

Immigration and environmental emissions: A U.S. county-level analysis

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Abstract This paper investigates the immigration–environment association using U.S. county-level data, for a subset of counties ($N = \sim 200$), and a model inspired by the STIRPAT approach. The analysis makes use of U.S. census data for the year 2000 reflecting U.S.-born and foreign-born populations, combined with county-level data reflecting emissions of CO₂, NO₂, PM₁₀, and SO₂. With a focus on approximately 200 primarily urban counties for which complete data are available, and after controlling for income, employment in the utilities and manufacturing sectors, and coal consumption for SO₂ estimations, few statistically significant associations emerge between population composition and emissions. Counties with a relatively larger U.S.-born population have higher NO₂ and SO₂ emissions. On the other hand, counties with a relatively higher number or share of foreign-born residents have lower SO₂ emissions. Although limited to cross-sectional analyses, the results provide a foundation for future longitudinal research on this important and controversial topic.

Keywords Emissions · Immigration · Environment · Migration · Pollution · IPAT · STIRPAT · Environmental inequality

Introduction

Immigration remains a contentious social and political issue within the United States. According to the U.S. Council of Economic Advisers, immigrants have played an important role in fueling economic growth and in raising the incomes of

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their American-born counterparts (Executive Office of the President 2007).¹ Indeed, immigrants are estimated to have contributed by around \$10 billion annually in net economic output (Smith and Edmonston 1997). Yet, opposition to immigration flourishes. Espenshade and Hempstead (1996) find that a large proportion of Americans share a common *isolationist* view that immigration should be restricted on the grounds that it exerts downward pressure on wages and leads to higher unemployment within the U.S.-born population. The current literature provides mixed support for these contentions—some research finds negative effects of immigration on U.S. worker wages (e.g. Borjas 1995; Card 2001), although some finds that immigrants drive up the average wages of their U.S.-born counterparts (Ottaviano and Peri 2005).

Other anti-immigrant groups might be characterized as neo-Malthusian given their focus on the environmental dimensions of immigration (e.g. BALANCE 1992; Daily et al. 1994; Cohen 1995; Pimentel et al. 1998). As an example, Population–Environment Balance (BALANCE) is a grassroots organization that aims to protect the carrying capacity of the United States via population stabilization. BALANCE (1992) argues that immigration should be limited on ethical and environmental grounds because: (i) it contributes to overpopulation; (ii) it aggravates urban sprawl; (iii) it is costly to American taxpayers; (iv) it hurts the sending countries; and (v) it adversely affects the population carrying capacity. Even the Sierra Club, long known for its active stance on protecting the environment through the implementation of conservation programs, was not spared from a short-lived and controversial immigration debate. The debate which had been initiated by a number of members who felt that overpopulation contributed to environmental degradation aimed to make the Sierra Club take an anti-immigration stance. This view, however, did not gain much popularity among organizational members and was voted down by about 60% of the members, thus affirming a commitment to neutrality on immigration issues (Pfeffer and Stycos 2002).

Cultural change represents another dimension of immigration's potential environmental impact. For example, DinAlt (1997) examines environmental degradation as related to immigrant lifestyle changes post-migration through quantitative estimates of the changes in resource consumption and pollution resulting from migration to the United States. DinAlt bases his calculations on the assumption that each new immigrant contributes to pollution at the U.S. ChloroFlouroCarbon (CFC) emissions per capita rate. This implies that immigrants must adopt the consumption patterns of their American-born counterparts. For instance, DinAlt estimates Indian immigrants to increase CFC emissions in the U.S. by 11,025% and to increase car usage by 32,350%. Vietnamese immigrants, on the other hand, are estimated to increase pesticide consumption by 11,214% and energy consumption by 9,249%. What remains unexamined, however, is the actual behavioral adjustments undertaken by immigrant populations once resident in the U.S.

Some of the more recent contributions to the immigration–environment debate include Neumayer (2006), Muradian (2006), and Chapman (2006), although none offer empirical examination of the association between immigration processes and

¹ The connotations *foreign population*, *foreign-born*, and *immigrants* that are used in this paper are defined by the U.S. Census Bureau as “anyone who is not a U.S. citizen at birth. This includes naturalized U.S. citizens, lawful permanent residents (immigrants), temporary migrants (such as foreign students), humanitarian migrants (such as refugees), and people illegally present in the United States.”

environmental change. For instance, Neumayer (2006) argues that “it is misleading and ethically indefensible to use environmental arguments against immigration” (p. 206) and, instead, efforts to curb immigration should address migration’s root causes. Chapman (2006) offers agreement with Neumayer’s suggestion but believes that “restrictive immigration policy based on environmental degradation is ethically justified” (p. 218).

On an individual level, some scholarship suggests the consumption patterns of foreign-born residents are actually more environmentally benign than native-born residents. Pfeffer and Stycos (2002) find that some behaviors (i.e. water conservation and meat consumption) of foreign-born New Yorkers are more pro-environment than those of the American-born. Furthermore, Hunter (2000a) provides evidence supporting that shorter-term foreign-born residents (those who migrated to the U.S. as adults) tend to express greater levels of environmental concern than U.S.-born residents.

Other research raises questions about the “sequential arrival timing” of immigrants and environmental risk (i.e. hazardous waste generators). In other words, the concern is whether the foreign-born population preceded the arrival of environmental risk. Hunter (2000b) finds that U.S. counties with higher proportions of foreign-born residents are more exposed to environmental risk. However, the causal link is difficult to establish because lower-income (foreign-born) residents may be drawn to lower housing prices near locally undesirable land uses (Been 1994) or, alternatively, environmental risk may be introduced into communities that are less educated and resourceful, hence less likely to express opposition (Bullard 1990).

Despite the controversy surrounding immigration, the reality is that immigrants comprise over 12% of the U.S. population (Ohlemacher 2007). With higher birth rates than their U.S.-born counterparts, foreign-born populations are expected to remain major contributors to future growth (Johnson and Lichter 2008). Indeed, immigration imposes a variety of costs and benefits on society that are not easily quantifiable. For instance, childbearing by the foreign-born population can benefit society by increasing the local and federal tax base to help finance health care and public pensions for the elderly or other government services that are independent of population size (UNFPA 2001). More births can also contribute to technological progress in the medium to long run through an expansion of human capital and the pool of skilled workers, thus potentially stimulating economic growth (Kremer 1993). External costs, on the other hand, may include a higher fiscal burden from increased government spending on social services, education, and health care (Huddle 1993; Borjas 1994). For instance, Huddle (1993) and Borjas (1994) estimate the fiscal burden imposed by immigration at around \$44 billion and \$16 billion, respectively. Borjas (1995) argues that “the deteriorating skill composition of the immigrant flow may have increased the fiscal costs of immigration substantially” (p. 4). However, in contrast, Passel and Clark (1994) find that immigration results in a \$27 billion net fiscal benefit.

Combined with the rising global awareness of climate change and the environmental implications of population growth, there is a pressing need for a more thorough understanding of immigration’s association with environmental pressures. To that end, this research note provides an empirical assessment of cross-sectional patterns and statistical associations between immigration at the U.S. county level and emissions of air pollutants. Although limited, the results provide a foundation for future longitudinal research on the topic.

Data and methodology

Data

Air pollutants

Environmental emission data are from the Environmental Protection Agency (EPA) and are limited to peak air quality statistics for the following four air pollutants for the year 2000 by county: Carbon Monoxide (CO, 8-h, ppm), Nitrogen Dioxide (NO₂, annual mean, ppm), Particulate Matter (PM₁₀, weighted annual mean, µg/m³), and Sulfur Dioxide (SO₂, annual mean, ppm).²

The peak air quality statistics have been established by the EPA under the Clean Air Act as a nationally uniform air quality index to monitor and inform the public about potential health hazards related to the emissions of pollutants. Importantly, because not all counties consistently report or monitor their emission levels, the sample is restricted to 247 observations for CO emissions, 218 for NO₂, 400 for PM₁₀, and 320 for SO₂. Unfortunately, missing observations for other variables further reduce the sample size to 172 for CO estimations, 157 for NO₂, 233 for PM₁₀, and 192 for SO₂.³

Carbon Monoxide (CO) is an odorless and tasteless gas that is the product of partial combustion of carbon-rich materials. Motor vehicles represent the largest contributing factors to CO emissions representing around 78% of total emissions and 85–95% in urban areas.

Nitrogen Oxides (NO_x) are highly reactive gases that are the product of high temperature combustion. The health and environmental impacts of such gases include ground-level ozone (smog), acid rain, particulate matter, water quality deterioration, increased earth temperature, increased air toxicity, and reduced visibility. The most important contributing factors are motor vehicles (55%) followed by electric utilities (22%) and other industrial, commercial, and residential fuel burning sources (22%).

Particulate Matter (PM) represents a mixture of fine solid and liquid particles suspended in the air. Inhalation of PM can cause serious respiratory diseases, asthma, chronic bronchitis, lung disease, and heart problems. Because PM can be carried by wind over long distances, this pollutant can also result in significant environmental damage including reduced visibility (haze), increased acidity of lakes, rivers, and water supplies, depletion of soil nutrition, and damage to forests and farm crops. The most dangerous particles are those smaller than 10 µm (PM₁₀) as they are small enough to settle in the bronchi and lungs. The most important human-induced contributions to PM emissions include motor vehicles, power plants, and construction sites.

² The EPA reports six air pollutants, the other two ground-level ozone and lead. These two are excluded from the analysis since ground level ozone is generally problematic only in the summer season and lead is specific to lead smelters and various stationary sources.

³ The full data set is available at <http://www.epa.gov/airtrends/aqtrnd00/pdf/files/county00.pdf>.

Sulfur Dioxide (SO₂) represents a common gas that is the product of combustion of sulfur rich materials including crude oil, coal, and other common metals. SO₂ is blamed for respiratory problems, visibility impairment, acid rain, and plant and water damage. Around 65% of SO₂ emissions can be blamed on the burning of coal. Other sources of emissions include mainly motor vehicles and metal processing.⁴

Socio-economic data

Summary statistics are presented in Tables 1 and 2. Table 1 includes statistics for the entire available data set, whereas Table 2 includes statistics for the smaller samples used in the analyses. Included variables are:

- U.S. Immigration by county (U.S. Census Bureau 2000). These data reflect the total population as well as the population foreign-born. The foreign-born represents all residents that indicated a foreign place of birth in the 2000 census. The U.S.-born population is simply the difference between the total and the foreign-born populations. An important limitation of these data is that they fail to capture the immigrants' length of residence.
- Per capita personal income by county (Bureau of Economic Analysis, 2000). These data are incorporated to reflect affluence (model described below).⁵
- Sector-based employment as percent of total county (Bureau of Economic Analysis 2000). The sectors of focus are Utilities and Manufacturing. These two variables are incorporated to control for emissions that are driven by large utilities and manufacturing sectors. More specifically, the size of the Utilities sector, as determined by employment, would be useful in capturing energy intensity from the production of utilities. Employment within the manufacturing sector, on the other hand, helps capture the industrial structure of the county. These two variables provide a more comprehensive reflection of technology as a determinant of environmental impact.⁶
- Coal consumption data, in short tons, by state (National Priorities Project Database 2001). The data are used to control for state-level SO₂ emissions that are created by the consumption of coal in electricity generation, which are likely to affect the emissions of individual counties.⁷

Methodology

This paper uses a model inspired by the standard Stochastic Impacts by Regression on Population, Affluence, and Technology (STIRPAT) approach

⁴ Further information about air pollutants are available at <http://www.epa.gov/air/urbanair/>.

⁵ Per capita GDP data are not available at the county level.

⁶ Previous research has typically used sector-based per capita GDP. However, such data are not available at the county level.

⁷ Unfortunately, such data are neither available for 2000 nor at the county level.

Table 1 Summary statistics

	Observations	Mean	Std. Dev.	Minimum	Maximum
CO	246	3.41	1.66	1	10
NO ₂	218	0.015	0.007	0.003	0.044
PM ₁₀	400	25.75	13.90	6	212
SO ₂	320	0.005	0.003	0.0003	0.041
USPOP	3,141	79,692.46	222,063	67	6,069,894
FPOP	3,135	9,922.77	81,689.26	2	3,449,444
FPOPRATIO	3,135	3.48	4.86	0.02	50.93
PCPI	3,112	23,108.02	5,861.24	7,459	85,826
UTIL	889	0.80	1.42	0.0007	27.30
MANUF	2,614	18.56	11.82	0.56	70.43
COAL	3,141	2.91e+07	2.71e+07	1,000	9.69e+07

The following descriptions apply to Tables 1 and 2. Emissions of CO represent the highest second maximum non-overlapping 8-h concentration measured in parts per million (ppm). NO₂ emissions are the highest arithmetic annual mean concentration in ppm. PM₁₀ emissions represent the highest weighted annual mean concentration in micrograms per cubic meter (µg/m³). SO₂ emissions represent the highest annual mean concentration in ppm. USPOP represents the U.S.-born population. FPOP represents the foreign-born population. FPOPRATIO represents the foreign-born population as a percent of the total population. PCPI is per capita personal income and is measured in U.S. Dollars. UTIL and MANUF represent employment as a percent of total county employment for the utilities and manufacturing sectors respectively. Coal consumption, COAL, is in short tons

(Dietz and Rosa 1994), modified slightly to capture the U.S.-born and immigrant populations as:

$$\ln I_i = \alpha_{0i} + \alpha_{1i} \ln \text{USPOP}_i + \alpha_{2i} \ln \text{FPOP}_i + \alpha_{3i} \ln \text{PCPI}_i + \alpha_{4i} (\ln \text{PCPI}_i)^2 + \alpha_{5i} \ln \text{UTIL}_i + \alpha_{6i} \ln \text{MANUF}_i + \epsilon_i \quad (1)$$

where environmental impact, I , is examined using four common air pollutants such that $I = \{\text{CO}, \text{NO}_2, \text{PM}_{10}, \text{SO}_2\}$ for county i .⁸ The population variable is such that $P = \{\text{USPOP}, \text{FPOP}\}$ denoting U.S.-born population and foreign-born population respectively. The variable A is measured using per capita personal income (PCPI) and per capita income squared to control for a potentially non-linear relationship between income and emissions.⁹ T is measured using employment as a percent of total county employment in the utilities (UTIL) and manufacturing (MANUF) sectors. For SO₂ regressions, a variable measuring the consumption of coal (in natural logarithm) is introduced to control for emissions that are created by the use of coal in energy generation. Moreover, to account for foreign population concentration, the equation is also estimated using foreign-born

⁸ See e.g. York et al. (2003) for CO₂ and Cole and Neumayer (2004) for CO₂ and SO₂. CO₂ is not included in this study because it is generally perceived as a global externality (Frankel and Rose 2005). The use of total emissions in lieu of emissions per capita is consistent with Cole and Neumayer (2004).

⁹ The introduction of income squared is consistent with Frankel and Rose (2005).

Table 2 Summary statistics of the reduced samples

Variable	Obs	Mean	Std. Dev.	Minimum	Maximum
CO	172	3.511628	1.623974	1	10
USPOP	172	583589	691175.9	38900	6069894
FPOP	172	109798.8	304035.2	475	3449444
POP	172	693387.8	967703.1	40554	9519338
FPOPRATIO	172	9.746686	8.389244	0.924993	37.79496
PCPI	172	30655.01	7973.877	14912	58977
UTIL	172	0.567052	0.527025	0.008181	3.611186
MANUF	172	12.61973	6.365106	1.122369	34.36863
NO ₂	157	0.015745	0.007503	0.004	0.044
USPOP	157	561021.6	718252.8	32202	6069894
FPOP	157	107092.2	310471.1	228	3449444
POP	157	668113.7	1001625	32500	9519338
FPOPRATIO	157	9.595046	8.110093	0.684274	36.23618
PCPI	157	30139.42	7920.405	16310	58977
UTIL	157	0.577549	0.540956	0.038792	4.317471
MANUF	157	13.34496	7.027956	1.122369	40.69727
PM ₁₀	233	26.65236	9.471109	9	71
USPOP	233	403303.3	628256	12947	6069894
FPOP	233	73095.66	259221.9	225	3449444
POP	233	476398.9	863724.3	14483	9519338
FPOPRATIO	233	8.041458	7.490827	0.608741	36.23618
PCPI	233	28139.45	7798.435	14912	66569
UTIL	233	0.568023	0.493839	0.008181	3.36424
MANUF	233	12.74955	8.242592	1.092828	51.77215
SO ₂	192	0.00547	0.003878	0.0003	0.041
USPOP	192	435780.7	672183.5	12164	6069894
FPOP	192	73946.03	280929.4	61	3449444
POP	192	509726.7	928110.5	12370	9519338
FPOPRATIO	192	6.296031	7.037618	0.280447	36.23618
PCPI	192	28337.83	7121.318	14912	58977
UTIL	192	0.834602	1.587894	0.011542	19.69965
MANUF	192	15.24536	8.264503	1.122369	42.61826
COAL	192	2.87E+07	2.71E+07	1000	9.69E+07

population as a percent of total county population (FPOPRATIO) in lieu of FPOP and total population (POP) in lieu of USPOP. The estimated specification can be expressed as follows:

$$\ln I_i = \beta_{0i} + \beta_{1i} \ln \text{POP}_i + \beta_{2i} \ln \text{FPOPRATIO}_i + \beta_{3i} \ln \text{PCPI}_i + \beta_{4i} (\ln \text{PCPI}_i)^2 + \beta_{5i} \ln \text{UTIL}_i + \beta_{6i} \ln \text{MANUF}_i + \mu_i \quad (2)$$

Two forms of the model are run for each emission outcome. The first estimated model uses \ln USPOP and \ln FPOP as proxies for population in order to distinguish the statistical association between emissions and the two different population groups. A Wald test is also completed for coefficient equality between \ln USPOP and \ln FPOP as a means to verify the results. The second estimated model modifies the traditional STIRPAT approach by including \ln POP and \ln FPOPRATIO as proxies for population. This model aims to confirm the well known positive relationship between population and environmental emissions while controlling for foreign-born population concentration. In both forms, income and sector employment are included, while the indicator of coal consumption is also incorporated within SO_2 estimations.

In line with Cole and Neumayer (2004), the analyses estimate population elasticities rather than treating population as a scale factor. While there may exist indirect links between population and environmental emissions via other omitted factors, the present approach focuses solely on the direct link between population composition and emissions. Moreover, other potential county-level factors are not included (e.g., level of urbanization). Neither does the analysis operate at the household level, thereby neglecting other characteristics such as household size, age, and/or gender composition. Admittedly, these are beyond the scope of this paper and should be explored in future research.

Tables 1 and 2 offer descriptive statistics of the variables in their raw form. Observations with values of zero for CO emissions and FOREIGN are excluded from all estimations since it is virtually impossible to have no CO emissions or no foreign-born residents within a particular county.¹⁰ NO_2 and SO_2 are rescaled by multiplying the data by 1,000 and 10,000 respectively. A closer look at the data for the reduced samples reveals the majority of analyzed counties are urban (with a total population greater than 50,000)—96%, 95%, 89%, and 87% for CO, NO_2 , PM_{10} , and SO_2 estimations, respectively. This corresponds nicely with the distribution of the foreign-born population. In fact, the full data set reveals that approximately one million foreign-born residents (3.5% of the total population) live in rural counties (with a total population lower than 50,000). As such, 96.5% reside in urban counties.

The coefficients of interest are α_{2i} and β_{2i} . Positive, statistically significant estimates suggest that counties with a higher number or proportion of foreign-born residents have higher environmental emissions. Negative, statistically significant estimates suggest the opposite. If not statistically different from zero, no difference is identified with regard to emissions across counties characterized by different levels of U.S.- and foreign-born populations.

Estimations are completed using three procedures. First, in order to accommodate potential outliers, estimations are completed using robust regression. This procedure is used to allay potential concerns about biased estimates. The benefit of using a robust regression lies in its iterative process that reduces the weight of extreme values on estimation results. The results derived by a robust regression would be generally very similar to those derived after excluding extreme values from the data.

¹⁰ I would like to thank an anonymous referee for this insight.

Second, to address the same concerns, estimations are also completed using quantile regression. This procedure, commonly described as a “median regression”, estimates the median, which is less sensitive to outliers than a mean, and fits a line through the data that minimizes the sum of the absolute residuals rather than the squared residuals. The third procedure used is a Least Squares estimation with robust standard errors. These heteroscedasticity-consistent standard errors are computed using the quasi-maximum likelihood procedure suggested by Huber (1967) and White (1980). Such a procedure is known to effectively deal with heteroscedasticity in non-binary dependent variable models and potential misspecification of the underlying distribution of the dependent variable.

Estimation results

A quick glance at Tables 3, 4, and 5 reveal that all three estimation procedures yield similar results. This suggests that the log-linear specification is effective in reducing the impact of potential outliers or that there are no observations influential enough to result in potentially biased estimates. Nevertheless, a robust regression is expected to perform better than a quantile regression since the former reduces the weight of extreme values from the data rather than try to fit them (Hamilton 2009). Hence, all interpretations will rely on the estimation results reported in Table 3.

Columns (1) of Table 3 report the estimation results of the first specification (with U.S.-born and foreign-born populations as primary explanatory variables). Counties with a larger foreign-born population have higher CO emissions, net of the other factors in the model. Even so, a Wald test for the null hypothesis of coefficient equality between \ln USPOP and \ln FPOP suggests that the null cannot be rejected at any of the conventional levels of significance.

As for the other pollutants, counties with relatively larger U.S.-born populations have higher NO₂ emissions, statistically significant at the 0.01 level. These results are further confirmed with the rejection of the null hypothesis of coefficient equality between \ln USPOP and \ln FPOP, statistically significant at the 0.01 level.

Estimation results for PM₁₀ emissions reveal that counties with relatively larger U.S.-born populations have higher emissions of this pollutant as well, statistically significant at the 0.01 level. Still, the Wald test for the null hypothesis of coefficient equality between \ln USPOP and \ln FPOP shows that the null cannot be rejected at any of the conventional levels of significance. This suggests that the U.S.-born and foreign-born populations are equally associated with PM₁₀ emissions at the county level.

On SO₂, counties with a larger U.S.-born population exhibit higher SO₂ emissions, whereas those with relatively larger foreign-born populations have lower SO₂ emissions, both statistically significant at the 0.01 level (net of the other factors in the model). This finding is further confirmed with the rejection of the null hypothesis of coefficient equality between \ln USPOP and \ln FPOP.

The results summarized in columns (2) of Tables 3, 4, and 5 suggest that the estimations of the second specification (with total population and proportion of foreign-born population as primary explanatory variables) yields conclusions that

Table 3 Robust regression results

	CO		NO ₂		PM ₁₀		SO ₂	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
U.S.-born population	0.03 (0.08)		0.40*** (0.06)		0.11*** (0.04)		0.49*** (0.10)	
Foreign-born population	0.13*** (0.04)		-0.01 (0.03)		0.03 (0.02)		-0.33*** (0.05)	
Total population		0.16*** (0.05)		0.38*** (0.04)		0.14*** (0.02)		0.16*** (0.05)
Foreign-born proportion		0.13** (0.05)		-0.06 (0.04)		0.01 (0.02)		-0.36*** (0.06)
Income	7.40 (8.36)	7.79 (8.25)	-20.67*** (7.12)	-19.50*** (6.96)	-8.64** (4.31)	-8.38** (4.24)	-0.78 (10.68)	0.80 (10.55)
Income Squared	-0.37 (0.40)	-0.39 (0.39)	0.98*** (0.34)	0.92*** (0.33)	0.40* (0.21)	0.38* (0.20)	0.06 (0.51)	-0.009 (0.51)
Utilities	-0.34** (0.13)	-0.34** (0.13)	0.13 (0.11)	0.11 (0.11)	0.19** (0.07)	0.18** (0.07)	0.08 (0.11)	0.07 (0.11)
Manufacturing	-0.12* (0.07)	-0.12* (0.07)	0.11* (0.06)	0.10* (0.06)	0.08** (0.03)	0.07** (0.03)	0.26*** (0.07)	0.26*** (0.07)
Coal							0.03* (0.02)	0.03* (0.02)
Intercept	-36.72 (42.96)	-39.32 (42.50)	98.99*** (36.60)	93.05*** (35.84)	47.83** (22.09)	46.35** (21.75)	-8.80 (54.78)	-15.56 (54.16)
Observations	172	172	157	157	233	233	192	192
R ²	0.22	0.22	0.42	0.42	0.17	0.18	0.21	0.21
Wald F-Stat	0.59		15.92		1.71		27.77	
Prob > F	0.44		0.00		0.19		0.00	

Coefficient estimates are reported with their corresponding standard errors between parentheses. The Wald test is completed for the null hypothesis that $\alpha_{1i} = \alpha_{2i}$. Asterisks, *, **, and *** denote statistical significance respectively at the 0.10, 0.05, and 0.01 levels

Table 4 Quantile regression results

	CO		NO ₂		PM ₁₀		SO ₂	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
U.S.-born population	0.01 (0.12)		0.44*** (0.09)		0.09** (0.03)		0.54*** (0.12)	
Foreign-born population	0.13** (0.06)		-0.03 (0.05)		0.02 (0.02)		-0.35*** (0.06)	
Total population		0.14** (0.06)		0.39*** (0.06)		0.12*** (0.02)		0.16** (0.06)
Foreign-born proportion		0.13* (0.07)		-0.07 (0.07)		0.02 (0.02)		-0.38*** (0.07)
Income	10.58 (11.57)	10.69 (11.36)	-22.85** (9.50)	-16.50 (10.54)	-5.96 (4.05)	-5.30 (4.03)	5.57 (12.20)	9.85 (11.40)
Income Squared	-0.53 (0.56)	-0.54 (0.54)	1.08** (0.45)	0.78 (0.51)	0.27 (0.19)	0.24 (0.19)	-0.24 (0.59)	-0.45 (0.55)
Utilities	-0.44** (0.19)	-0.44** (0.19)	0.01 (0.16)	0.03 (0.19)	0.20*** (0.07)	0.20*** (0.07)	0.05 (0.13)	0.03 (0.13)
Manufacturing	-0.18* (0.09)	-0.18 (0.09)	0.17** (0.08)	0.14 (0.09)	0.06** (0.03)	0.06** (0.03)	0.19** (0.09)	0.21** (0.08)
Coal							0.03 (0.02)	0.03 (0.02)
Intercept	-51.83 (59.39)	-53.04 (58.49)	110.20** (48.76)	77.55 (54.13)	33.95 (20.74)	30.40 (20.67)	-40.94 (62.55)	-61.65 (58.58)
Observations	172	172	157	157	233	233	192	192
Pseudo R ²	0.13	0.13	0.30	0.31	0.13	0.13	0.14	0.14
Wald F-Stat	0.46		9.78		1.46		22.60	
Prob > F	0.49		0.00		0.22		0.00	

Coefficient estimates are reported with their corresponding standard errors between parentheses. The Wald test is completed for the null hypothesis that $\alpha_{1i} = \alpha_{2i}$. Asrrisks, *, **, and *** denote statistical significance respectively at the 0.10, 0.05, and 0.01 levels

Table 5 Least squares with robust standard errors results

	CO		NO ₂		PM ₁₀		SO ₂	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
U.S.-born population	0.09 (0.09)		0.37*** (0.07)		0.11*** (0.03)		0.47*** (0.10)	
Foreign-born population	0.09* (0.05)		0.003 (0.04)		0.02 (0.02)		-0.30*** (0.06)	
Total population		0.19*** (0.05)		0.38*** (0.03)		0.14*** (0.02)		0.17*** (0.05)
Foreign-born proportion		0.09 (0.06)		-0.03 (0.05)		0.009 (0.02)		-0.34*** (0.06)
Income	1.89 (9.22)	2.51 (9.00)	-21.22*** (5.98)	-20.16*** (5.71)	-7.09 (5.09)	-7.01 (5.04)	-4.54 (10.95)	-2.95 (10.78)
Income Squared	-0.10 (0.44)	-0.13 (0.43)	1.01*** (0.28)	0.95*** (0.27)	0.32 (0.24)	0.32 (0.24)	0.24 (0.53)	0.16 (0.52)
Utilities	-0.28* (0.16)	-0.28* (0.16)	0.20* (0.11)	0.19 (0.11)	0.18** (0.07)	0.17** (0.07)	0.11 (0.13)	0.10 (0.13)
Manufacturing	-0.10 (0.07)	-0.10 (0.07)	0.12** (0.06)	0.11** (0.05)	0.06 (0.03)	0.05 (0.03)	0.26*** (0.08)	0.26*** (0.08)
Coal							0.03* (0.02)	0.03* (0.02)
Intercept	-8.77 (47.56)	-12.37 (46.58)	101.92*** (30.67)	96.46*** (29.40)	39.70 (26.10)	39.17 (25.90)	11.46 (56.37)	4.61 (55.57)
Observations	172	172	157	157	233	233	192	192
R ²	0.26	0.26	0.46	0.47	0.23	0.24	0.21	0.21
Wald F-Stat	0.00		9.56		3.10		22.87	
Prob > F	0.99		0.00		0.08		0.00	

Coefficient estimates are reported with their corresponding robust standard errors between parentheses. The Wald test is completed for the null hypothesis that $\alpha_{1i} = \alpha_{2i}$. Asterisks, *, **, and *** denote statistical significance respectively at the 0.10, 0.05, and 0.01 levels

are generally consistent with those reported in columns (1). Based on the estimation results, counties with a higher number or share of foreign-born residents have lower SO₂ emissions. Moreover, as expected and consistent with the previous literature, counties with a larger total population are associated with higher emissions of all four analyzed pollutants.

Conclusions

This manuscript provides an examination of the association between population composition (native- and foreign-born U.S. residents) and pollutant levels for approximately 200 U.S. counties. Overall, we find no evidence of association between these aspects of population composition and levels of the four considered pollutants.

While these findings provide initial insight on the statistical association between immigrant presence and emissions of air pollutants, further research is strongly recommended. The analyses presented here are limited by data availability (emissions data for approximately 200 urban counties), and the estimates are further limited by the inclusion of only income and employment as control variables. Additional research should incorporate household-level inquiry, longitudinal dimensions, while also controlling for other important factors (e.g., length of residence). Of course, additional environmental pollutant measures would also be useful.

In sum, the ongoing debate about the immigration–environment relationship appears primarily based on subjective arguments due to a lack of empirical evidence on the immigration environment association. In this context, we stress the importance of careful examination of this association and hope this initial analysis provides a foundation for future research.

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