$; $^{***}p < 0.01$. Specification(6) and (7) does not have region dummy

5 Model

This section presents a model that seeks to explain the relationships between low skilled immigrant entry and deunionization. The model helps formalize the mechanism behind the data facts we see in previous sections. Also, the model is crucial to verify some of the specifications used in the empirical section and to perform calibrations to see how well the model can predict declining union rates. Before laying out the model foundations, it is essential to show two critical differences between low-skilled native-born, i.e., high school graduates or less and immigrants. Firstly, there is extensive documentation that immigrants are paid less than natives even after controlling for observables. I formalize this argument by looking at immigrants in the U.S. using the CPS data and comparing

them to low-skilled native-born. [36] I analyze the differences across industries, including only individuals between the age group of 18-65 and excluding all who are self-employed, work below 35 hours per week and are working without pay. Total wage income deflated to 1999 U.S. Dollar and divided by the number of hours worked per year, after controlling for outliers, is used to generate average hourly wage.[37] Figure 13 reports these figures; native-born earn more in all industries except for the hospitality sector, where the averages are very close.



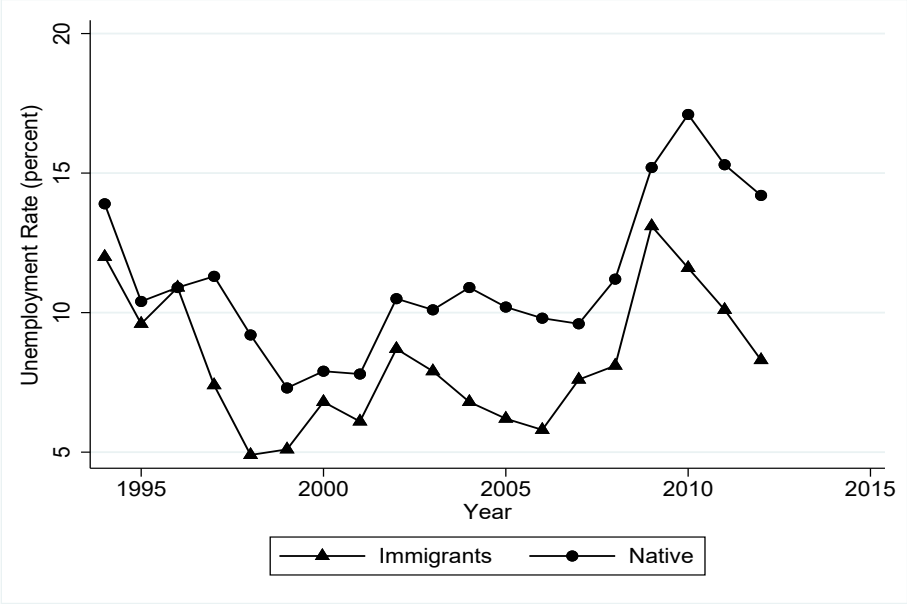
Note: Averages drawn from 1994-2007 CPS March files.

Figure 13: Hourly wage of low-skilled workers (1999 dollar)

Next, I look at unemployment rates and employment-unemployment transition rates across natives and immigrants who are low skilled. Again using CPS March Supplement

[36] In my model, I will formally classify any native who does not have a high school diploma or less as being low-skilled.

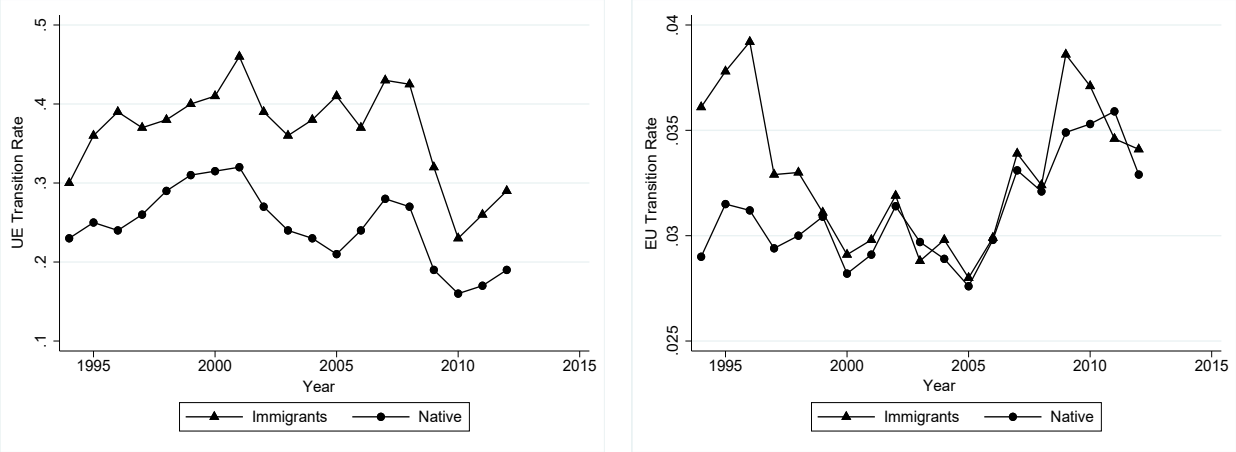
[37] drop first and 99th percentile of the distribution



Note: Constructed using CPS March data.

Figure 14: Unemployment Rates

files over time, I find that as shown in figure 14 the unemployment rates of low-skilled native-born workers is higher than that of immigrant workers. The averages are closer in the 1990s but get more expansive in the 2000s. As this difference in the unemployment rate could be due to higher job finding rates or lower job separation rates for immigrants, I analyze both these aspects to check as to see what might explain these differential unemployment rates.



Note: Yearly averages constructed using CPS basic monthly files.

Figure 15: Transition Rates

Using CPS basic monthly files, I calculate unemployment to employment (U.E.) and employment to unemployment (E.U.) transition rates for all individuals who can be linked over time, closely following Shimer (2012). The left panel of Figure 15 documents unemployment to employment transition rates between natives and immigrants, and the right panel shows employment to unemployment transition rates. In a search and matching set-up, this is synonymous with the job-finding rate and job separation rate, respectively. In all years, the job-finding rates of immigrants are higher than natives, which can account for the lower unemployment rates in figure 14 as the differences in the separation rates post 2000 do not seem to be significant. These empirical findings are important as they motivate the assumptions in the model that will follow. In summary, compared to low skilled native-born, immigrants have lower wages and higher job finding rates but similar job separation rates.

5.1 Baseline Model

The model is mainly adopted from Blanchard and Diamond (1994), Chassamboulli and Palivos (2014) and Açıkgöz and Kaymak (2014). It extends the seminal search and matching literature, introduced by Mortensen and Pissarides (1994) with the existence of low skilled immigrants and a separate union player in two different skill markets.

There is a continuum of measure one of risk-neutral, infinitely lived native workers in the economy. These workers are further divided into either high-skilled (H) or low-skilled (L). Besides native-born, there are also immigrants in the economy. The mass of native-born is normalized to unity and let I denote the mass of immigrants. Let λ of native-born be L type, and $1-\lambda$ be H type with I being immigrants who are all low skilled (L) type.[38] There is also a large measure $(n >> 1)$ of ex-ante identical and risk-neutral firms. Time is discrete and all agents have a common subjective discount factor $r \ \epsilon \ (0,1)$. There is also a representative union that is separate from the firm. The representative union has an egalitarian approach and sets a uniform wage for all workers who join the union, irrespective of type. The union does not discriminate based on the type or nativity of the worker. All workers, native-born or immigrants, besides being of a particular type also have an unobservable skill measure: efficiency given by ζ such that $\zeta \epsilon \mathbb{R}$ with distribution $g(.)$. This internal efficiency is known to workers, and the firms know this efficiency only after they match with the worker.[39] Given a skill type, the higher the efficiency of the worker, the more productive the worker. All workers draw their efficiency parameter from the same distribution. I assume, that the efficiency parameter for the highest efficiency high (H) type is above the efficiency parameter for the highest efficiency low-type worker. However, the efficiency of lowest efficiency high type workers could be below the highest efficiency low type worker.

The workers identify the market they must enter based on their observable type (H or L) and decide to join the union or not. After this, they enter the market and potentially match with a firm. The firm can potentially hire factors of production from three markets, the high-skilled, low skilled labour market and a capital market. However, a firm hires either an individual H type or L type workers and produces the respective good which can only be produced by worker of that skill, i.e. H or L. These intermediate goods and

[38] All immigrants are expressed as low-type because, being immigrants, their education or an observable skill is not as valued as that of natives. However, even immigrants have an efficiency parameter attached to them drawn from the same distribution as natives.

[39] The difference between skill type denoted as either being H or L and efficiency given by (ζ) is that skill type is an observable and verifiable measure, such as educational attainment, which workers, firms and unions can see. Whereas efficiency is observed post match like cognitive ability, punctuality or logical ability.

sold to the final good producer who combines it with Capital (K) and makes final numeraire good. The final good determines the price of the individual intermediate good. After all vacancies have been filled, the firm produces an intermediate good using either high skilled or low skilled worker with production function $f(\zeta)$, where ζ is the worker's efficiency. The function $f : \mathbb{R} \to \mathbb{R}_{++}$ is continuously differentiable, measurable with respect to μ such that, $f^{'}(\zeta) > 0$, $lim_{\zeta \to -\infty} f(\zeta) = 0$ and $lim_{\zeta \to \infty} f(\zeta) = \infty$. Thus, implying that higher efficiency workers, irrespective of type, would produce higher output. I also assume, $\int_{-\infty}^{\bar{T_L}} f(\zeta) = L$ for all L types and $\int_{\bar{T_H}}^{\infty} f(\zeta) = H$ for all H types. That is, low type workers have efficiency between $-\infty$ to $\bar{T_L}$ and high type workers have efficiency between $\bar{T_H}$ and ∞, where $\bar{T_L}$ could be greater than or equal to $\bar{T_H}$. A final output Y is produced using two intermediate inputs H and L. The final good is numeraire, and its production function is given by:

$$Y = AK^{\alpha}[\gamma H^{\sigma} + (1-\gamma)L^{\sigma}]^{\frac{1-\alpha}{\sigma}}, \quad 0 < \alpha, \ \frac{1}{2} < \gamma < 1, \ \sigma \leq 1 \tag{5.1}$$

where A and K represents efficiency parameter of the worker employed and capital stock, α and γ are parameters that govern the income shares. $\frac{1}{1-\sigma}$ is the elasticity of substitution between skilled input and unskilled input respectively. All three goods are sold in a competitive market. The prices of the two intermediate goods say p_H and p_L will equal the marginal product of the inputs, $\frac{\partial Y}{\partial i}$, $i = H, L$. There also exists a competitive capital market for firms where they can buy and sell capital. The marginal product of capital is equal to rental price $p_k = \delta + r$, which is the interest rate plus depreciation rate.

5.2 Matching Wage Bargaining union choice

The High skilled (H) and Low skilled (L) markets are simultaneously open, and workers in both markets are matched with vacant positions available in every period. Firms post vacancies in either high skilled or low skilled workers market, which can be applied for and matched by only that type of worker. Each firm posts one vacancy, and firm entry in each market is determined endogenously. Firms in the high skilled market randomly match with high type native workers. However, firms can post nativity specific vacancies in the low skilled market and perform a kind of directed search. Therefore, firms that

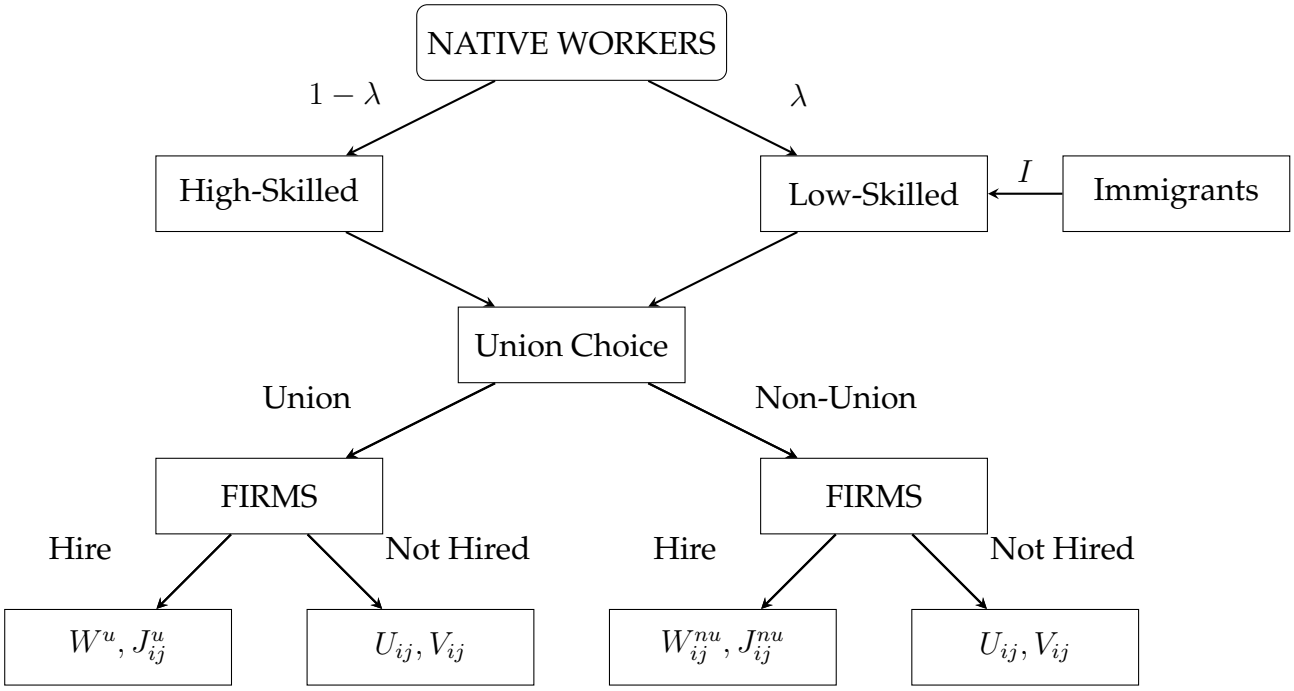
desire to hire low-skilled workers can do so from either the immigrant or native markets.

The matching function in each market is defined by $M(U_{ij}, V_{ij}) = MU_{ij}^{\epsilon} V_{ij}^{1-\epsilon}$, where M is an efficiency parameter and U_{ij} and V_{ij} denote unemployed workers and vacancies of the particular skill type i and nativity j. The flow rates of a match for a worker and for vacancy are $M(U_{ij}, V_{ij})/U_{ij} = M\theta_{ij}^{1-\epsilon} = m(\theta_{ij})$ and $M(U_{ij}, V_{ij})/V_{ij} = M\theta_{ij}^{-\epsilon} = q(\theta_{ij})$, respectively. $\theta_{ij} = \frac{V_{ij}}{U_{ij}}$ is an indicator of the tightness in labour market i and j. Finally, a vacant firm has to incur a recruitment cost, $c_i,\ i = H, L$. The assumption that firms can post nativity specific post can be rationalised from the empirical finding as discussed in figure 14 and 15 as discussed earlier in this section. This assumption allows us to rationalize the data fact that immigrants and natives who are both low skilled to have different unemployment and job finding rates.

On the worker's side, if workers are unemployed, they receive a net flow of income given by b_{ij}, which is a combination of unemployment benefits, cost of search and value of leisure. Here, I make an important reasonable assumption that $b_{iN} > b_{iI}$, since most immigrants, especially undocumented ones, have higher search costs, do not qualify for unemployment or regular benefits and do not value leisure as highly in a foreign country.[40] This is backed by the empirical finding in figure 13 where I find native-born workers earn more than foreign-born workers with similar skills across industries. Once a worker matches with a firm, they bargain over surplus from a match. The skill type of the worker and output that will result from the match are known to the firm and worker. Following the literature, I assume that wages are determined via Nash bargaining, where the relative allocation of power towards a worker is given by β. If a worker joins a union, then the union sets a uniform wage for all the workers irrespective of skill type, nativity and efficiency. Once workers have decided on their union participation; they enter the market specific to their skill and nativity. Here, firms potentially match with workers and decide whether to hire the worker or keep the vacancy unfilled. Firms, when hiring a worker, know their skill, efficiency and union status. If the worker is unionized, the firms know

[40]Drawing from empirical evidence from both survey data and Census information, paper-like Monras et al. (2018) and Albert (2021) have shown how immigrants, especially undocumented ones, are reluctant to apply for unemployment benefits. Munshi (2003) shows how immigrants, especially newly arrived ones, do not value leisure as much in a foreign country using survey data from the New Immigrant Survey

that they are to pay them the union set wage otherwise if they are not unionized, they are paid the non-union wage which depends on the worker characteristics. Production begins once a match takes place between worker and firm. Matches between firm and worker can also break exogenously at rate (s_i), following which they return to the market to search for work if they are a worker or create a vacancy if they are a firm.[41] The following flow chart can help formalize the structure of the model environment.[42]



5.3 Value functions

Having defined the model environment and layout, it is now crucial to understand the flow values of all parties involved in the market. Let W_{ij} represent the value function of an employed worker where $i = H, L$ denotes skill-type of the worker and $j = N, L$

[41] Note here that a match break-up is dependent only on skill type and not nativity as referenced to from the data finding in figure15.

[42] Here, I assume that individual bargaining weights are independent of the nativity. In other words, immigrants, and natives when bargaining individually, have similar bargaining weights. This assumption does not distort the model results as it is natural to assume that immigrants may have lower bargaining weights than natives, and that will only reduce their equilibrium weights further.

denotes nativity of the worker. For unemployed workers, let the flow value function from being unemployed be given as rU_{ij}. Similarly, J_{ij} denotes value functions of the firm who have matched to a worker, as their flow value depends not only on the skill type (i) of the worker they match with but also nativity (j) of the worker. For still vacant firms, let the value function be denoted by V_{ij}. A superscript (u) denotes if it is a union match and (nu) denotes a non-union match.

5.3.1 Workers' value functions

Now, workers can either join the union or not, depending on which the value functions change, presented below. Value function for a worker who has not joined a union is

$$\begin{aligned} rW_{ij}^{nu}(\zeta) &= w_{ij}(\zeta) + s_i[U_{ij}(\zeta) - W_{ij}^{nu}(\zeta)] \\ rU_{ij}(\zeta) &= b_{ij} + m(\theta_{ij})[M_{ij}^{w}(\zeta) - U_{ij}(\zeta)] \end{aligned} \tag{5.2}$$

where again $i = H, L$ and $j = N, I$. The value function of the employed worker denotes that if the worker gets employed they received wage $w_{ij}(\zeta)$ and in the next period with some probability they break away from the firm and receive unemployed flow value or otherwise they remain employed. An unemployed worker in the next period can possibly join the union, therefore their flow value in the next period is given by $M_{ij}^{w}(\zeta)$, where:

$$M_{ij}^{w}(\zeta) = \begin{cases} W_{ij}^{u}(\zeta) & \text{if } \textit{worker joins union} \\ W_{ij}^{nu}(\zeta) & \text{if } \textit{worker does not join union} \end{cases}$$

If workers decide to join union:

$$rW_{ij}^{u}(\zeta) = w^{u} + s_i[U_{ij}(\zeta) - W_{ij}^{u}(\zeta)] \tag{5.3}$$

5.3.2 Firms' value functions

Value functions for a firm is given as follows. Firstly, for firms who match with workers not part of the union.

$$\begin{aligned} rJ_{ij}^{nu}(\zeta) &= p_i f_i(\zeta) - w_{ij}(\zeta) + s_i[V_{ij} - J_{ij}^{nu}(\zeta)] \\ rV_{ij} &= -c_i + q(\theta_{ij})[\int M_{ij}^{f}(\zeta)d\mu - V_{ij}] \end{aligned} \tag{5.4}$$

where $i = H, L$ and $j = N, I$. As before in the case of the workers, continuation value depends on if the firm matched with a unionised worker. Therefore,

$$M_{ij}^{f}(\zeta) = \begin{cases} J_{ij}^{u}(\zeta) & \text{if } meet\ unionized\ worker \\ J_{ij}^{nu}(\zeta) & \text{if } meet\ non-unionized\ worker \end{cases}$$

If they meet unionized workers, the flow value would be as follows:

$$rJ_{ij}^{u}(\zeta) = p_i f_i(\zeta) - w^u + s_i[V_{ij}(\zeta) - J_{ij}^{u}(\zeta)] \tag{5.5}$$

5.3.3 Free entry conditions and unemployment

Free entry and exit of a firm in each market where they hire L type and H type workers implies that in equilibrium, an additional vacancy has an expected net profit equal to zero,

$$V_{ij} = 0 \tag{5.6}$$

Now, I first analyse the non-union case. Total surplus from a match is given as

$$S_{ij}(\zeta) = J_{ij}^{nu}(\zeta) + W_{ij}^{nu}(\zeta) - U_{ij}(\zeta) - V_{ij} \tag{5.7}$$

On the other hand how, total surplus is divided between workers and firm with bargaining weights β and $1-\beta$ respectively. Thus, we get

$$\begin{aligned} W_{ij}^{nu}(\zeta) - U_{ij}(\zeta) &= \beta S_{ij}(\zeta) \\ J_{ij}^{nu}(\zeta) - V_{ij} &= (1-\beta) S_{ij}(\zeta) \end{aligned} \tag{5.8}$$

Given the total mass of highly skilled and low-skilled workers $1-\lambda$ and $\lambda + I$ respectively, we can get the steady-state employment levels of each type of worker as follow:

$$H = \frac{m(\theta_H)(1-\lambda)}{s_H + m(\theta_H)} \tag{5.9}$$

$$L = \frac{m(\theta_{LN})(\lambda)}{s_L + m(\theta_{LN})} + \frac{m(\theta_{LI})(I)}{s_L + m(\theta_{LI})} \tag{5.10}$$

After calculating the steady-state level of employment, it is also possible to find out steady-state unemployment levels for each skill and nativity type.

$$U_H = \frac{s_H}{s_H + m(\theta_H)} \tag{5.11}$$

$$U_{LN} = \frac{s_L}{s_L + m(\theta_{LN})} \quad , U_{LI} = \frac{s_L}{s_L + m(\theta_{LI})} \tag{5.12}$$

5.4 Equilibrium

The equilibrium in the economy would be defined as follows:

A *steady-state equilibrium* with unions and immigrant workers consists of non-union wages $w_{ij}^{nu} \epsilon \mathbb{R}_+$, union wages $w^u \epsilon \mathbb{R}_+$ and net income when unemployed $b_{ij} \epsilon \mathbb{R}_+$ and set of values $\{M_{ij}^w, M_{ij}^f,\ p_i^*, p_k^*, H^*, L^*, K^*, u_{ij}^*, \theta_{ij}^*\}$ where $i = H, L$, $j = N, I$, so that given w_{ij}^{nu}, w^u and b_{ij}, the following conditions are met:

- $M_{ij}^w(\zeta)$ and $M_{ij}^f(\zeta)$ constitute equilibrium payoffs for each $\zeta \epsilon \mathbb{R}$.
- The goods market for both final and intermediate goods gets cleared.
- The free entry conditions and optimal vacancy posting condition are met.

- The Nash bargaining optimality condition is met for all firms and workers of all nativity and skill-type.
- Number of employed and unemployed workers of each skill and nativity remain constant.
- Non-union wages are determined by individual bargaining for each $\zeta \epsilon \mathbb{R}$ and union wage w^u is determined by solving the union maximizing total membership given non-union wage.

5.5 Analysis of the baseline model- Non-union sector

The first step of the analysis would be to find the surplus values and the wages offered by the firms to the workers in the non-union sector. Using Eq. 5.3, 5.4 and 5.6, we get:

$$S_{ij}(\zeta) = \frac{1}{1-\beta}\frac{p_i f_i(\zeta) - w_{ij}(\zeta)}{r + s_i} \tag{5.13}$$

Now, substituting the above equation into the flow value for the workers and using the split of surplus-value result, we get

$$w_{ij}(\zeta) = \beta p_i f_i(\zeta) + (1-\beta) r U_{ij}(\zeta) \tag{5.14}$$

This is an intuitive result showing that the wage rate should be a convex combination of the value of production $p_i f_i(\zeta)$ and worker's reservation wage rate, $rU_{ij}(\zeta)$. Now substituting out U_{ij} from the system in 5.14, using 5.2, we get

$$w_{ij}(\zeta) = b_{ij} + (p_i f_i(\zeta) - b_{ij})\frac{\beta(r + s_i + m(\theta_{ij}))}{r + s_i + \beta m(\theta_{ij})} \tag{5.15}$$

As the equation shows, a worker's wage would depend positively on the unemployment benefits they get (part of b_{ij}), productivity term captured by $(p_i f_i(\zeta))$ and market tightness, θ_{ij}. This makes intuitive sense because the more productive the worker, the higher return they get from working. An increase in the opportunity cost of working increases their reservation wage and hence negotiated wage. Finally, as we call $\theta_i = \frac{V_i}{U_i}$ so an increase in θ_i would imply an increase in the probability of getting a job, which again

increases negotiated wage. Also, the higher the surplus the worker negotiates for β, the higher their wage. Now to get equilibrium values we use the above equation and match it to the value of p_i we get from the production function. So, differentiating 5.1 we express the prices of the intermediate goods as:

$$p_H = (1-\alpha)\gamma A^{\frac{1}{1-\alpha}}(\frac{\alpha}{r+\delta})^{\frac{\alpha}{1-\alpha}}[\gamma + (1-\gamma)(\frac{L^*}{H^*})^{\sigma}]^{\frac{1-\sigma}{\sigma}} \tag{5.16}$$

Similarly,

$$p_L = (1-\alpha)(1-\gamma)A^{\frac{1}{1-\alpha}}(\frac{\alpha}{r+\delta})^{\frac{\alpha}{1-\alpha}}[\gamma(\frac{L^*}{H^*})^{-\sigma} + (1-\gamma)]^{\frac{1-\sigma}{\sigma}} \tag{5.17}$$

The two equations imply diminishing marginal products and complementarity between two different inputs. This is because, $\frac{\delta p_i}{\delta i} < 0$ and $\frac{\delta p_i}{\delta j} > 0$. Finally from equation 5.9 and 5.10 we can see that $\frac{\delta_i}{\delta \theta_i} > 0$.

5.6 Option to hire

Crucially, since immigrants are low skilled workers, they always have lower reservation wage than low-skilled native-born, it would mean that their wage would also be lower. Thus, it can mean that all firms can extract a higher surplus after matching with immigrants and, therefore, post vacancies only in the immigrant market when hiring a low-skilled worker. However, this would not be true as the firms may choose to post only immigrant specific vacancies, but then they would not always be able to match with them as the tightness increases, and it becomes less likely for each firm to match as v increases, so they still have an incentive to post vacancies in the low skilled native-born market as well.

Next, to formalize, I consider from 5.4, $J_{ij}^{nu} > V_{ij} = 0$ since firms in a non-union match retain a positive share of the total surplus. At equilibrium, a filled non-union position is always strictly preferred to keeping a vacancy for another period. Therefore, for a firm, a non-union match would always result in hiring. Therefore, they would 'not hire' a non-unionized worker. Next, considering workers, from 5.2, we know $W_{ij}^{nu} > U_{ij}$ as wages in the non-union sector as given by 5.15 shows that $w_{ij}^{nu}(\zeta) > b_{ij}$ which would be true for all

ζ. Therefore, all non-union workers would prefer being employed than not. Therefore, all non-union matches in either marker irrespective of skill and nativity would result in a match.

5.7 Union Membership and Wage Determination

To solve the entirety of the model, I first determine how to calculate union membership and union wage. The model is solved by backward induction, such that unions take the market (non-union) wage as given and then decide union wage to maximize union membership. Having determined the equilibrium conditions in the non-union sector, I now try and determine the union wage rate and compare it to the non-union sector. I do this by first calculating union membership based on the non-union market wage. I use the following result:

Result 1: Given a union wage $w^u > 0$, there exists, $\overline{\zeta}$ such that a high type worker would only be a union member if $\zeta_H < \overline{\zeta}$ and there also exists, $\underline{\zeta}$ such that a low skill type would only be a union member if $\zeta_L > \underline{\zeta}$.

Assumption: The assumption here is that the lowest efficiency threshold for the high skilled workers to join the union is below the highest efficiency threshold for the low-skilled worker to join the union. These two thresholds are below the highest efficiency high-skilled workers joining the union and above the lowest efficiency low-skilled worker joining the union. Therefore, these are not binding. Hence, we need to concentrate only on the highest efficiency high-skilled workers joining the union and lowest efficiency low-skilled workers joining the union. Below I prove Result 1:

- From the non-union sector we know that $J_{ij}^{nu}(\zeta) > V$ and $W_{ij}^{nu}(\zeta) > U(\zeta)$ as established in 5.6. Given these two conditions it is possible to figure out the payoff functions for the workers who are contemplating joining the union.
- For workers irrespective of type and nativity, $M^w(\zeta)$ will be equal to $W^{nu}(\zeta)$ and similarly for firms, $M^f(\zeta)$ will be equal to $J^{nu}(\zeta)$ if $W^{nu}(\zeta) > W^u(\zeta)$ or if $J^u(\zeta) <$

$V = 0$. That is if the firm gets negative return from a worker of efficiency ζ, who is unionized, they would never hire them, which sets the binding constraint.

- Similarly, irrespective of type and nativity, $M^w(\zeta)$ will be equal to $W^u(\zeta)$ and $M^f(\zeta)$ will be equal to $J^u(\zeta)$ if and only if $W^u(\zeta) > W^{nu}(\zeta)$ and $J^u(\zeta) \geq V = 0$. Workers must decide to join the union given their efficiency, and the firm should be earning non-negative profits once they hire them.

- Therefore, we get two equilibrium values of efficiency to get our threshold cutoffs to determine union participation. The two conditions are: $J^u_{ij}(\underline{\zeta}) = V = 0$ and $W^u_{ij}(\overline{\zeta}) = W^n_{ij}(\overline{\zeta})$.

- Now, given that $w^u > 0$ and $f_i'(\zeta) > 0$ and $lim_{\zeta \to -\infty} f_i(\zeta) = 0$ and $lim_{\zeta \to \infty} f_i(\zeta) = \infty$. Equation 5.5 would imply that, $J^{nu}_{ij}(\underline{\zeta}) = 0$ if and only if $w^{nu}_{ij}(\underline{\zeta_L}) = w^u$, which gives us the lower cutoff threshold, $\underline{\zeta}$.

- Similarly, from Eq. 5.2, 5.4 and 5.15, we have $W^u_{ij}(\overline{\zeta}) = W^{nu}_{ij}(\overline{\zeta})$ if and only if $w^u_{ij} = w^{nu}_{ij}(\overline{\zeta})$. This is because from Eq.5.15, 5.16 and 5.17 again, $w^{nu}_{ij}(\zeta)' > 0$ and $lim_{\zeta \to -\infty} w^{nu}_{ij}(\zeta) = 0$ and $lim_{\zeta \to \infty} w^{nu}_{ij}(\zeta) = \infty$. This could gives us the higher cutoff threshold, $\overline{\zeta}$.

- Therefore, we get two unique thresholds of efficiency at which a worker decides to join the union, and the firm decides to hire a union worker. The worker decides the upper efficiency $\overline{\zeta}$, and the firm profit condition and free-entry decides $\underline{\zeta}$.

So, as the non-union wage increases with efficiency, workers of higher productivity would choose not to join the union as their efforts are better rewarded elsewhere. Therefore, the gains from joining the union are not worth the loss of extra wages. As a result, these workers would prefer not to join the union. Similarly, workers of lower efficiency would not be hired by the firm because their productivity does not allow the firm to make non-negative profits as they have to pay them a higher union wage. For these low-efficiency workers, it is better to work than to go unemployed. As all non-union matches lead to hiring, they prefer to bargain individually and not join the union. Hence, both workers and firms have an incentive in deciding the correct efficiency distribution

of workers who join the union.

After determining the non-union wages, profit conditions and efficiency threshold for union membership, it is now time to solve the union problem and determine union wage. Unions, as stated before, have two major concerns: equality of pay for all their workers and maximizing total union membership. The union takes the non-union sector wage and thus the formation of the two thresholds in efficiency for membership as given. Therefore, the union knows that for any wage it sets, there would be two workers, one with the highest efficiency and one with the lowest efficiency, who are indifferent between joining the union or non-union sector. Therefore, the objective function for the union is to maximize total union membership given the two wage thresholds. The tension in the maximizing exercise for the union comes from the fact that if the unions set too low a wage, that would lower the $\underline{\zeta}$ threshold, but then high-skilled workers would choose to leave the union. On the other hand, setting too high a wage would mean high skilled workers would join the union, but low-skilled workers would leave the union as firms would not hire them. Therefore, the maximizing problem of the union can be expressed as follows:

$$Max \quad \int_{\underline{\zeta_L}}^{\overline{\zeta_H}} g(\zeta)\, d\zeta \quad w.r.t \;\; w^u \tag{5.18}$$

where, $G(\zeta)$ is the probability density function of workers over the efficincy parameter, ζ. Also here, $\underline{\zeta_L}$ is determined by solving, $p_L f(\underline{\zeta_L}) = w^u$. And $\overline{\zeta_H}$ is determined from, $w_{ij}^{nu}(\overline{\zeta_H}) = w^u$. Solving the two equations gives:

$$\underline{\zeta_L} = f^{-1}(\frac{w^u}{p_L}) \tag{5.19}$$

$$\overline{\zeta_H} = f^{-1}(\frac{w^u + b_H(1 - \frac{\beta(r+s_i+m(\theta_H))}{r+s_i+\beta m(\theta_H)})}{p_H \frac{\beta(r+s_i+m(\theta_H))}{r+s_i+\beta m(\theta_H)}}) \tag{5.20}$$

It is hard to obtain a closed-form expression for union wage from Eq.(5.18). Especially so if no functional forms are assumed for distribution of workers over efficiency $g(\zeta)$ and the production function given efficiency $f(\zeta)$. I first assume that workers are normally

distributed over efficiency, ζ. The unions want to maximize total membership by selecting union wage, w^u. Assuming, efficiency is distributed normally over the workers with mean T and standard deviation, σ. Union wage can be obtained by solving the following equation:

$$\frac{1}{\sigma\sqrt{2\pi}}e^{-1/2(\frac{\overline{\zeta_H}-T}{\sigma})^2}\frac{\partial\overline{\zeta_H}}{\partial w^u}-\frac{1}{\sigma\sqrt{2\pi}}e^{-1/2(\frac{\underline{\zeta_L}-T}{\sigma})^2}\frac{\partial\underline{\zeta_L}}{\partial w^u}=0 \tag{5.21}$$

I further use the values for $\underline{\zeta_L}$ and $\overline{\zeta_H}$ from Eq. (5.19) and (5.20) and assumed $f(\zeta)$ is a log function. I can further reduce solve the get the following expression for w^u.

$$w^u=\frac{1}{2\sigma^2}[(e^{\frac{w^u}{p_H\frac{\beta(r+s_i+m(\theta_H))}{r+s_i+\beta m(\theta_H)}}}-T)^2-(e^{\frac{w^u}{p_L}}-T)^2][\frac{p_H\frac{\beta(r+s_i+m(\theta_H))}{r+s_i+\beta m(\theta_H)}p_L}{p_L-p_H\frac{\beta(r+s_i+m(\theta_H))}{r+s_i+\beta m(\theta_H)}}] \tag{5.22}$$

Although, it is difficult to get a closed form solution for the the union wage, is can be seen that it is a function of both p_H and p_L. Therefore, a rise or fall in either is reflected in w^u, unlike the non-union sector case. [43]

5.8 Effect of Immigration

Having set up and solved the model, we come to the main matter at hand: to analyze the effect of an increase in immigration and how that affects equilibrium values. Essentially, a change in immigrant workers can be decomposed into two channels:

- An impact through prices of the intermediate good $p_i(\zeta)$, where it follows that a change in I would effect L and through that to $p_H(\zeta)$ and $p_L(\zeta)$.
- An impact through the expected employment cost and hence the price, where because I affects θ_{ij}, it impacts the expected cost of hiring the worker.

Now, given the model, I analyze the most general case where the high skill and low skill goods are imperfect substitutes, given by $\sigma < 1$ and we assume as before that $b_{LN} >$

[43] Açıkgöz and Kaymak (2014) uses a higher bargaining weight for unions to argue for something similar. Equivalently this can also be thought of as the unions giving all its members a higher share of the total surplus.

b_{LI}, which means natives have higher income or lower search costs while unemployed than immigrants. Here, an increase in I impacts both $p_H(\zeta)$ and $p_L(\zeta)$ and also C_{LN}.

5.8.1 When immigrants do not join union

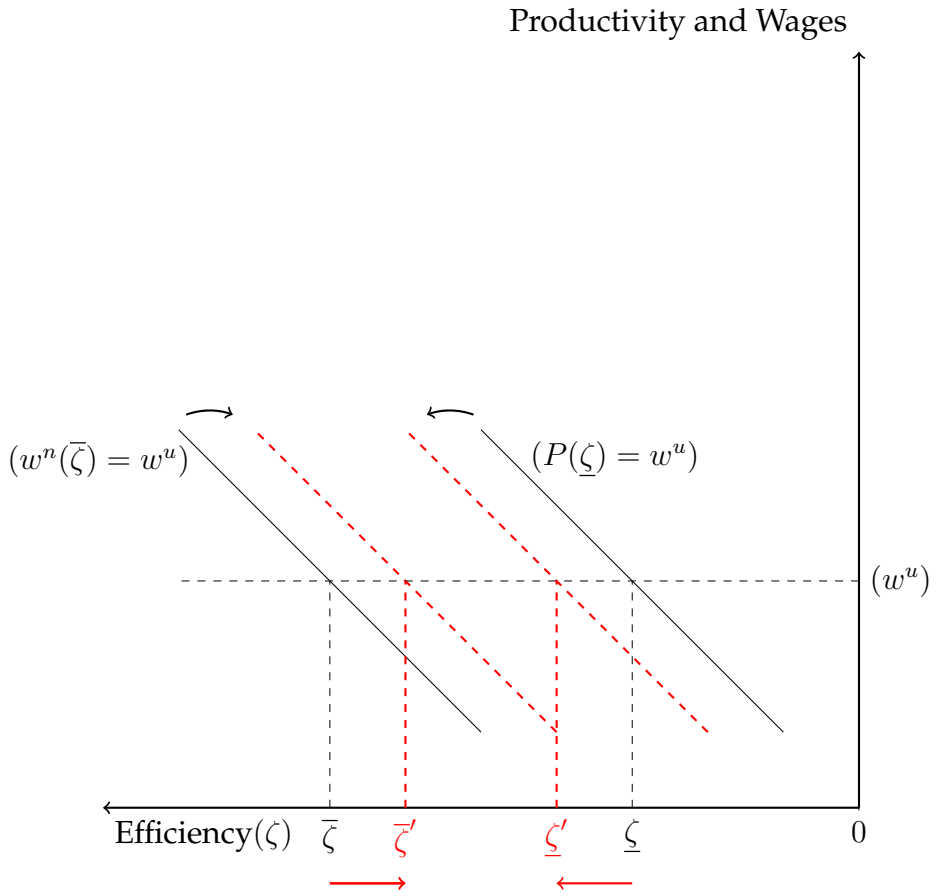
Let us assume that immigrants are not allowed to join the union as the first case of analysis. Here, the impact of an increase in I is on the prices of intermediate output and the cost of hiring native workers alone. Following an increase in I, it leads to an increase in L from Eq.5.10, resulting in an increase in p_H as shown in Eq.(5.16). This in turn increases their wage in the non union sector w_H^{nu} from Eq.(5.15). While the change in C_H is not altered. Therefore, high skilled workers get higher non-union wages given efficiency once immigrants enter the labour market. This is because markets reflect the changes in productivities exactly as is the case when bargaining individually. In a union, since both high and low skilled workers and workers are paid the same, productivity changes are not reflected fully. Now, for low skilled native workers, an increase in I leads to an increase in L and therefore a fall in p_L through 5.17. As low skilled markets for immigrants and natives are separate, an increase in I leads to lower tightness in the native low skilled market as θ_{LN} goes down; this leads to a fall in $m(\theta_{LN})$ as firm post more vacancies in the immigrant market because $b_{lN} > b_{LI}$. This increases u_{LN} and from Eq.(5.15) we know w_{LN}^{nu} falls.

Now, after immigrants enter the market such that I goes up, unambiguously we see that high skilled workers get higher non-union wage and low skilled workers get lower non-union wage given efficiency, as p_H is higher and p_L is lower. Therefore, the wage curve in the non-union sector for high skilled workers shifts out, and the wage curve in the non-union sector for low skilled workers shifts inwards. Thus, the highest productivity high skilled workers would choose to leave the union and prefer to join the non-union sector and hence move $\overline{\zeta}$ inwards because they are better compensated in the non-union sector and do not consider sharing wage worthwhile for their efficiency level. Similarly, low skilled workers would choose to leave the union and hence move the $\underline{\zeta}$ inwards because the firm would not hire them once they join the union and charge a union wage with their now lower productivities. Therefore, a simultaneous fall in $\overline{\zeta}$ and rise in $\underline{\zeta}$ would lead to a shrinking of the workers covered by the unions and effectively reduce its size.

5.8.2 When immigrants do join union

The previous analysis follows that immigrants reduce the size of the union by making high efficiency high-skilled and low-efficiency low-skilled workers leave the union. The effect explained above is generated by just immigrants entering the economy. Now, once immigrants enter unions, they increase the size of workers in the union with lower efficiency, which increases the tail of the efficiency distribution of the workers in the union. Given that the union is maximizing workers' total membership, as more workers are earning lower market wages and must be hired when joining the union, unions are forced to reduce the union wage size to accommodate the workers.This is especially more so as we might recall, that $b_{LN} > b_{LI}$, which will imply $w_{LN}(\zeta) > w_{LI}(\zeta)$. A fall in w^u leads to the reduction in the efficiency amount required to equate the wages; therefore, we have more highly skilled workers leaving the unions once immigrants join the union to allow for the lowered union wage. Alternatively, high skilled native-born workers or low skilled native-born workers must leave the union if union wage is to be kept constant. Thus, immigrant workers joining the union compounds the reduction in union coverage of native workers. Thus equivalently, we can think of $[\underline{\zeta}, \overline{\zeta}]$ shrinking even more from the case when immigrants do not join the union and thus reducing the total population covered by unions. A useful diagram to illustrate the model findings and the comparative static exercise outlined in the model is as below.[44]

[44]In the Appendix, the model has been extended to consider the case where there is the same market for immigrant and low skilled native workers. In this case, as in the model presented above, high skilled workers see an increase in wage rate but the wage change in low skilled workers is ambiguous. This extended model is calibrated, and the results show that between 1980 and 2000, low skilled native workers saw a decrease in wages and employment on the entry of immigrants.

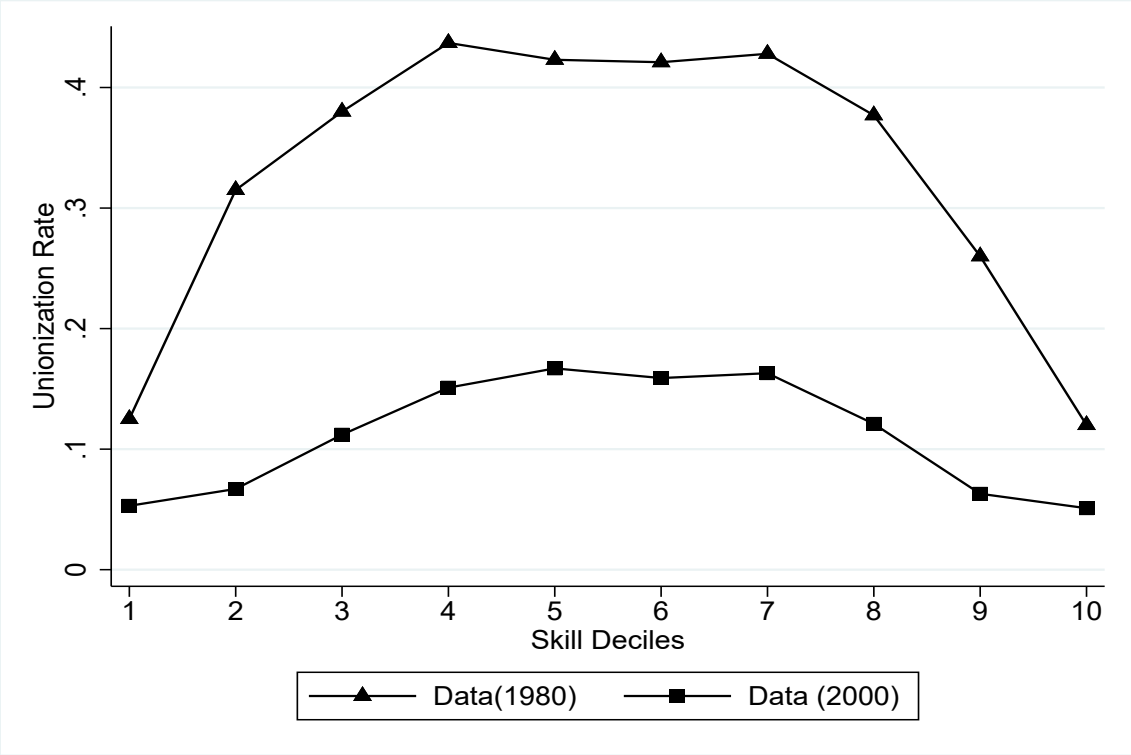


6 Testing the Model Predictions

As described in the previous section, the model is intuitive and straightforward and thus can be utilized to get a qualitative understanding of how low skilled immigrant entry can lead to a fall in union density. Besides allowing for qualitative exploration, the model also makes some valuable predictions that can be tested in the data. Besides being novel in their own right, these predictions also allow us to be more confident of the model, and the causal mechanism explained in the section. In the section below, I list these predictions and carry out simple regression-based explorations:

- Firstly, the model predicts that efficiency and union membership is inversely proportional to the high skilled sector and directly proportional to the low skilled sector.

In other words, the model predicts an inverted 'U' shape between skills and unionization rates. Higher efficiency high skilled workers do not join the union as they are more productive once immigrants enter the economy, and lower efficiency low skilled workers are not profitable for the firm once they enter the union. So on average, it is more likely that we find higher efficiency, low skilled and lower efficiency high skilled workers join the union. This matches the predictions of other papers looking at unionization like, Abowd and Farber (1982), Farber (1983) and Açıkgöz and Kaymak (2014), although their definitions of efficiency and skills differ from mine. This is further confirmed in the data as shown in figure 16 below, where I show an inverted 'U' shape pattern between skill deciles and unionization rate.



Note: Unionization rates in 1980 and 2000. Data Source: Based on calculations from the CPS. Each Skill decile represents education and experience cell.

Figure 16: Unionization Rate Across Skills (1980-2000)

The model also predicts that unionization reduces faster towards the two tails of the skill distribution of union rates but testing that is difficult for two reasons. Firstly, due to the economy's evolution, the skill distribution of workers across different deciles has changed, especially so between 1980 and 2000. This leads to data shortages where we cannot follow the same person over 20 years and observe their union choice as their skills change. Secondly, the entry of low skilled immigrants is not the only reason for falling union rates. Other reasons exist and have played an important part, and thus these reasons together have shaped the union rate across skill deciles patterns.

- Secondly, as immigrants enter the labour market, the wage in the non-union sector of the high skilled worker's increases and the wage in the non-union sector of the low skilled worker's decreases. Also, more highly skilled and low skilled native workers join the non-union sector in equilibrium as they prefer to leave the union. Therefore, we should see a higher rise in wage inequality in the non-union sector where immigrants enter the labour market. However, it is the relatively lower efficiency high-skilled workers and higher efficiency low-skilled workers joining the non-union sector; therefore, I check to see the overall impact on non-union wages.

To check if this prediction of the model works, I use a reduced form regression where I regress the change in wage rates between high and low skilled workers in the non-union sector on the immigrant to native-born ratio changes in the same region.[45] The specification and the further controls used is similar to the one used in the previous empirical section of this paper for ease of comparisons. The results are provided below in table 11. As the results show, I find a significant negative relationship between the wage gap between high and low skilled non-union workers and the entry of low skilled immigrants. Given the log-log nature of the specification considered, I find a 0.19% fall in wage gap among non-union workers after a 1% increase in immigrant to the native-born ratio in the MSA. This result, in general, is significant because the literature has found scare evidence of entry of immigrants leading to an increase in skill wage gap among natives,

[45] I use as the measure of wages the real weekly wages for full-year, full-time workers, constructed by dividing annual earnings by weeks worked and then deflating using a GDP deflator. Full-time workers are individuals who usually work 35 or more hours per week and work at least 40 weeks in a year. As suggested and adopted in the literature, I chose to work with weekly wages due to a reduced chance of measurement errors.

Card (2009).[46]

Table 11: Estimates of the impact of low-skilled immigrant entry on wage gap betweem high and low skilled workers, 1980-2000 (MSAs)

Dependent Variable:			Full Sample		IV-1970	JRS-IV
Δ Wage (H-L) Non-union	(1)	(2)	(3)	(4)	(5)	(6)
(Immigrant/Native) Ratio	0.097***	0.102***	0.107**	0.135**	0.191***	0.211***
	(0.03)	(0.04)	(0.05)	(0.06)	(0.03)	(0.04)
Region Dummy	x	x	x	x	x	x
Log Population	-	x	x	x	x	x
Average Income	-	-	x	x	x	x
Average Education	-	-	-	x	x	x
R^2	0.25	0.26	0.27	0.28		
N	162	162	162	162	162	162

Note: The results are obtained from March CPS (1994-2004) and Census 1960, 1970, 1980, 1990 and 2000. Robust standard errors are in paranthesis, adjusted for clustering at MSA level. $^{*}p < 0.10$; $^{**}p < 0.05$; $^{***}p < 0.01$.

- Finally, as we saw in the model, immigrants entering unions amplifies the effect of natives leaving the unions. This is to compensate for the now lower union wage. Therefore, we can test the geographical impact of more immigrant workers joining the union on union wages. The model predicts a fall in union wages where more immigrants join the union.

To check if this prediction of the model works, I again use a reduced form regression where I regress the union wages on the immigrant to the native-born ratio in unions across states.[47] The results are discussed below in table 12. I find a substantial reduction in union wages in regions with a higher percentage of immigrant workers in a union. The

[46] Although alternate specifications at time series level, Borjas (2003) and IV specifications, Jaeger et al. (2018) and Gould (2019).

[47] As with the previous section, I again use a GDP deflator, and real wages are calculated using CPI index from The Bureau of Labor Statistics for the appropriate states and years from (https://www.bls.gov/cpi/)

IV estimates point to a 0.24% fall in union density when the immigrant to native-born ratio increases by 1%.

Table 12: Estimates of the impact of low-skilled immigrant entry on union wages, 1994-2006 (States)

Dependent Variable:			Full Sample		IV-1970	JRS-IV
Δ Mean Union Wage	(1)	(2)	(3)	(4)	(5)	(6)
(Immigrant/Native) Unions	-0.127***	-0.116***	-0.163***	-0.225**	-0.228**	-0.241**
	(0.03)	(0.04)	(0.04)	(0.095)	(0.09)	(0.10)
Region Dummy	x	x	x	x	x	x
Log Population	-	x	x	x	x	x
Average Income	-	-	x	x	x	x
Average Education	-	-	-	x	x	x
R^2	0.18	0.19	0.23	0.24		
N	51	51	51	51	51	51

Note: The results are obtained from CPS (1994-2004) and Census 1960, 1970. Robust standard errors are in paranthesis, adjusted for clustering at state level. $^{*}p < 0.10;\ ^{**}p < 0.05;\ ^{***}p < 0.01$.

So, in summary, this section finds that the model predictions considered hold when evaluated in the data. There is a robust inverted 'U' shaped relationship between skills and union rates, which has been pointed to before in the literature and predicted in this paper. Secondly, this paper finds that an increase in the entry of low skilled immigrants in a region leads to a rise in wage inequality among skilled and unskilled workers in the non-union sector. It also verifies that the entry of low skilled immigrants leads to a reduction in average union wages. After confirming these predictions in the data, the following sections undertake a calibration exercise where the model presented in section 6 is analyzed quantitatively and then used to predict if and how much of the fall in union rate can be explained using the model and the mechanism considered.

7 Union Calibrations

This section calibrates the model discussed in section 6 and tries to see if the model can predict the fall in union rates as observed in the data. To begin the calibration exercise and simplify things, I assume an explicit form for the production parameters and justify the basic arguments for the exercise. Then I use a combination of reduced-form estimates and parameter targetting to generate the changes after accounting for the entry of low skilled immigrants in the U.S. economy and check to see how that impacts union rates.[48] The calibration exercise draws heavily from the works of Açıkgöz and Kaymak (2014), Taschereau-Dumouchel (2020) and Borjas (2003).

I firstly start by assuming a simpler linear structure for individual level of output given by $f(s,\zeta) = exp[\Psi(s+\zeta)]$ where s is used to denote the skill of the worker and ζ the efficiency as previously established in the model. Variable ζ is assumed to be normally distributed with mean μ_ζ and variance σ^2_ζ. Given the wage equation in Eq. 5.15 and using $b_{ij} = \rho w_{ij}$, I assume a log wage function in non-union sector as $log\, w^{nu}(s,\zeta) = logB(\beta) + \Psi(s+\zeta)$.[49] The union wage as established in the model section, from Eq.(5.18) does not have an explicit form solution. However, given the context in the model and drawing from the empirical literature, that union wages have low variance and are far more homogenous across skills, I propose that an explicit form of the union wage would not take into account ζ as in the model and therefore can be written as $log\, w^u = log\, \phi_0 + \phi_1 \Psi s$, where let $\phi_1 \epsilon (0,1)$ denote the relative price of skill in the union sector and ϕ_0 would be obtained as the constant term of the wage equation. I assume the higher wage the unions pay to their members is by taking a higher share of the total product, and thus that would be captured in this constant term.[50] Now, given the wage function and union wage policy characterized by (ϕ_0, ϕ_1), workers would select into the union sector only if their skill level is concentrated towards the middle. For a given level of s, ζ_L which is the lowest level of efficiency which allows for union membership, can be obtained by

[48] Essentially, this would be an indirect inference approach which shall be explained in more detail later.

[49] Here B is obtained from the wage equation as is given by $\frac{\rho B'}{1-\rho+\rho B'}$ where B' can be written as $\frac{\beta(r+s_i+m(\theta_{ij}))}{r+s_i+\beta m(\theta_{ij})}$

[50] The assumption on how union wage varies with skill is considered to be log-linear and has been used before in previous papers dealing with unions and is essentially empirically motivated.

equating the firm's profit to zero and similarly for ζ_H is determined by equating union and non-union wage at that level of efficiency.[51] Now, given the wage forms assumed in this section and the way the threshold efficiency thresholds are determined in the model, I can get similar thresholds to determine union membership using the following condition:

$$log\phi_0 \leq \Psi(1-\phi_1)s + \Psi\zeta \leq log\phi_0 - logB(\beta) \tag{7.1}$$

The predictions of whether a worker would be unionized are based on solving the above equation and normalizing the total workers in a skill decile to get percentage unionized. The model is calibrated to reproduce the labour market conditions in 1980 and then used to predict the unionization rates in 2000. The parameters from search and matching are mainly derived from the literature, as discussed in the previous section. After estimating the skill prices in the union versus non-union sector, I used them as calibration targets for the remaining parameters. I used a method from Borjas (2003) to generate changes in prices of skills and use that to predict new union rates and see if that can explain the union rate changes between the years considered.

7.1 Estimation of Calibration Targets

The productivity distribution and skill index are identified in two steps. Firstly assuming union status is random, skill prices are estimated assuming this, which leads to biased estimated when union status is, in fact, endogenous. Second, using the selection implied by the model then helps us identify the true underlying parameters, which is essentially an indirect inference approach. I have two sectors denoted as non-union (nu) and union (u) sector. For both, I use the wages data from the merged outgoing rotation groups of the Current Population Survey (CPS). For each non-union worker, I use the log of monthly wages (non-union) and regress that on a set of observable and other indicator variables for control as explained in Eq.7.2 below.

$$log\, w_{nuit} = X_{1it}\Gamma_{nut} + X_{2it}\psi_{nut} + e_{nuit} \tag{7.2}$$

[51] More formally, union membership can be accounted for by the equation, $log\phi_0 \leq \Psi(1-\phi_1)s + \Psi\zeta \leq log\phi_0 - logB(\beta)$.

Here, X_1 contains variables that reflect skill characteristics for the worker: education and experience and X_2 includes non-skill related controls. The skill composite is obtained by using the above equation at the initial time(t) and calculating a prediction for skill prices, given as:[52]

$$\hat{s}_{it} = X_{1it}\hat{\Gamma}_{nut} \tag{7.3}$$

This skill prediction is obtained for all workers, including those in the union sector. The price of skill in 1980 given as $\Psi_{t=1980}$ can be normalised to 1 which allows us to identify $\sigma_{s,1980}$ by the standard deviation of $\hat{s}_{i,1980}$.[53] The next step would be to calculate the compression in wages paid to skills in the union sector. This is done by projecting the actual wages of only union workers on their predicted skills and other controls as obtained above from Eq.7.3. This is done using the regression equation below:

$$logw_{uit} = \Phi_t \hat{s}_{it} + X_{2it}\psi_{ut} + e_{uit} \tag{7.4}$$

The coefficient Φ measures the degree of wage compression in the model. Among high skill workers, those with low efficiency join the union, whereas, among low skill workers, those with high efficiency join the union. As a result, the skill price is overestimated in the non-union sector and underestimated in the union sector when selection is ignored. Therefore, estimation using Eq.7.2 and 7.3 leads to exaggeration of wage compression by union and overestimation of skills which has to be corrected for selection using the model.

7.2 Selection in Union Participation

Three parameters: union and individual share of total product and dispersion of efficiency σ_ζ cannot be estimated directly, and the model's prediction are used to identify these and to correct the bias in the estimates in Eq.7.2 and Eq.7.3. The aim was to generate union participation by skills in the benchmark case in 1980. Given the value of σ_s, the value of σ_ζ determines the curvature of the unionization profile. Therefore, the curvature

[52]The initial period is 1980, but I use data from 1979-1981 to construct the average values for 1980. This is done to avoid small sample issues.

[53]The standard deviation of $\hat{s}_{i,t}$ will be the estimate of $\Psi_t\sigma_{s,t}$.

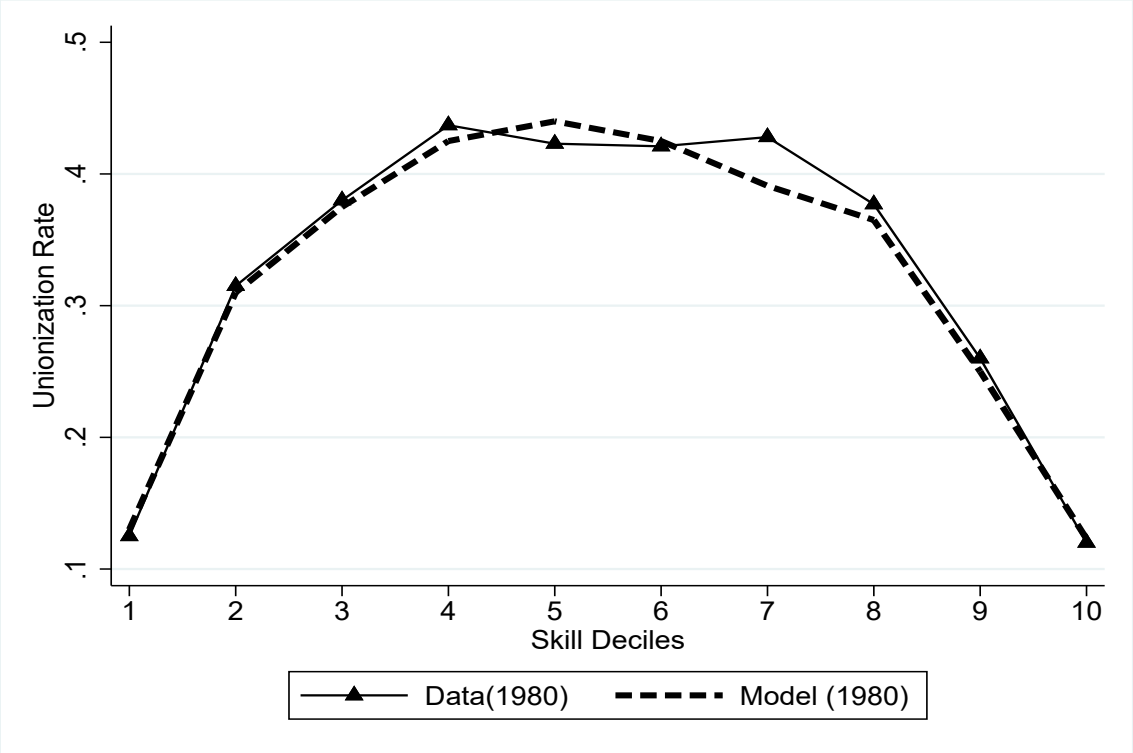
of the slope gives a unique value of σ_ζ. Using a Generalized Method of Moments (GMM) approach, I simultaneously get the values for total income shares β_u and β, the relative price of skill in union sector ϕ_1, the standard deviations of skill and efficiency σ_s and σ_ζ to match the observed rate of unionization by deciles of the predicted skill distribution $\hat{s}_i$, the standard deviation of the skill distribution estimate from Eq.7.2 and wage compression in unions from Eq.7.3. As there are more moments than parameters, each data moment is weighted by the standard deviation. Figure 17 shows how the model fits the data from 1980.

7.3 Calibration of Search Environment and Results

The data for estimation as specified comes from the outgoing merged rotation group for 1999-2001 data and May supplement files for 1979-1981 data. It is restricted to only male, wage and salaried workers between the ages of 16-65. Skill is measured using education and experience, and it is kept the same to match the model estimates to data and for estimating the changes in skill prices. Characteristics like industry, race, marital status and presence of "right-to-work" laws are controlled for in the X_2 variable. The analysis period is one month, owning to the monthly data considered with monthly discount rate. To ease the analysis, labour market tightness is considered to be unity. The probability of a worker being matched to a worker is taken from the CRS matching function, combined with an average duration of unemployment in 1980, which was 3.10 months. The average unemployment rate in 1980 was 6.01%. Reasonable estimates of income replacement ratio are taken from Shimer (2005).

The standard deviation of skill index as estimated from Eq.7.2 for 1980 is 0.291. Then using the predictions and the wages in the union sector, the wage compression in the union sector is estimated to be $\hat{\phi_1} = 0.531$. These estimates, along with the unionization rate by deciles of predicted skill composite in 1980, are used to obtain the true underlying parameters that are corrected for selection as they are obtained from matching actual data. The model generated prediction to match the original data from 1980 is shown in figure 17. The model closely replicates the hump-shaped observed in the data. The corrected estimate for skill dispersion is 0.262, which is slightly lower than the estimate from

Eq.7.2. The implied share of total income retrieved from the estimates is 0.25 for individuals and 0.41 for the union. The estimate for efficiency given by $\sigma_\zeta = 0.12$ in 1980. Table 13 provides the values for the parameters as taken from the literature and the estimates.



Note: Model vs Data Unionization rates in 1980

Figure 17: Unionization Rate Across Skills

Table 13: Estimated and Calibrated parameter values

Parameter Values	Value	Targeted Moment	Source
Exogenous Parameters:			
Discount Rate (r)	$0.95^{1/3}$	Annual Interest Rate, US	5%
Unemployment Insurance Benefit (ρ)	0.4-0.6		Shimer (2005)
Matching Compoent (ϵ)	0.5		Açıkgöz and Kaymak (2014)
Skill Premium - 1980 $(\Psi_{t=1980})$	1		Normalization
Vacancy Cost (c)	1.8		Silva and Toledo (2009)
Jointly Calibrated:			
Skill Deciles (S)	10		See text
Matching Coefficient (M)	0.325	Mean Unemployment Duration	3.10 months
Separation rate (s)	0.019	Mean Unemployment rate	6.01%
Union share of income (β_u)	0.41	Estimate	Figure 17
Individual share of income (β)	0.25	Estimate	Figure 17
Skill Dispersion (σ_s)	0.262	Estimate	0.28 (0.001) Eq.7.2
Ability Dispersion (σ_ζ)	0.11	Estimate	Figure 17
Union Skill price (ϕ_1)	0.6	Estimate	0.54 (0.021) Eq.7.4
Skill premium - 2000 $(\Psi_{t=2000})$	1.33	Estimated skill dispersion	Eq. 7.2 for 2000
Estimates from Eq.7.5: (Θ)			
Less than high school	-1.566 (0.38)		
High School Dropuots	-1.314 (0.29)		
High School Graduates	-0.766 (0.31)		
Some College	-0.244 (0.34)		
College Graduates	1.139 (0.41)		

Note: Standard errors are used to weigh the moment where applicable and are mentioned in the parentheses. Standard errors are adjusted for clustering within experience cell. All regressions are weighted by the sample size of the education-experience-period cell. Regression include education, experience, and period fixed effects, as well as interactions between education and experience fixed effects, education and period fixed effects, and experience and period fixed effects.

7.4 Estimation of Change in Skill Prices

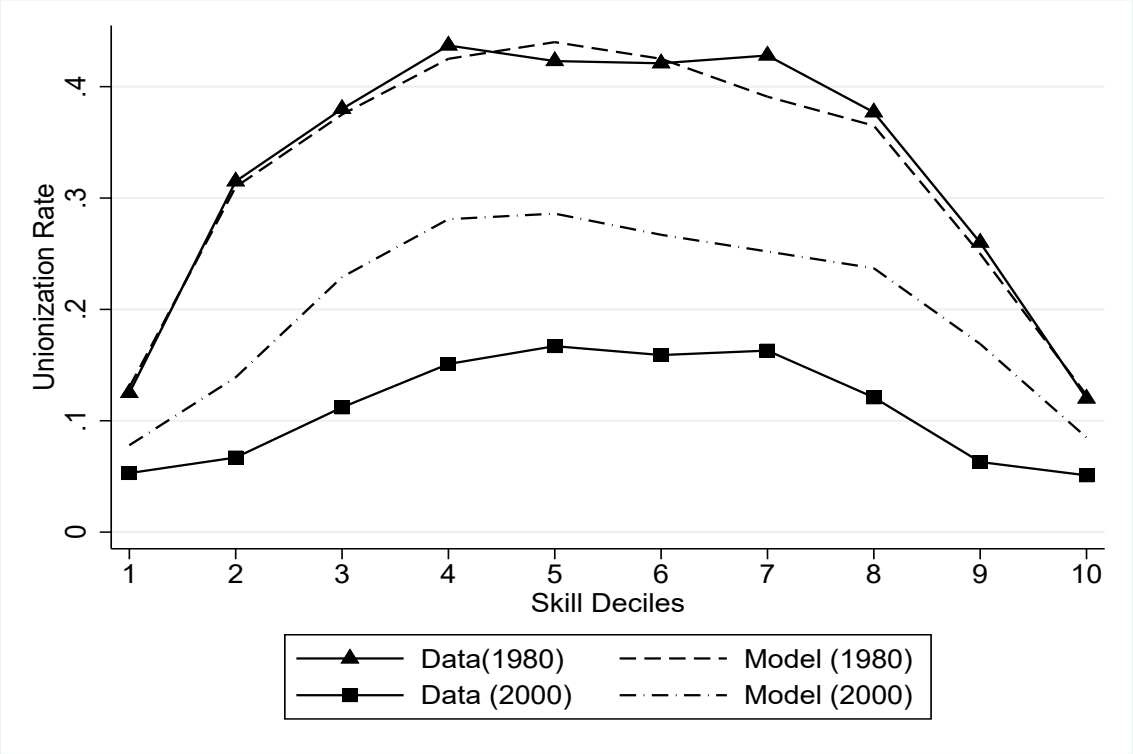
To obtain an estimate of the change in prices of skill levels in the U.S. economy between 1980 and 2000, I follow Borjas (2003) and estimate the coefficient when I regress

the weekly log earnings for native workers by skill and education groups at the national level at time (t) on the relative share of immigrants in that same education-experience bracket. It involves estimating the following by skill groups:

$$y_{ijt} = \Theta\, p_{ijt} + a_i + b_j + \vartheta_{ijt} \tag{7.5}$$

where i stands for education group and j for experience group evaluated for at time t. y_{ijt} denoted log weekly earnings and the main variable is p_{ijt} denoting the immigrant share in education group i and experience level j at time t.[54] I estimate the above regression equations for 1980, 1990 and 2000 and use the estimate of Θ for the years for each education and experience cell corresponding to s (skill) in the original model. These estimates are shown in Table 13. To get the final changes, I require a measure of skill prices in the non-union sector in 2000 relative to 1980. This increase in skill price is calibrated to match the standard deviation obtained from Eq.7.2 for 2000, given as $\hat{s}_{i,2000}$. I then use the estimates from Eq.7.5 and add that by skill group to the estimate of $\hat{s}_{i,2000}$. Essentially, this method allows me to calculate $\hat{s}_{i,2000}$ by evaluating how differentially each skill group is affected after the entry of immigrants in 2000. Having estimated the changes in the skill prices, the aim is to find the unionization rate in 2000 using these changes and keeping all other parameters fixed as obtained from the 1980 estimate. Then the aim would be to see if the model can match the actual data for the unionization rate in 2000. The figure 18 below provides the main calibration results and compares the change in unionization rates from the data to the predictions of the model.

[54] More formally, following Borjas (2003), I define $p_{ijt} = \frac{I_{ijt}}{I_{ijt}+N_{ijt}}$, where I_{ijt} is the number of immigrants in cell ijt and N_{ijt} is the number of native in cell ijt.



Note: Model vs Data Unionization rates in 1980 and 2000

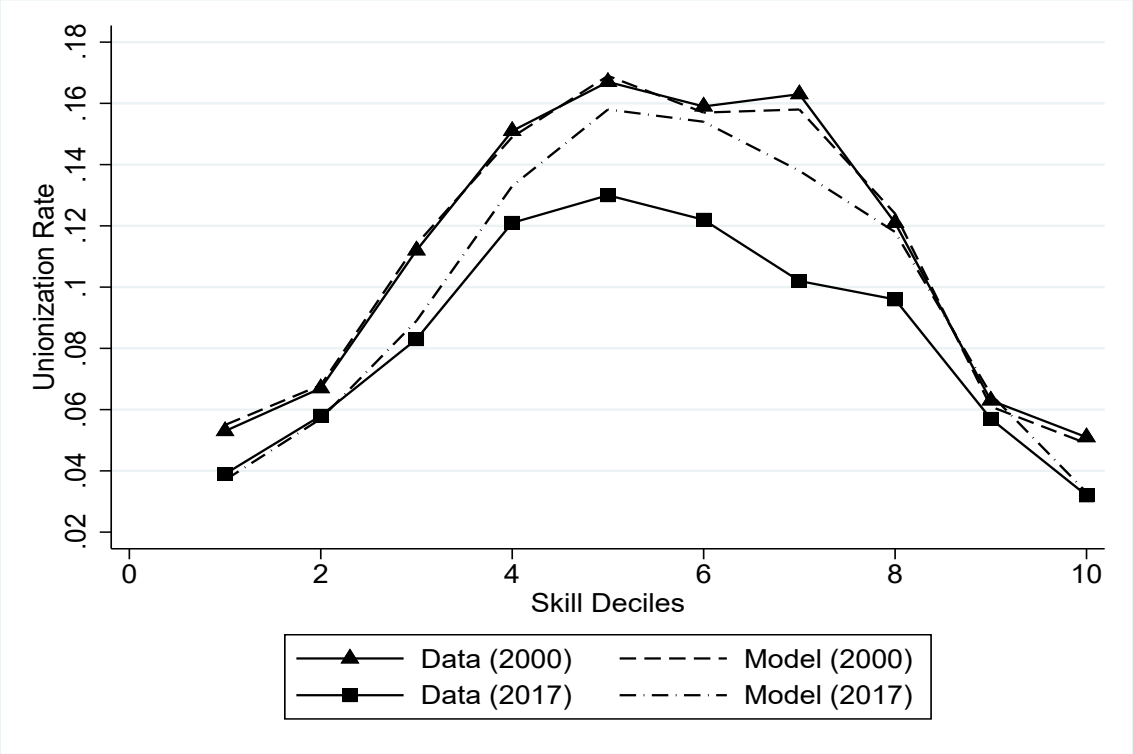
Figure 18: Unionization Rate Across Skills (1980-2000)

As shown in the figure 18 above, the model captures the fall in union rates well. Unionization rate on average decreased from 33% in 1980 to 11% in 2000. Using the estimates as predicted by the model, the model predicts an average unionization rate of 20.3%, which is about 56% of the total unionization fall. At the extreme ends of the skill distribution, the model's predictions are closer to the data than towards the middle of the skill distribution. Based on the calibration strategy explained in this section, I try to see how well the model can explain the changes in union density between 2000 and 2017. The 2000s in the U.S. saw an increase in high skilled immigrant entry, and the model would predict an increase in union rates following this increase. As high-skilled immigrants enter the economy, there is a fall in the price paid to skill, leading to higher efficiency high-skilled workers now being ready to join the union. On the other hand, low skilled workers are now better, and even lower efficiency workers can demand higher union wages from firms. Therefore, there should be an increase in union entry among

both high and low skilled workers. As a comparative exercise, it is essential to consider the case of Canada and how immigrant entry and union rates have changed there. In Canada, the immigrant entry has mainly been highly skilled. As a result, although both countries have seen similar union rates leading up to the 1970s, they diverge after that, with the U.S. undergoing a pronounced fall in union rates once immigrants started entering the labour market.[55] A description of the entry of high skilled immigrants and the effect on U.S. productivity and native outcomes can be seen in Kerr and Lincoln (2010), Borjas (2009) and Greenwood and McDowell (2011). So I use the data on union membership from 2000 and re-estimate the parameters of interest using the model predictions in 2000. Using the estimated values, I again calculate the changes in the wages of different education-experience cells and calibrate the model for finding the union rates in 2017. Interestingly, the income shares between unions and individuals are a lot closer at 0.27 and 0.24 compared to the figures in 1980, suggesting how the power enjoyed by the unions has decreased over time. The results and the comparison between the model and data are shown in figure 19 below. As the figure shows, the model again explains about 55% of the total fall in union rates between 2000 and 2017.[56] The model does better at predicting the fall at the two ends of the skill deciles and does not explain the fall in the middle as much.

[55] Riddell (2009) for a detailed study of the difference in the union rates of the U.S. and Canada and Fortin et al. (2012) for an analysis of the impact of union rates on differences in wage inequality between the US, Canada and the U.K.

[56] I again use the average rates between 2016-2018 to construct 2017 data.



Note: Model vs Data Unionization rates in 2000 and 2017

Figure 19: Unionization Rate Across Skills (2000-2017)

8 Conclusion

This paper analyzes the rapid fall in unionization rates in the U.S. and the rise in wage inequality that followed it. Farber et al. (2021) claim an inverse relationship between unionization and wage inequality in the U.S. using high-frequency survey data. At the same time, immigrant entry, especially low skilled, fell after World Wars when union rates increased and steadily increased from the mid-1960s when union rates started declining. This paper proposes low skilled immigrant entry as causal to falling union rates. As seen in the data, it puts forward a mechanism that can explain this phenomenon and the resulting rise in wage inequality. Empirically, higher immigrant entry leads to a higher fall in union rates which is valid across states and MSAs. At the state level, a 1% increase in immigrant to population ratio leads to a 0.42% fall in union rates in the 1980-1990

decade. The results correct long-term adjustments when using the standard 'ethnic enclaves' IV approach and more modern JRS-IV approach. I also hold other causes as put forward by the literature to closer empirical scrutiny and find a lack of evidence to support their claim. Though plausible, these reasons cannot explain the entire fall in union rates, whereas, in this paper, I find that immigrant entry can lead to a 45-46% decline in union rates. The novel empirical finding of immigrant entry leading to a fall in unionization rates is the essential contribution of the paper.

The paper then proposes a general equilibrium search and matching model with assumptions motivated from data facts, where firms hire workers who differ in skills (observable) and efficiency (unobservable). Unions operate separately from firms and workers and follow an egalitarian approach where all workers are paid the average productivity but are afforded a higher bargaining weight than the individual bargaining case. Workers decide in equilibrium based on their efficiency if they want to join the union or not. An entry of low skilled immigrant increases the productivity of high skilled workers and decreases that of low skilled workers. This prompts high skilled workers to leave the union as they are now more productive and better paid in the non-union sector for their given efficiency level. Simultaneously, low skilled workers are now worse off and would not be hired if they charge the extra union wage. Therefore, as they prefer to be employed than not, they prefer to leave the union and bargain individually. The model predicts that higher efficiency high skilled workers and lower efficiency low skilled workers leave the union.

The predictions of the model are then taken to the data for numeric evaluation. The calibration exercise helps figure out the changes in wages paid to high-skilled and low skilled workers after the influx of low skilled immigrants between 1980-2000. After matching the moments from the data in 1980, the model is used to predict the union rates in 2000. It predicts 45-55% of the total changes but better explains the differences towards the tails of the distribution of union rates across skill deciles. A similar exercise between 2000 and 2017 also suggest similar findings. The research conducted here, though rich, can be extended through the use of better data and can be used to answer more questions. Specifically, from the lens of occupations and industries and creating an index to quantify

how much natives and immigrants compete for certain occupations or compete in specific sectors can be a valuable way to see if immigrant entry affects industries or occupations differently. Also, the literature on immigrants is rich. Certain aspects like outmigration and immigrant assimilation should be brought in to evaluate the model and dive deeper into how immigrants impact union rates.

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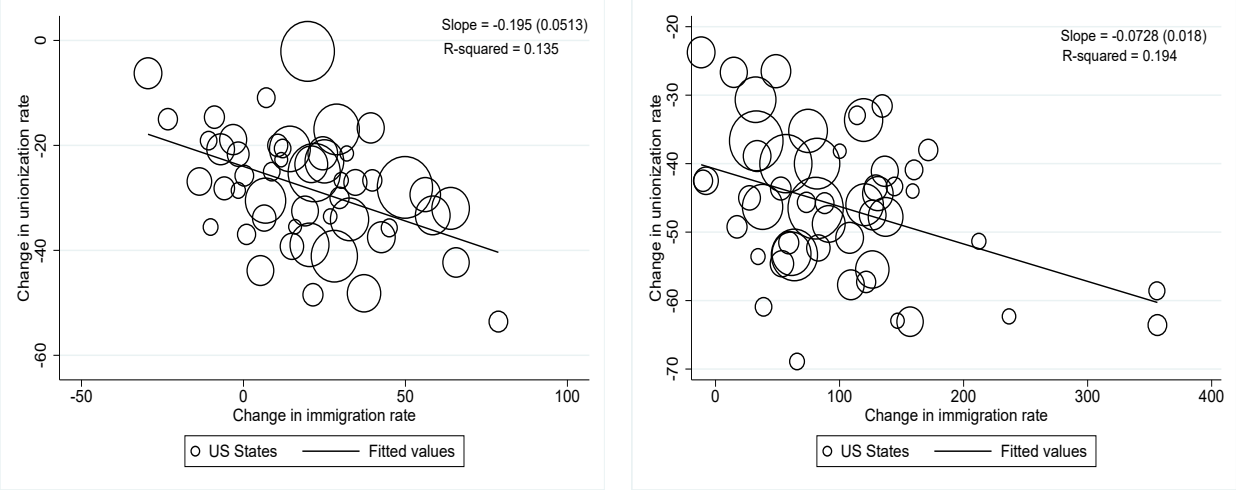
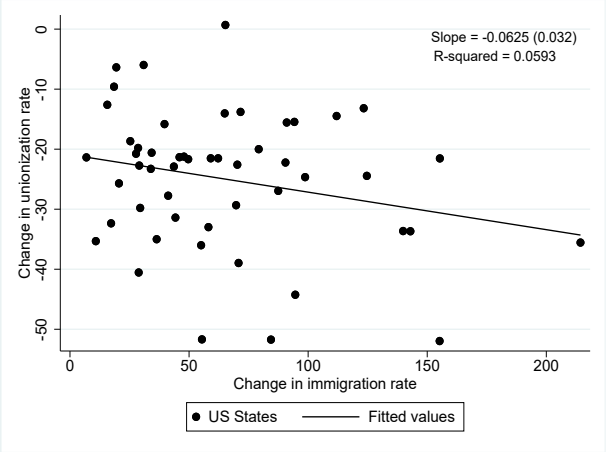
9 Appendix

A Figures



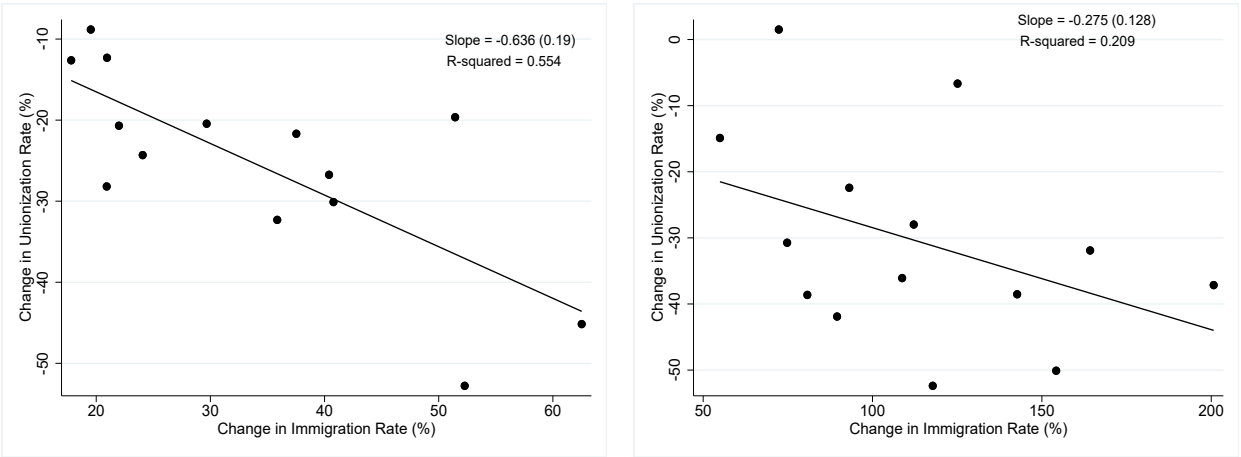
Note: In the left panel: Change in union rates and immigrant population shares across states between 1980 and 1990 with employment shares as weights. In the right panel: Change in union rates and immigrant population shares across states between 1980 and 2000 with employment shares as weights. Data on state level unionization rates comes from CPS and Hirsch and Macpherson (1993). The p-value of the slope coefficient using robust standard errors in reported in parantheses.

Figure 20: Cross-State Evidence on De-unionization and Immigrant entry, 1980-90 and 1980-2000



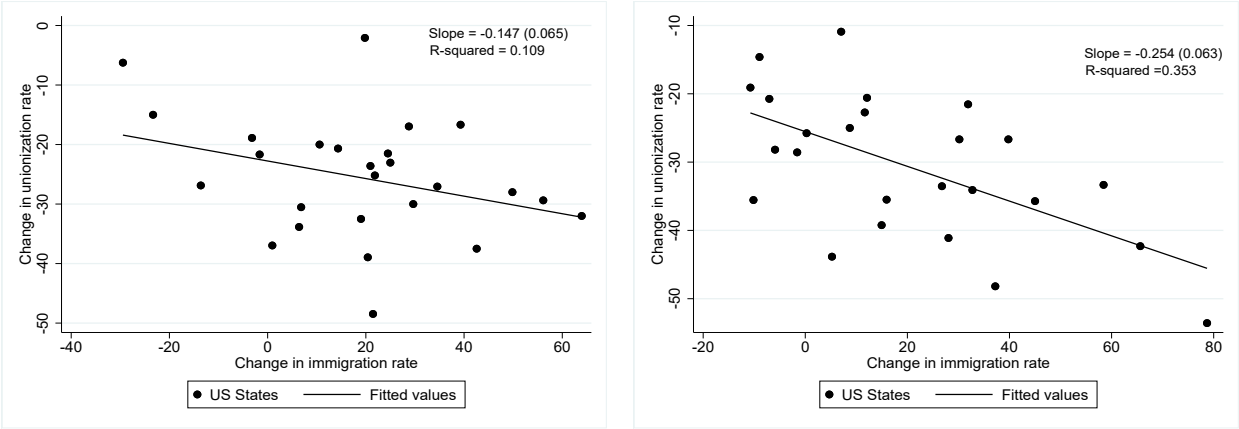
Note: Change in union rates and immigrant population shares across states between 1990 and 2000. Data on state level unionization rates comes from CPS and Hirsch and Macpherson (1993). The p-value of the slope coefficient using robust standard errors in reported in parantheses.

Figure 21: Cross-State Evidence on De-unionization and Immigrant entry, 1990-2000



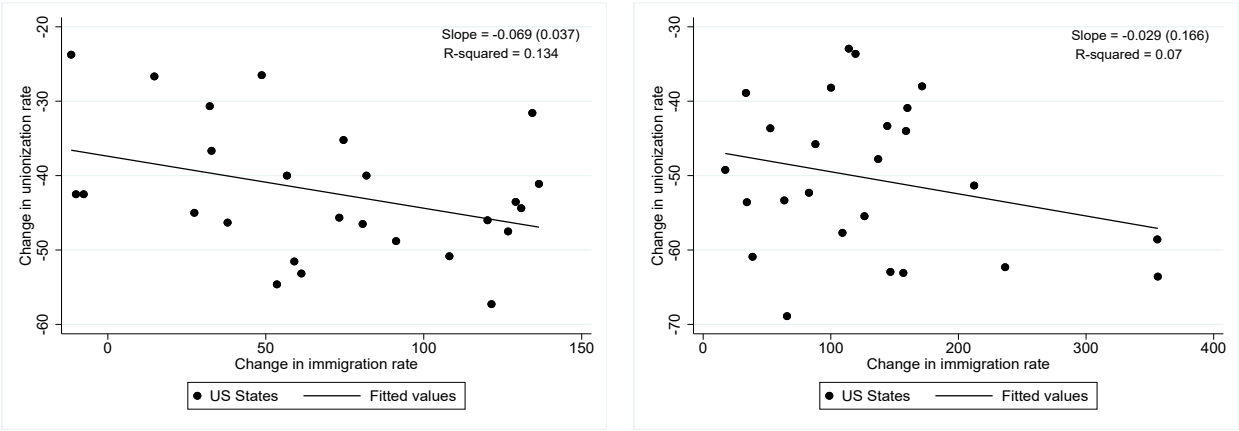
Note: In the left panel: Change in union rates and immigrant population shares across industries between 1980 and 1990. In the right panel: Change in union rates and immigrant population shares industries states between 1980 and 1998. Data on industry level unionization rates comes from CPS and Hirsch and Macpherson (1993). Correlations are unweighted. Slope coefficient and robust standard errors in reported in parantheses.

Figure 22: Cross-Industry Evidence on De-unionization and Immigrant entry, 1980-1998



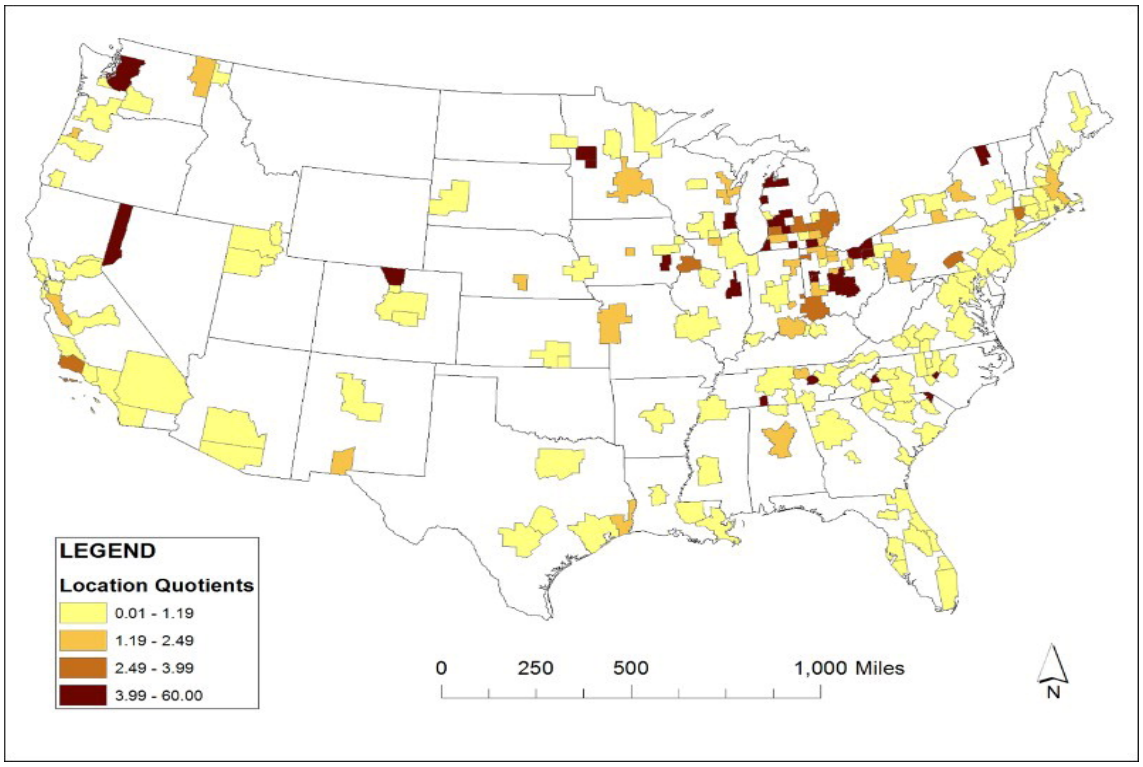
Note: In the left panel: Change in union rates and immigrant population shares across states between 1980 and 1990 in non right to work states. In the right panel: Change in union rates and immigrant population shares across states between 1980 and 1990 in right to work states. Data on state level unionization rates comes from CPS and Hirsch and Macpherson (1993). The p-value of the slope coefficient using robust standard errors in reported in parantheses.

Figure 23: Cross-State Evidence on De-unionization and Immigrant entry



Note: In the left panel: Change in union rates and immigrant population shares across states between 1980 and 2000 in non right to work states. In the right panel: Change in union rates and immigrant population shares across states between 1980 and 2000 in right to work states. Data on state level unionization rates comes from CPS and Hirsch and Macpherson (1993). The p-value of the slope coefficient using robust standard errors in reported in parantheses.

Figure 24: Cross-State Evidence on De-unionization and Immigrant entry



Note: Source: Leigh and Kraft (2018)

Figure 25: Robotics-related location quotients for core-based statistical areas (CBSAs) in the United States.

B Tables

Table 14: Estimates of the impact of low-skilled immigrant entry on union rates, 1980-2000 (MSAs)

			Full Sample			IV-1970	JRS-IV
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(Immigrant/Native) Ratio	-0.191***	-0.190***	-0.183***	-0.187**	-0.201**	-0.211**	-0.212**
	(0.080)	(0.087)	(0.075)	(0.09)	(0.10)	(0.10)	(0.10)
Log Population	x	x	x	x	x	x	x
Average Income	-	x	x	x	x	x	x
Average Education	-	-	x	x	x	x	x
Right-to-Work	-	-	-	-0.011	-0.014	-0.07	-0.08
				(0.04)	(0.15)	(0.04)	(0.16)
Right-to-Work X (I/N) Ratio	-	-	-	-0.121	-0.122	-0.09	0.11
				(0.18)	(0.10)	(0.12)	(0.33)
% Services	-	-	-	-	-0.107	-0.11	-0.15
					(0.23)	(0.23)	(0.21)
R^2	0.14	0.16	016	0.21	0.21	0.28	0.27

Note: The results are obtained from the decennial Census, 1970, 1980 and 1990. Robust standard errors are in parentheses, adjusted for clustering at MSA level. $^{*}p < 0.10;\ ^{**}p < 0.05;\ ^{***}p < 0.01$.

Table 15: Right-to-work Adoption by States

States	Year of Adoption
Alabama	1953
Arizona	1946
Arkansas	1947
Florida	1968
Georgia	1947
Idaho	1985
Indiana	2012
Iowa	1947
Kansas	1958
Kentucky	2017
Louisana	1976
Michigan	2012
Mississippi	1954
Nebraska	1946
Nevada	1951
North Carolina	1947
North Dakota	1947
Oklahoma	2001
South Carolina	1954
South Dakota	1946
Tennessee	1947
Texas	1947
Utah	1955
Virginia	1947
West Virginia	2016
Wisconsin	2015
Wyoming	1963

Note: Data compiled from the "Right to Work States Timeline". *National Right To Work Committee* Report, July, 2018 and Neuman, Scott (2018) "Missouri Blocks Right-to-Work Law".

Table 16: Estimates of the impact of low-skilled entry on union/coverage rates-CPS (1980-2000), industry level

	Union Rates	Coverage Rates	IV-1970	IV-1960
	(1)	(2)	(3)	(4)
(Immigrant/Native)	-0.274**	-0.287**	-0.296**	-0.311***
	(0.131)	(0.134)	(0.137)	(0.122)
Average Income	x	x	x	x
Employment Shares	x	x	x	x
R^2	0.272	0.274		

Note: The results are obtained from the decennial Census, 1960, 1970, 1980, 1990, 2000 and CPS (March files). Robust standard errors are in paranthesis, adjusted for clustering at state level. $^{*}p < 0.10;\ ^{**}p < 0.05;\ ^{***}p < 0.01$..

Table 17: Estimates of the impact of low-skilled immigrant entry on union rates, 1980-2000, (States)

	Full Sample					IV-1970	JRS-IV
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(Immigrant/Native) Ratio	-0.220***	-0.205***	-0.201***	-0.228***	-0.227**	-0.229**	-0.231***
	(0.065)	(0.068)	(0.068)	(0.10)	(0.11)	(0.11)	(0.10)
Log Population	x	x	x	x	x	x	x
Average Income	-	x	x	x	x	x	x
Average Education	-	-	x	x	x	x	x
Right-to-Work	-	-	-	-0.18	-0.17	-0.07	-0.03
				(0.10)	(0.16)	(0.05)	(0.14)
Right-to-Work X (I/N) Ratio	-	-	-	-0.132	0.173	-0.06	0.09
				(0.19)	(0.16)	(0.11)	(0.33)
% Services	-	-	-	-	-0.109	0.16	0.03
					(0.18)	(0.14)	(0.22)
R^2	0.18	0.26	0.27	0.31	0.32		

Note: The results are obtained from the decennial Census, 1970, 1980, 1990 and 2000. Robust standard errors are in parentheses, adjusted for clustering at state level. $^{*}p < 0.10;\ ^{**}p < 0.05;\ ^{***}p < 0.01$.

C Model Extension and Calibrations

In the previously discussed model, I allow firms to post nativity and skill specific vacancies in the low skilled labour market. This has a simple and useful explanation in the sense that it allows us to fully internalize the competition coming from immigrant workers on native low skilled workers. In this model extension, we now do not allow firms to post nativity specific vacancies. Thus, here we are likely to see job competition as well as

job creation effect of immigrant entry. From the previous model, we change the following key equations:

- The tightness in the low skilled labour market is now independent of nativity. Therefore, $\theta_L = \frac{V_L}{U_L}$, which gives flow rate of match as $m(\theta_i)$ and for vacancy as $q(\theta_i)$.

- Equation 5.4 is now written as :

$$rV_{ij} = -c_i + q(\theta_{ij})[\int(\phi_i M^f_{iN}(\zeta) + (1-\phi)M^f_{iI}(\zeta))d\mu - V_{ij}] \tag{9.1}$$

  where ϕ_i is the fraction of unemployed workers of type i that are native.

- Equation 5.10 would now be:

$$L = \frac{m(\theta_L)(\lambda + I)}{s_L + m(\theta_L)} \tag{9.2}$$

  And Equation 5.12 would now be:

$$U_{LN} = U_{LI} = \frac{s_L}{s_L + m(\theta_L)} \tag{9.3}$$

The wage and price conditions obtained remain the same as shows in Eq.5.15 and 5.16 and 5.17. The main difference would be in Eq.**??**, where the value of C_L would be now given as:

$$C_L = \phi_L b_{LN} + (1-\phi_L)b_{LI} + \frac{c_L(r + s_L + \beta m(\theta_L))}{(1-\beta)q(\theta_L)} \tag{9.4}$$

where $\phi_H = 1$ and $\phi_L = \lambda/\lambda + I$.

The effect of immigration on natives, now again depends on two things: the price effect through Eq(**??** and 5.16) and through expected employment cost, (C_L), where a change in I, now changes ϕ. I again analyse the most general and plausible setting concerned where, $\sigma < 1$ and $b_{LN} > b_{LI}$, that is high skilled and low skilled goods are imperfect substitutes and immigrants have lower search costs and thus lower market wages as

compared to natives. Now to analyse the effect of a rise in immigrants on high skilled and low skilled natives. We see that through Eq(5.16) that an increase in I still increases L and therefore it increases p_H and a decrease in C_L leaves high skilled workers unaffected, therefore high skilled workers now given an efficiency level now earn more wages. For the low skilled workers, from Eq(5.17), an increase in I, increases L and therefore, it decreases p_L. However, a increase in I decreases ϕ_L and as $b_{LN} > b_{LI}$, we get a decrease in C_L, therefore, immigrant entry decreases the cost of hiring low skilled workers, this leads to an increase in firms entering the market for hiring low skilled workers, bringing down the unemployment level of unskilled workers and leading to a rise in w_L. Therefore, immigrant entry can lead to an increase in non-union wages for low skilled workers through one channel and decrease it through another channel. Therefore, the effect on immigrants on high skilled workers leads them again to quit the unions, as they are still better paid in the non-union sector for a given efficiency level. However, the empirical question now is will the new non union wage of the low skilled workers be able to compensate for this exit by the high skilled workers. This crucially depends on which effect dominates for the low skilled native workers, it is the price effect which decreases the wages and we revert to the standard model discussed previously or does it lead to an increase in wages through the job creation effect of reduced employment costs. Therefore, to analyse this empirically, I calibrate the non-union sector for the US economy for the period 1980-90 and analyse the impact of immigrant entry of non-union wages of low and high skilled workers.

Calibration

Here, I describe the parametrization of the non-union sector by using data from the literature, data equivalent or direct estimation. The efficiency parameters in the production function and the matching function, namely A and M are normalized to one. The bargaining weight to individual worker in the non-union setting, β is set to 0.5 and so that the Hosios condition is met, unemployment elasticity in the matching function is assumed to be 0.5 as well.[57] The value of elasticity of substitution between skilled and unskilled labour has been a subject of intrigue and papers like Autor et al. (1998) have claimed it

[57] Hosios (1990)

to be 1.6 for the US, whereas Ciccone and Peri (2005) have claimed it to be 1.5 for the US between 1950-1990. Therefore, I use $\sigma = 1/3$ so as to get the elasticity of substitution as 1.5. The annual interest rate between the period of consideration was 4%. The other parameter of interest is the share of unskilled workforce in the US, this is calculated from the decennial census so $\lambda = 0.467$.[58] And also using the census the number of immigrants in 1980 is normalised with respect to natives so, $I = 0.042$. Estimate of US depreciation rate is taken from the Bureau of Economic Analysis and is given as, $\delta = 6.4\%$.[59]

The remaining parameters are jointly calibrated by matching targets from the US economy. The capital to output ratio is calculated using St. Louis Fed data and is equal to 1.216.[60] Following Borjas (1999), I define entry of "new immigrants" as those having arrived within five years of the Census. I then use the CPS outgoing rotation group to calculate the wage of non-union native workers who are low skilled and compare that to the wage of immigrant worker from the Census.[61] I calculate the native-immigrant wage gap for unskilled workers to be around (-21%). I also need market tightness ratios or the vacancy to unemployment ratio in each market. Here I use the vacancy posting data from Conference Board's Help-Wanted Index (HWI) and unemployment rates from the March CPS for the period of interest.[62] Estimates of the flow payment of unemployment range between 0.4, the upper end of the range of income replacement rates in Shimer (2005), and 0.955 in Hagedorn and Manovskii (2008). I choose a value of 0.7 of average wage for natives and 0.6 of average wage for immigrants as the option value but the results are not sensitive to using 0.4 as the value as suggested by Shimer (2005). Table 18 is used to summarize the parameters under consideration.

[58] A skilled worker is defined as someone who has at least a high school graduate as has been the consideration throughout the paper.

[59] The Measurement of Depreciation in the U.S. National Income and Product Accounts By Barbara M. Fraumeni

[60] The definition of capital stock that we used includes nonresidential equipment and software aswell as nonresidential structures. This variable was then divided by a measure of private output that is equal to GDP—gross housing value added—compensation of government employees following Ottaviano and Peri (2012)

[61] Unfortunately, CPS does not allow the identification of immigrants before 1994 and the Census does not identify union status.

[62] The convention in the literature is to use JOLTS data for finding vacancy postings but unfortunately this data is not available for before December 2000. Therefore, I use the HWI data and Abraham and Wachter (1987).

Table 18: Baseline Parameterization

Parameters	Definition and Source
$A = 1$, $M = 1$	Normalization
$\epsilon = 0.5$	Literature
$\beta = 0.5$	Hosios Condition
$\sigma = \frac{1}{3}$	Literature
Measured from data	
$r = 0.0034$	Annual rate 4%
$\delta = 0.064$	BEA Website
$\lambda = 0.467$	Share of unskilled labour
$I = 0.046$	Normalized number of immigrants
$s_L = 1.5\, s_H$	Separation Rates
Jointly calibrated	
$\alpha = 1.216$	Capital-output ratio 4%
$c_H = 0.556$	Liu (2010), Ortega (2000)
$c_L = 0.421$	Chassamboulli and Palivos (2014)
$\gamma = 0.6$	Normalized number of immigrants
$b_{iN} = 0.7 w_{iN}$, $b_{LI} = 0.6 w_{LI}$	Outside Option Value

Note: All variables are monthly

Calibration Results

Using Census data, the total immigration inflow who were low skilled increased to 5.2% of the total US population, which allows me to calculate an increase in I to be equal to 0.28. The results of the simulations can be summarized in Table 19 below.

Table 19: Effects of immigrant entry, 1990-1980

Category	$\phi_L = 0$	$\phi_L = \frac{\lambda}{\lambda+I}$
Low-skilled Natives		
w_{LN}	-0.18	-0.11
u_{LN}	-4.88	-1.81
High-skilled Natives		
w_{LN}	2.91	2.62
u_{LN}	0.47	0.11
Immigrants		
w_{LI}	-0.33	-0.06
u_{LI}	-0.07	-0.02

Note: The variable w indicates the wage rate, u the unemployment rate, θ the tightness in the labor market. The subscript L stands for unskilled, H for skilled, N for native and I for immigrant. All results are percentage changes.

The increase in the number of unskilled immigrants raises job entry for the high skilled workers. And also improves their wage rates. This is true for both the cases where low skilled markets are different for natives and immigrants or when they are the same. As the immigrants' share of unskilled labor force increases, firms with low-skill vacancies anticipate that they will have to pay lower wages on average. This encourages low-skill job entry. The resulting increase in the unskilled labor input (L) causes the price of skilled labor input to rise (p_H), thereby also encouraging the creation of skilled jobs. This effect is further expanded because as explained previously, due to their higher search costs low-skilled immigrants receive lower wages than low-skilled natives which the fimrs know and is exaggerated when the markets are separate for the two.

Now, to analyse the effect on low skilled natives. We know an increase in the number of immigrants, influences the equilibrium wage through two channels: (1) through its im-

pact on the marginal product of labor and thus the price of the labor input; for example, an increase in the number of unskilled immigrants lowers the marginal product of unskilled labor, thereby lowering the unskilled worker's wage; (2) through its impact on the worker's value of outside option. An increase in I spurs job entry and raises the matching rate and the value of search, thereby strengthening the workers' position in wage setting, and in turn, causing their wage to rise as estimated from the cost function, C_L. From the calibration it is clear that in the case of low-skilled native workers, the first effect, which is negative, dominates on the second, which is positive, causing a small decrease in the unskilled wage w_{LN}. The effect is stronger when the markets are separate. Similarly for immigrants I observe a small fall in wage and employment once more immigrants come in and the markets are the same for both low skilled natives and immigrants. The impact is slightly larger when markets are separate as the single market absorbs most of the impact of the immigrant influx.