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Factors Influencing the State-Level Settlement Pattern of the Undocumented Immigrant Population in the United States

Richard J. Cebula · Christopher M. Duquette · Franklin G. Mixon Jr.

Abstract This study empirically attempts to identify key factors determining the settlement patterns of undocumented immigrants within the United States. The estimations imply that undocumented immigrants appear to settle in states that border the Atlantic Ocean, Pacific Ocean, or the Gulf of Mexico, and states where median family income is higher, average January temperatures are higher, the percent of the state population that is Hispanic is higher, and where economic freedom is higher. On the other hand, undocumented immigrants are less likely to settle in states with a higher cost of living.

Keywords Unauthorized immigration · Settlement patterns · Pull factors · Push factors

JEL J61 · J62 · J69

Introduction

Undocumented or illegal immigration has been a serious political and economic issue in the United States (U.S.), especially during the past decade. Policies for addressing

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the problem have ranged from increasing border security and sterner deportation policies to policies that pave a direct pathway to legal residence or U.S. citizenship. The issue of immigration, especially undocumented immigration, has also increasingly become the subject matter of scholarly research that addresses a variety of diverse topics.

For example, Mavisakalyan (2011) examined the issue of undocumented immigration and its implications for public education spending and private schooling. In particular, Mavisakalyan (2011, p. 397) investigated the effect on private school enrollment through the mechanism of public education outlays, finding that a growing immigrant share of the population raises enrollment in private schools, confirming similar conclusions by Betts and Fairlie (2003). Other studies have also focused on the issue of immigration and public education (Gerdes 2013; Gradstein and Justman 2000, 2002). Regarding a different form of public outlays, Borjas (1999) addressed the issue of immigration, public welfare, and the related topic of the "welfare magnet."

Regarding a different topic entirely, namely, the skill level of undocumented immigrants, the Pew Hispanic Center (2013) found that they constitute approximately 24 % of all workers in farming occupations, 17 % in cleaning occupations, 14 % in construction, and 12 % in food preparation industries. Cebula and Koch (2008) investigated the impact of undocumented immigration on identity theft (ID theft) in the U.S., finding strong empirical evidence that ID theft is an increasing function of the extent of undocumented immigration, whereas Cebula and Githens (2010) found undocumented immigration to positively impact property crime in the form of both robbery and burglary. From yet a different perspective, Hanson (2006) investigated reasons underlying the increased flow of undocumented immigrants from Mexico to the U.S. He found that there are three specific contributors to this phenomenon: (1) a rise in the relative size of the working-age population in Mexico; (2) greater volatility in U.S.-Mexico relative wages; and (3) changes in U.S. immigration policies. In the case of the latter, Hanson (2006) noted that although U.S. law requires authorities to prevent illegal immigration and take punitive measures against firms employing undocumented immigrants, there has often been relatively lax enforcement of these laws, a view shared by the Congressional Research Service (2006).

Unlike the existing literature on undocumented immigration, the objective of the present study is to empirically investigate what factors influence/have influenced the settlement pattern of undocumented/illegal immigrants within the U.S. In other words, although the issue of undocumented migration has been studied from a variety of very diverse perspectives, the present empirical study is the first to seek to formally identify those key factors motivating this demographic group to choose location in one state as opposed to another. The study is undertaken at the state level for the year 2005, given the availability of pertinent data.

The Framework of Analysis and the Data

In this study, it is assumed that undocumented migrants view the decision to migrate to the U.S. as an investment decision. As such, the decision to migrate from the country of origin, country *i*, to state *j* (within the U.S.) requires that his/her expected net discounted present value of that migration, *DPVij*, be both (a) positive and (b) the

maximum net discounted present value that can be expected from moving from the origin country *i* to any other known and plausible alternative state *j* within the U.S. It is observed that because this study uses undocumented immigration from a variety of undisclosed source nations, and because illegal immigration occurs at a variety of locations along U.S. borders, issues such as distance and moving costs are obviously omitted from the computation of the value of *DPVij* and, thus, from the model based thereupon.[1]

Accordingly, following in principle the models in Tullock (1971), Riew (1973), Renas (1983), Vedder et al. (1986), and Cebula and Alexander (2006), among others, *DPVij* consists in this study of two broad sets of considerations. These are as follows:

1. Economic conditions (broadly defined) in those states; and
2. Quality-of-life conditions in those states.

According to this framework, it follows that population will flow from origin nation *i* to state *j* only if:

$$DPVij > 0; \text{ and } DPVij = \text{MAX for } j, \text{ where } j = 1, 2, \ldots, 50 \quad (1)$$

where 50 represents all of the plausible known alternative state-level destinations for an undocumented migrant in the U.S.

The dependent variable, *SETTLEj*, indicates the percentage of the population in state j that is estimated to consist of undocumented immigrants. Expressing the latter as a percent of the state's total population permits comparisons of the undocumented immigrant settlement pattern across state lines.[2] In effect, this variable can be regarded as a de facto cumulative net in-migration rate. The value of *SETTLEj* is positive for all states. The estimate of the total cumulative undocumented immigrant population residing in the U.S. is estimated at 11.1 million for our study year, 2005, the data for which were estimated with especially rigorous methodologies according to the Pew Hispanic Center (2013, esp. p. 2).[3]

In order to measure economic conditions in state *j* for the econometric estimations provided in this study, five factors are adopted: *MFINCj*, nominal median family income in state *j* (for the year 2003), which is included as a measure of income/wage prospects in state *j*; *COSTj*, the overall cost of living in state *j* for the average four-person family in the year 2005, expressed as an index having a value greater than 0, with COST*j*=100.00 being the mean; *EMPLGRj*, the percentage growth rate of employment in non-farm establishments in state *j* from 1996 to 2000; *ECONFREEj*, an index of economic freedom in state *j* in 2005; and *STINCTXj*, a binary variable indicating the presence of a state income tax in state *j* in 2005, where *STINCTXj*=1 if there is a state income tax and 0 otherwise.

[1] Indeed, such data are effectively unavailable.

[2] An alternative specification of the measure of undocumented immigration is provided in column (c) of Table 3.

[3] For example, it is estimated that in 2005, undocumented migrants accounted for 30 % of the foreign-born population. For the interested reader, the highest concentrations of undocumented immigrants in 2005 were (and still can be) found in the so-called Texas/Louisiana/Oklahoma "zone," Florida, New York, Virginia, Colorado, and the so-called Arizona/Utah/Nevada "zone" (Pew Hispanic Center (2013).

The choice of the variable *MFINCj* is standard in empirical population studies, whereas inclusion of the variable *EMPLGRj* is based on findings in Vedder (1976), Vedder et al. (1986), and Cebula and Alexander (2006) that recent past employment growth is a population magnet. The adoption of a variable such as *COSTj* has become more common in population studies in recent years (Renas 1983; Cebula 1979; Conway and Houtenvile 1998, 2001, 2003; Gale and Heath 2000; Cebula and Alexander 2006). The role of state income taxation in population studies has recently become more prevalent (Conway and Houtenvile 1998, 2001, 2003; Gale and Heath 2000; Cebula and Alexander 2006); in this study, the variable *STINCTXj* is adoped to reflect the presence of a state income tax in state *j*. Finally, the inclusion of a measure of economic freedom (*ECONFREEj*) in a population study has been previously undertaken by Cebula and Clark (2011).

According to various studies, a given population cohort (such as undocumented immigrants) would prefer settling in a state with a higher income since such a circumstance implies better economic prospects, *ceteris paribus* (Riew 1973; Mixon 1993; Saltz 1998; Cebula and Alexander 2006). In addition, since higher previous-period employment growth implies better employment/job prospects (Riew 1973; Vedder et al. 1986; Saltz 1998; Cebula and Alexander 2006), a population cohort would prefer settling in a state with a stronger job growth history, *ceteris paribus*. Since a higher cost of living reduces the purchasing power of one's income, we expect that the population cohort (undocumented immigrants) being studied here would prefer settlement in a state with a lower cost of living, *ceteris paribus* (Renas 1983; Conway and Houtenvile 1998, 2001, 2003; Gale and Heath 2000; Cebula and Alexander 2006). Ruger and Sorens (2009, p. 1) define "economic freedom" as "… the ability to dispose of one's…justly acquired property and resources however one sees fit, so long as it does not coercively infringe upon another individual's ability to do the same." Ruger and Sorens (2009) use a large number of variables representing various factors (including state fiscal policies) that influence economic freedom in all 50 of the states to create an index/measure of economic freedom. The value of this economic freedom index can be either positive or negative. The range for this variable goes from a low of −0.596 for the state of New York, the state ranked lowest in economic freedom, to a high of +0.385 for South Dakota, the state with the highest degree of economic freedom. Given that a state with a higher degree of economic freedom, by its very nature, offers greater economic and entrepreneurial opportunities, our population cohort would presumably prefer residence in such a state, *ceteris paribus* (Ruger and Sorens 2009; Cebula and Clark 2011). Finally, the absence of a state income tax implies not only a lower income tax burden for undocumented immigrants but also a potentially reduced probability of detection by government authorities. In theory, this cohort would prefer states without state income taxes, *ceteris paribus* (Tullock 1971; Conway and Houtenvile 1998, 2001, 2003; Gale and Heath 2000; Cebula and Alexander 2006). To measure quality of life conditions for undocumented immigrants in state *j*, the focus in this study is on three factors, namely: *JANTEMPj*, the mean January temperature in state *j* (1971–2000), as a measure of climatic conditions; *COASTj*, a binary dummy variable indicating that state *j* borders the Atlantic Ocean, the Pacific Ocean or the Gulf of Mexico; and *HISPj*, the documented percentage of the population of state *j* in 2000 that was classified as Hispanic. As in many studies of population settlement patterns (Renas 1983; Saltz 1998; Conway and Houtenvile 1998, 2001, 2003; Gale and Heath

2000; Cebula and Alexander 2006), *JANTEMPj*, or some reasonable substitute for *JANTEMPj*, is considered as a potentially important influence. In earlier studies, and in the present one as well, it is expected that a warmer climate is likely to be an attraction to most population groups, *ceteris paribus*. The variable *COASTj* is a dummy/binary variable used to reflect peoples' preferences for closer proximity to the Atlantic Ocean, the Pacific Ocean, or the Gulf of Mexico, *ceteris paribus* (Vedder 1976; Saltz 1998; Cebula and Alexander 2006; Gale and Heath 2000). Finally, it is expected that the greater the value of *HISPj,* the more attractive state *j* is for settlement for undocumented immigrants because of an elevated expectation of social assimilation due to cultural and language commonalities, *ceteris paribus* (Cebula et al. 1973). Indeed, according to Cebula et al. (1973, p. 500), this kind of behavior is called a "friends and relatives" phenomenon. Moreover, Cebula et al. (1973) further argued that a higher value of *HISPj* might also "…reduce the costs of labor market information."

Based on the variables outlined above, the following eclectic models are to be estimated:

$$\begin{aligned}\mathrm{Log}(SETTLEj) = {} & a_0 + a_1 MFINCj + a_2 COSTj + a_3 EMPLGRj + a_4 ECONFREEj \\ & + a_5\, STINCTXj + a_6\, JANTEMPj + a_7\, COASTj + a_8\, HISPj + u\end{aligned} \tag{2}$$

$$\begin{aligned}(\mathrm{SETTLE}j) = {} & b_0 + b_1 MFINCj + b_2 COSTj + b_3 EMPLGRj + b_4 ECONFREEj \\ & + b_5\, STINCTXj + b_6\, JANTEMPj + b_7\, COASTj + b_8\, HISPj + u'\end{aligned} \tag{3}$$

Equation (2) represents the basic model expressed in semi-log form, whereas Eq. (3) represents the basic model expressed in linear form. Estimating population settlement determinants in semi-log form has become more common in recent years, in part because it is easier to interpret than the standard linear form. Thus, in effect, the linear model in Eq. (3) is to some extent a test of the robustness of the results in Eq. (2). The definitions and data sources for all of the variables in the analysis are provided in Table 1. The expected signs on the coefficients are as follows:

$$\begin{aligned}& a_1, b_1 > 0, a_2, b_2 < 0, a_3,\ \ b_3 > 0, a_4, b_4 > 0, a_5, b_5 < 0, a_6, b_6 > 0, a_7, \\ & \quad b_7 > 0, a_8, b_8 > 0\end{aligned} \tag{4}$$

Descriptive statistics for each of the variables in the analysis are provided in Table 2.

Empirical Findings

In this section of the study, two sets of estimation results are provided: semi-log results, as dictated by Eq. (2); and linear results, as dictated by Eq. (3). The results from estimating semi-log Eq. (2) by OLS, using the White (1980) heteroskedasticity correction, are found in column (a) of Table 3. The terms in parentheses are t-values.

Table 1 Definitions and data sources

Variable	Definition and data source
SETTLEj	the undocumented migrant population in state j as a percent of the state population, 2005; Pew Hispanic Center (2013), U.S. Census Bureau (2007, Table 17)
MFINCj	median family income in state *j*, 2003; U.S. Census Bureau (2005, Table 455)
HISPj	percentage of state *j* population that was documented as Hispanic, 2000; U.S. Census Bureau (2003, Tables 18, 23)
COSTj	ACCRA (2005)
EMPLGRj	percentage growth rate in state *j* employment, 1996–2000; U.S. Census Bureau (2002, Table 602)
STAXj	binary dummy for state *j* income tax; U.S. Census Bureau (2005, Table 455)
COASTj	binary (0, 1) dummy variable for state *j*; U.S. Census Bureau (2009, Table 35)
JANTEMPj	average January temperature in state *j*; U.S. Census Bureau (2005, Table 378)
ECONFREEj	index of economic freedom in state *j*; Ruger and Sorens (2009, Table III, p. 12)
STATEPOPj	total population in state *j*, 2004; U.S. Census Bureau (2006, Table 17)
SETTLENRj	*number* of undocumented immigrants in state j, 2005; Pew Hispanic Center (2013)

Meanwhile, the results from estimating linear Eq. (3) by OLS, using the White (1980) heteroskedasticity correction, are found in column (b) of Table 3.

In column (a) of Table 3, all eight of the explanatory variables exhibit the expected/hypothesized signs,[4] with four statistically significant at the 1 % level and two statistically significant at the 5 % level. The coefficients on the employment growth and state income tax dummy variables both fail to be statistically significant at the 10 % level. The coefficients of determination (R^2 and adjusted R^2) indicate that the model explains approximately seven-tenths to three-fourths of the variation in the interstate settlement pattern of the undocumented immigrant population. Finally, the *F*-statistic is statistically significant at the 1 % level, attesting to the overall strength of the model. Thus, the results shown in column (a) of Table 3 imply that the undocumented population in a state, expressed as a percentage of the population of that state, is an increasing function of the state's median family income level, degree of economic freedom, the mean January temperature, location of the state along "the coast," and the relative size of the documented Hispanic population presence, while being a decreasing function of the overall cost of living in the state.

In this version of our model, the settlement pattern of the undocumented immigrant population is, at the 1 % significance level, an increasing function of *MFINCj*. The evidence indicates that a $1,000 increase in median family income in a state, *ceteris paribus*, would lead to a 9 % increase in the undocumented immigrant population as a percent of the state's total population. The estimated coefficient on the *COSTj* variable is negative and statistically significant at the 1 % level. This result indicates that a one unit rise in the overall living cost index in a state would, *ceteris paribus*, lead to a 1.2 % decline in the undocumented immigrant population as a

[4] See Eq. (4).

Table 2 Descriptive statistics

Variable	Mean	Standard deviation
SETTLEj	2.792	2.109
MFINCj	43,266	6,886
COSTj	100.00	17.31
EMPLGRj	4.291	3.597
ECONFREEj	0.004	0.224
STINCTXj	0.86	0.35
JANTEMPj	32.71	12.65
COASTj	0.40	0.495
HISPj	7.786	8.915

percent of that state's total population. The settlement pattern of the undocumented immigrant population is, at the 5 % statistical significance level, an increasing

Table 3 Semi-log and linear estimation results

Dependent variable: Explanatory variables:	Log (SETTLE*j*) (a)	SETTLE*j* (b)	Log (SETTLENR*j*) (c)
MFINCj	0.00009[a]	0.00016[a]	0.000155[a]
	(6.36)	(4.43)	(4.52)
COSTj	−0.012[a]	−0.023[b]	−0.023[b]
	(−3.51)	(−1.99)	(−2.34)
EMPLGRj	0.018	0.116[c]	0.008
	(0.87)	(1.95)	(0.22)
ECONFREEj	0.79[b]	1.345[b]	1.35[b]
	(2.14)	(1.99)	(2.11)
STINCTXj	−0.117	−0.539	0.33
	(−0.89)	(−1.24)	(0.84)
JANTEMPj	0.027[a]	0.065[a]	0.045[a]
	(4.05)	(3.10)	(2.88)
COASTj	0.32[b]	0.978[b]	0.495[c]
	(2.11)	(2.16)	(1.85)
HISPj	0.0432[a]	0.126[a]	0.035[a]
	(7.09)	(4.90)	(2.87)
STATEPOPj	–	–	0.0000001[a]
			(4.10)
Constant	−2.95	−4.58	5.84
R^2	0.74	0.81	0.78
$adjR^2$	0.69	0.77	0.73
F	14.54[a]	21.47[a]	15.68[a]

[a] statistically significant at 1 % level

[b] statistically significant at 5 % level

[c] statistically significant at the 10 % level

function of the *ECONFREEj* variable. In this case, a 1 % increase in the economic freedom index for a state would, *ceteris paribus*, lead to a 0.79 % increase in the undocumented immigrant population as a percent of the state's total population. The coefficient on *JANTEMPj* is statistically significant at the 1 % level, such that a one degree Fahrenheit increase in the average temperature would induce a 2.7 % increase in the undocumented immigrant population as a percent of the state's total population. The coefficient on *COASTj* is positive and statistically significant at the 5 % level. Given that the results in this estimate are semi-log, it is necessary to adopt the procedure in Halvorsen and Palmquist (1980) when interpreting this dummy variable. Accordingly, the location of a state on the Pacific Ocean, the Atlantic Ocean or the Gulf of Mexico implies a nearly 32 % greater undocumented immigrant population as a percent of that state's total population. Finally, the coefficient on the *HISPj* variable is positive and statistically significant at the 1 % level. Consequently, a 1 % higher value for the documented Hispanic population in a state would be expected to lead, *ceteris paribus*, to a 4.3 % rise in the undocumented immigrant population as a percent of that state's total population.

Qualitatively speaking, the results in column (b) of Table 3 largely parallel those in column (a) of the Table. In particular, all eight of the estimated coefficients in this linear estimate exhibit the expected signs, with three statistically significant at the 1 % level, three statistically significant at the 5 % level, and one nearly significant at the 6 % level (*EMPLGRj*). The results for the latter variable constitute only marginal support for a positive impact of employment growth on the undocumented immigrant population as a percent of a state's total population; nevertheless, the strength of this variable must be interpreted with caution since the t-value does fail to meet the standard criterion for statistical significance, i.e., the 5 % level. In other words, although the empirical evidence from the linear model potentially supports the job growth variable, in view of its weak performance in the semi-log estimate shown in column (a) of Table 3 it is not identified as a key variable in the settlement pattern being investigated in this study. The coefficients of determination (R^2 and adjusted R^2) in this linear specification of the model imply that it explains roughly four-fifths of the interstate variation in the settlement pattern of undocumented immigrants in the U.S. in 2005. Furthermore, the *F*-statistic is again statistically significant at the 1 % level, attesting once again to the strength of the model. Overall, these results imply that the undocumented population in a state, expressed as a percentage of the population of that state, is an increasing function of the state's median family income, degree of economic freedom, average January temperature, location on the coast, and the relative size of the documented Hispanic population presence, while being a decreasing function of the state's overall cost of living. The empirical results for the job growth variable are not compelling enough, especially in view of their weak performance in the semi-log estimate shown in column (a) of Table 3, to be identified as a key variable in the settlement pattern being studied here.[5]

Before proceeding to one additional test of the robustness of the basic model in this study, it is worth mentioning that there were no multi-collinearity issues among the explanatory variables in the model. This finding is illustrated in Table 4, which is the

[5] Arguably, the 5 % level is considered the minimum acceptable critical value for a variable to be considered statistically significant.

Table 4 Correlation matrix

	MFINC	*COST*	*EMPLGR*	*ECONFREE*	*STINCTX*	*JANTEMP*	*COAST*	*HISP*
MFINC	1.000							
COST	0.491	1.000						
EMPLGR	0.086	−0.062	1.000					
ECONFREE	−0.251	−0.052	0.225	1.000				
STINCTX	−0.035	0.006	−0.232	−0.052	1.000			
JANTEMP	−0.154	0.088	0.162	−0.069	−0.055	1.000		
COAST	−0.301	−0.068	−0.134	0.301	0.141	−0.423	1.000	
HISP	0.127	−0.057	0.324	−0.191	−0.218	0.350	−0.248	1.000

correlation matrix. As shown in Table 4, not a single zero-order correlation coefficient has a value of 0.5. As an additional test of the basic model and its robustness, the study now focuses on explaining the settlement pattern of the number of undocumented immigrants in state *j*, *SETTLENRj*. Accordingly, in order to investigate the settlement issue at hand, the study now estimates the following re-specification of Eq. (2):

$$\begin{aligned} \mathrm{Log}(SETTLENRj) = {} & a_0 + a_1 MFINCj + a_2 COSTj + a_3 EMPLGRj \\ & + a_4 ECONFREEj + a_5 STINCTXj + a_6 JANTEMPj + a_7 COASTj \\ & + a_8 HISPj + a_9 STATEPOPj + u'' \end{aligned} \tag{5}$$

Log (*SETTLENRj*) is the natural log of the number of undocumented immigrants in state *j* in the year 2005, *SETTLENRj*; the latter variable has a mean of 225,909 and a standard deviation of 455,242. The variable *STATEPOPj* is the state *j* total (documented) population in 2004 and is included in the estimate as a control variable for state size, i.e., to control for the total state population-size differentials among the 50 states.

The estimation of semi-log form Eq. (5) is provided in column (c) of Table 3. All of the estimated coefficients, except for the case of *STINCTXj*, exhibit the expected signs. The coefficients on variables *STINCTXj* and *EMPLGRj* fail to be borderline significant. However, six of the estimated coefficients, one of which is the population control variable, are statistically significant at the 5 % level or beyond. The coastal variable is borderline significant at the 7.5 % level. Overall, these findings can be regarded as further affirmation of the results in the basic model.

Conclusion

This empirical study has endeavored to identify key variables that have influenced the interstate settlement pattern of the undocumented/illegal immigrant population in the U.S. (United States). The study focuses on this settlement pattern for the year 2005 as a reflection of the assessment by the Pew Hispanic Center (2013) of the accuracy and dependability of the 2005 figures.

In any case, two of the empirical estimates in this study find that the undocumented population in a state, expressed as a percentage of the total documented population

of that state, is an increasing function of the state's median family income level, the degree of economic freedom in the state, the mean January temperature in the state, location of the state along the coast of the Pacific Ocean or the Atlantic Ocean and/or the Gulf of Mexico, and the relative size of the documented Hispanic population presence in the state, while being a decreasing function of the overall cost of living in the state.

Moreover, in the third empirical estimate, the natural log of the number of undocumented immigrants is also found to be an increasing function of the state's median family income level, degree of economic freedom, average January temperature, location along the coast of the Pacific Ocean or the Atlantic Ocean and/or the Gulf of Mexico, and the relative size of the *documented* Hispanic population presence, while being a decreasing function of the overall cost of living.

The consistency of the pattern of findings for the explanatory variables considered in this study notwithstanding, these results should be regarded as somewhat preliminary in nature. This is because there may be other explanatory variables that have been overlooked, e.g., state and local sales tax rates. In addition, the actual numbers of undocumented immigrants are not precisely known, a fact that may confound empirical studies. The latter issue is especially noteworthy in view of the existence of sanctuary states, cities, and counties across the U.S. that do not report the presence and number of undocumented immigrants to federal authorities (Congressional Research Service 2006). Given the apparent magnitude of the illegal immigrant presence in the U.S., much more work needs to be undertaken.

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