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Do foreign-educated nurses displace native-educated nurses?

Abstract

We examine whether there is any movement in the employment of native-educated nurses due to the influx of foreign-educated nurses. To avoid conflating the short- and long-term reactions to the entry of newly arrived foreign-educated nurses, we implement a multiple instrumentation procedure. We find that there is no significant effect of foreign-educated nurses on the employment of native nurses in both the short- and the long-runs. Our results suggest that relying on foreign-educated nurses to fill gaps in the US healthcare workforce does not harm the employment of native nurses.

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1 Introduction

The US population is aging rapidly as the baby boomers reach retirement age. While the number of US citizens aged 65 and over is projected to almost double from 43.1 million in 2012 to 83.7 million by 2050, the working population is expected to decline (Ortman et al., 2014). With this aging population, the prevalence of chronic health problems is expected to increase, and these demographic trends will result in a high demand for nursing care. Therefore, labor-market strategies that can satisfy health-care demands in the long run are needed.

Hiring foreign-educated nurses is one of the strategies that have been actively used to balance demand and supply of health care (Aiken et al. 2007; Kline 2003; Lafer 2005; Tsitouras and Lopez 2009). The US Congress and the Executive Branch have used the immigration policy to increase the nursing workforce. Policies that vary from year to year lead to wide swings in the waiting time for immigrant nurses to obtain work visas. For example, compared to a total of 140,000 permanent employment-based immigrant visas (EB-3) available in 2005 for all skilled workers, the US government earmarked 50,000 special category permanent EB-3 visas for nurses in May 2005 (Arends-Kuenning 2006). In contrast, the Trump administration has been restricting immigration, including through decreases in the number of visas issued (National Foundation for American Policy 2019), historically high denial rates for H-1B visas (Anderson 2019), and slow-walking adjudication processes (Hobson 2019). In particular, the administration has mandated that all applicants for employment-based permanent residency must undergo an in-person interview (Pierce 2019).

The Trump administration argues that immigration has produced lower wages and higher unemployment for US citizens (Borjas 2016); moreover, the strategy of recruiting foreign workers is controversial in nursing markets. Several papers have raised questions about the effects of recruitment of foreign nurses on the quality of patient care in the United States, the quality of care in the sending countries, and labor market opportunities for native workers (Glaessel-Brown 1998; Trucios-Haynes 2002; Martineau et al., 2002; Brush et al., 2004; Lovell 2006; Aiken et al. 2004). The goals of this paper are to evaluate whether the inflow of foreign-educated nurses in the US nursing market displaces native-educated nurses and to answer whether the short-run supply of native-educated nurses is different from the long-run supply.

An emerging literature contributes to the debate about the relationship between recruiting foreign-educated registered nurses (RNs)¹ and the labor market outcomes of domestic nurses (Schumacher 2011; Kaestner and Kaushal 2012; Cortes and Pan 2014; Cortes and Pan 2015). Papers that define immigrant nurses as foreign trained (Schumacher 2011; Kaestner and Kaushal 2012) conclude that the effects of immigrant nurses on native nurses' wages are often statistically insignificant, and when they are statistically significant, they are small. Kaestner and Kaushal (2012) find modest displacement effects of foreign-trained nurses on US-trained nurses but warn that their results might be biased due to weak instruments. Cortes and Pan (2014) define immigrant nurses as foreign born, and they find large displacement effects on native-born nurses, although no significant impacts on wages. The size of the displacement effects of immigrant nurses on native nurses remains an unsettled question. Moreover, studies exploring the effect of immigrant nurses on the US nursing labor market have not focused on the change covering recent periods. Nursing labor markets may have changed because older

¹ Throughout the paper, the term "nurses" refers to registered nurses.

nurses have postponed their retirement and retired nurses have reentered the labor market in response to the Great Recession (Buerhaus et al., 2009). In addition, the US nursing workforce faces increased demand for health services with the passage of the Patient Protection and Affordable Care Act (ACA) in 2010 (Buerhaus et al. 2017; Dillender et al. 2019). In other words, the labor impacts of foreign-educated nurses on native-educated nurses may have changed since 2008, validating an exploration of the question with more recent data.

To observe whether there is any particular movement in the supply of native-educated nurses caused by an increase in foreign-educated nurses, we use two data sets, the 1980–2000 US Censuses and the American Community Survey (ACS) multiyear aggregates, in addition to several empirical strategies. The sample includes employed RNs of ages 25–70 years. Because an RN requires greater skill and has experienced greater employment growth as well as lower unemployment than other major nursing occupations (Benson 2012), this paper considers only RNs. In addition, focusing on one specific occupation alleviates empirical problems. Previous studies examining the effects of immigration on a broader range of native workers did not make the adjustment for demand shifts that may confound the relationship between immigration and wages/employment (Kaestner and Kaushal 2012). Variables that affect the demand for nurses, such as the number of physicians or demographic composition in an area, are controlled for in this study. Therefore, restricting the sample to RNs improves the internal validity of the analysis.

For the empirical strategy, we use an approach based upon the linear model of Cortes and Pan (2014) with ordinary least squares (OLS) and instrumental variable (IV) methods. There are two main differences between our approach and the approach of Cortes and Pan. First, we focus on foreign-educated nurses, not foreign-born nurses. Second, our IV for the inflows of foreign-educated nurses per 1,000 population in a commuting zone (CZ) is the interaction term between the historical distribution by source country of skilled immigrants, excluding nurses across areas in the United States, and the national inflow of new foreign nurses educated abroad. This past settlement instrument helps identify exogenous labor supply shocks. We find no evidence of displacement effects in either the OLS or the IV approach. Instead, we find evidence of complementary effects in the IV approach – for every foreign-educated nurse that migrates to a CZ to work, between one and two native-educated nurses are additionally employed in the area. The difference between our results and those of Cortes and Pan (2014) is primarily driven by our definition of immigrant nurses as foreign educated instead of as foreign born. Because a single instrument may conflate the short- and long-run responses to newly arrived foreign-educated nurses, we implement a multiple instrumentation procedure introduced by Jaeger et al. (2018). Foreign-educated nurses' inflows and their lagged inflows into a CZ are instrumented by the past settlement instrument and its lag. We fail to find any statistically significant displacement effects in either the short or the long run. The double IV estimates are smaller than their corresponding conventional IV estimates, and this is consistent across most of the different age and education groups. In terms of native wages, the estimated impact of the lagged foreign-educated nurses is positive and significant. Our results highlight the importance of longer-term adjustment processes and of the sensitivity of results to the choice of IV.

This study contributes to the literature about the effects of foreign-educated nurses on the US labor market in two ways. First, we approximate local US labor markets by a different

geographic unit, compared to existing studies that conduct the analysis across metropolitan statistical areas (MSAs). MSAs cover areas of the United States with major urban population centers and are adjusted periodically to reflect the growth of cities. In contrast, CZs are a time-consistent measure of local labor markets and cover the entire United States. A CZ is excluded if we observe either zero native or zero foreign-educated RNs.² The resulting 140 CZs encompass both metro and nonmetro areas and thus provide a better understanding of the nursing labor market in the United States than is available using MSAs as the unit of analysis. Table A1 of the Appendix presents a list of the 140 CZs used in this analysis. Second, it is the first study that examines the causal relationship between an increase in foreign-educated nurses and the employment of native-educated nurses with double instruments. Little evidence of displacement effects observed when using a multiple instrumentation procedure implies that the risks of recruiting foreign-educated nurses are overstated. Therefore, the findings of this paper provide policy implications and stimulate several follow-up research questions.

2 Related research

A large body of literature exists on the overall performance of immigrants in the US economy; however, recently, economists have focused attention on the labor market for nurses. To provide general trends in the reliance of the US health-care system on foreign-born health professionals and to suggest how policymakers and health-care practitioners ought to deal with the issue of nursing migration, Arends-Kuenning (2006) examines the relative earnings of RNs, licensed practical nurses, and nursing aides over the time period 1990–2000. She shows the wage differentials by using simple mean comparisons and finds some evidence that foreign-born health professionals have higher annual and hourly wages than their native counterparts.

Schumacher (2011) uses econometric analysis and investigates whether immigrant nurses depress the wages of native nurses. By using the Current Population Survey, which contains information about the country of birth and citizenship status, he finds a lower wage for non-citizen nurses born outside the United States. However, his estimates of the returns to foreign education may be because some immigrant nurses may have obtained training in the States after they migrated. To address this issue, he runs additional regressions with data from the National Sample Survey of Registered Nurses (NSSRN), which identifies nurses who received their training outside the United States. The results indicate a significant wage disadvantage for newly arrived foreign-educated nurses. However, his research on the effects of immigration on the wages of native nurses did not address the nonrandom location decisions of foreign nurses. Kaestner and Kaushal (2012) apply an IV approach with the same NSSRN data set. They adapt the methods of Altonji and Card (1991), using the lagged numbers of the foreign-educated nurses to instrument for the current supply of nurses, concluding that there is no statistically significant relationship between wages and an increase in supply induced by foreign-educated nurses.

Cortes and Pan (2014) also attempt to alleviate the endogeneity issue by an alternative instrument in the nursing market. They exploit the US Censuses for 1980–2000 and the ACS

2 Table A1 of the Appendix shows the distribution of the numbers of native and foreign-educated nurses across commuting zones. Each commuting zone in the sample has at least one native nurse, whereas 217 commuting zones have no foreign-educated nurses sampled in 2015. When we exclude commuting zones that have less than either five US- or five foreign-educated nurses from 1990 to 2015, we have 133 commuting zones as the final areas. Likewise, 120 commuting zones are left if we only include commuting zones with more than both 10 native and 10 foreign-educated nurses.

3-year aggregates for 2010 to estimate the displacement effects of an increase in the supply of foreign-born nurses per capita on the employment of native nurses. For the instrument, they interact the historical distribution of skilled migrants by country of origin across MSAs with the total number of foreign-born nurses from the country. The standard shift-share IV interacts the historical distribution with the inflow of newly arrived immigrant nurses, not the stock at one point in time.³ Their IV estimates imply that one to two native nurses are displaced by each foreign-born nurse and show little evidence that wages fall due to foreign-born nurses. To check whether the quality of coworker interactions in a workplace is an important factor affecting the labor supply decision, the authors use data from the 2006 and 2010 Survey of Registered Nurses conducted by the California Board of Registered Nursing. Their method involves regression of two dependent variables, support from other nurses and teamwork with other nurses, on the share of foreign-educated nurses at the county level in California. They estimate regressions separately for native- and foreign-educated nurses. They have not calculated an instrument for the share of foreign nurses because the sample size is too small. They find that the share of foreign-educated nurses affects domestic nurses and foreign nurses in opposite directions and suggest evidence that a falling off in the quality of working conditions partially drives the displacement. Cortes and Pan (2015) analyze the quality differentials of nurses educated abroad and measure wages as a proxy of skill. They conclude that foreign-educated nurses are on average more productive than native nurses, and Filipino nurses gain a large and highly statistically significant wage premium.

Combining the national inflow of immigrants with their past geographic distribution is a well-known instrument to identify exogenous labor shocks in the literature on immigration. However, relying heavily on a single instrument may cause inconsistent results because of the compound effect generated by the short- and long-run responses to immigrant arrivals (Jaeger et al., 2018). General equilibrium adjustments and the high correlation between the country-of-origin composition and immigrant's settlement patterns are key factors that result in this problem. They argue that multiple instruments ought to be used to avoid conflating a fall in wages when new immigrants enter and a positive movement toward equilibrium. Instrumenting two endogenous variables with the past settlement instrument and its lagged instrument, they address the endogeneity of current and past immigrant inflows to current and past labor demand shocks. The base period to construct the two instruments is 1970, when the country of origin of immigrants was less concentrated and showed more variation than in subsequent years. Furthermore, the authors use US Census data starting from 1980 to avoid a mechanical relationship between the lagged independent variable and the instrument because the instrument is a function of past values of the lagged independent variable. For example, the instrument is correlated with the lagged independent variable if it is determined by the historical distribution of the immigrant share in 1980. They find a negative effect and a positive effect of immigration on natives' wage in the short and long runs, respectively. Their strategy can be used in the study of the US nursing labor market, and hence, this paper separates the initial response and the long-period effects of an increase in foreign-educated nurses on native nurses by adding a lagged past settlement instrument to the regression.

³ The article of Cortes and Pan (2014) is ambiguous about the instrument that they used. On page 165, the description implies that they used a shift-share instrument. However, on page 168, the description given in the text and Eq. (2) indicate that the authors used the stock of foreign nurses from a specific country in year t , rather than the flow of nurses who entered the United States from time $t - 1$ to t .

3 Data and descriptive statistics

The 1980–2000 US Censuses and the ACS's 3-year aggregates for both 2007 (2005–2007) and 2010 (2008–2010) and the 5-year aggregate for 2015 (2011–2015) are used as the data sources. All data were obtained through the Integrated Public Use Microdata Series from the United States (IPUMS-USA) (Ruggles et al. 2017). The decennial Census samples and the ACS sample for 2015 include 5% of the US population, and the ACS samples for 2007 and 2010 include 3% of the population. They contain information on personal and demographic characteristics, the country of birth, earnings, and employment. However, their major limitation is the absence of data on the country of education.⁴ We assume that a foreign-born RN was educated in the United States if the nurse was younger than 25 years old when he or she first arrived to live in the United States. The age of 25 years was chosen to allow for completion of a Bachelor's degree along with 2 years of hospital nursing experience, required to obtain a visa to work as an RN in the United States. According to a person's specific year of entry into the States and the age of this person in the relevant period surveyed, we identify US- and foreign-educated RNs.⁵ In this process, we will miscode those who studied to become a nurse after arriving in the United States and those who completed training in their country of origin and arrived in the United States before the age of 25 years. Nurses born in the United States are assumed to have completed their education in the States.

The samples that represent the population include all individuals not residing in group quarters, while the employment samples are restricted to employed workers aged 25–70 years who reported their occupation to be that of an RN. The population and employment samples are weighted by the Census personal weights. The sample only includes nurses who worked a positive number of hours and weeks in the previous year and received a strictly positive hourly wage. The hourly wage is calculated as the annual earnings divided by the product of usual hours worked per week and weeks worked last year. The wage samples are weighted by the product of the Census personal weight and the number of weeks worked in the previous year. The variable “weeks worked last year” for 2010 and 2015 is a categorical variable, namely, intervals of weeks worked (such as 14–26 weeks or 50–52 weeks). In contrast, the variable “weeks worked last year” for the period 1980–2007 is the precise number of weeks worked. Thus, each variable for 2010 and 2015 is converted to a continuous variable by using the 50th percentile of each interval in 2007. The annual earnings variable includes wages, salaries, commissions, cash bonuses, or tips from all jobs, before tax deductions. Wages are deflated so that they are in terms of the 1999 wages using the Bureau of Labor Statistics (BLS) Consumer Price Index for All Urban Consumers (CPI-U). Wages that were calculated to be less than the minimum wage are set to the minimum wage, and wages calculated to be more than the top-coded yearly wages are set to dollars⁶ adjusted by the CPI-U Research Series (CPI-U-RS) using current methods. We trim hourly wage outliers.

Previous studies, e.g., Kaestner and Kaushal (2012) and Cortes and Pan (2014), have often used MSAs as a proxy for US nursing labor markets. MSAs are defined by the US

⁴ The National Sample Survey of Registered Nurses (NSSRN) includes information about whether the nurse was educated in the United States or another country, and previous literature used this data set. We cannot use it because it was discontinued in 2008. It is also a small data set relative to the Census and the ACS.

⁵ For example, a nurse whose age is 32 years in 2000 and entered into the States to live in 1992 is assumed to be a US-educated nurse because the person's age was calculated as 24 years old when he/she first arrived in the States.

⁶ For example, hourly wages that are more than \$184.55 that are censored at the top are set to \$184.55 for 2015 (Economic Policy Institute 2018).

Office for Management and Budget for statistical purposes and adjusted periodically. However, geographic inconsistency is problematic for an analysis of the changes in employment composition over time. In addition, MSAs only cover areas of the States with major urban population centers. Hence, the main geographical unit of this paper is the CZ, which is a time-consistent measure of local labor markets developed by Tolbert and Sizer (1996). CZs are clusters of counties that are characterized by strong within-cluster and weak between-cluster commuting ties. To match the geographic information contained in the IPUMS data to the CZs, the crosswalk developed by Autor and Dorn (2013) is applied. We multiply the person weights with an adjustment factor that accounts for that fraction of a Census Public Use Micro Area (PUMA) that maps to a given CZ.

Table 1 compares the demographic and labor supply characteristics for US- and foreign-educated RNs. The foreign-educated RNs are more likely to be older and male than US-educated nurses. The average age of nurses and the proportion of nurses who are male have been increasing over time, suggesting that the RN workforce is aging and gender role attitudes have liberalized. The foreign-educated RNs earn higher hourly wages than their counterparts. One explanation for wage differentials in favor of internationally educated nurses is that the foreign educated have higher levels of education on average than the US-educated nurses. Each year, the foreign-educated RNs are more likely to have at least a Bachelor's degree than domestic nurses. In 2015, only 45% of the US-educated RNs had a Bachelor's degree, compared to 61% of the foreign-educated RNs. The foreign-educated RNs work more than the US-educated ones and are also less likely to work part time, which is defined as working ≤ 35 hours during a typical week. Thus, the foreign-educated nurses show greater attachment to the workforce, which would tend to result in higher hourly wages.

Table 2 presents the top 10 source countries for employed foreign-educated RNs from 1980 to 2015. These 10 countries account for close to 70% of the total number of foreign-educated nurses. The largest country of origin is the Philippines. The dominance of the Philippines as a source country can be explained by its history as a colony of the United States and its government policy that encourages overseas employment as a source of funds (Yang and Martinez 2006; Garchitorena, 2007; McDonald and Valenzuela 2012). India has been second, at 7% from 2000, followed by Canada. Canada was the second largest among the source countries, but the percentage of nurses trained in Canada is steadily falling. Table 2 illustrates that there is no large change in the percentage of total foreign-educated nurses accounted for by the top 10 source countries from 1980 to 2015 and that the country-of-origin composition for foreign-educated nurses might not vary much over time.

4 Methodologies and results

4.1 OLS and Single Instrument

To examine the causal effects of immigration of foreign-educated nurses on the employment of domestic nurses in the United States, the analysis closely follows a linear model that Cortes and Pan (2014) used. It basically uses the “cross-area approach” proposed by Card (2001), with the assumptions that areas represent separate labor markets and that employment of an RN is determined by the supply and demand factors in those markets. We exclude CZs that have zero RNs among the 741 CZs that encompass the 51 US states. Thus, 140 CZs are finally used

Table 1 Demographic and labor supply characteristics of US-educated and foreign-educated nurses, 1980–2015

	US-educated RNs					
	1980	1990	2000	2007	2010	2015
Age, mean, in years	39.25	40.01	42.90	44.71	44.99	44.60
Gender						
Female	95.91	94.48	92.44	91.29	91.12	90.20
Male	4.09	5.52	7.56	8.71	8.88	9.80
Race						
White	90.14	88.18	85.01	83.38	82.22	81.17
Black	7.97	8.66	8.71	9.34	9.95	10.10
Asian	1.46	1.94	3.64	4.33	5.11	5.41
Native American	0.30	0.39	0.40	0.45	0.40	0.40
Other races	0.12	0.83	2.25	2.50	2.32	2.93
Hispanics	1.84	2.67	3.26	4.17	5.10	5.96
Marital status						
Married	67.13	67.53	68.14	65.88	65.40	63.96
Widow/divorced/separated	18.26	18.79	19.56	20.56	20.25	19.09
Single	14.61	13.68	12.30	13.56	14.35	16.95
Educational attainment						
Less than high school	12.35	0.56	0.21	0.07	0.21	0.19
High school	6.06	15.43	11.27	6.45	6.69	6.00
Associate's degree	48.51	38.38	35.96	37.32	37.40	34.65
Bachelor's degree	21.91	32.45	38.75	42.01	42.66	44.83
Graduate degree	11.18	13.19	13.80	14.15	13.04	14.33
Spanish speaking	1.98	2.91	3.62	3.91	4.15	4.50
Part time	31.00	30.22	26.32	25.13	23.37	21.70
Hourly wage (US \$), mean	16.24	20.65	22.89	24.42	24.47	23.97
Hours worked/week, mean	34.67	36.24	37.11	37.46	37.52	37.72
Number of observations	51,739	81,944	100,102	72,886	78,993	137,429
Estimated number	1,034,780	1,638,880	2,002,040	2,429,533	2,633,100	2,748,580
	Foreign-educated RNs					
	1980	1990	2000	2007	2010	2015
Age, mean, in years	41.15	44.00	45.74	46.61	47.12	48.16
Gender						
Female	93.63	93.88	89.48	86.75	86.36	84.33
Male	6.37	6.12	10.52	13.25	13.64	15.67
Race						
White	36.33	27.22	24.02	20.66	19.36	19.50
Black	16.56	18.52	20.65	21.57	20.14	22.84
Asian	45.96	52.30	49.14	54.39	57.19	54.03
Native American	0.16	0.22	0.18	0.06	0.18	0.20
Other races	0.99	1.74	6.01	3.32	3.14	3.43
Hispanics	8.49	7.25	5.12	5.11	5.34	5.62
Marital status						
Married	64.27	68.74	71.68	71.53	73.32	72.86
Widow/divorced/separated	14.55	15.63	15.03	16.27	15.32	16.79
Single	21.18	15.63	13.29	12.20	11.36	10.34

(Continued)

Table 1 Continued

	Foreign-educated RNs					
	1980	1990	2000	2007	2010	2015
Educational attainment						
Less than high school	17.50	1.42	0.80	0.60	0.58	0.53
High school	5.09	15.30	11.19	6.06	5.15	5.05
Associate's degree	26.12	24.98	22.77	20.45	19.85	18.92
Bachelor's degree	27.46	43.57	51.06	57.98	61.15	61.01
Graduate degree	23.84	14.74	14.19	14.91	13.27	14.48
Spanish speaking	6.29	6.15	5.44	5.27	5.11	5.77
Part time	17.60	16.89	15.14	12.07	12.89	13.77
Hourly wage (US \$), mean	18.36	24.41	27.49	28.16	27.52	27.87
Hours worked/week, mean	37.29	38.60	39.04	40.12	39.48	39.10
Number of observations	3,241	4,459	5,460	4,955	5,871	10,332
Estimated number	64,820	89,180	109,200	165,167	195,700	206,640

RN, registered nurse; BLS, Bureau of Labor Statistics; CPI-U, Consumer Price Index for All Urban Consumers.

Source: The data are from the US Censuses and the American Community Survey (ACS) multiyear aggregates.

Notes: The Census samples and ACS sample for 2015 include 5% of the US population, while the ACS samples for 2007 and 2010 include 3% of the population. The samples are restricted to employed registered nurses aged 25–70 years old. Wages are deflated so that they are in terms of the 1999 wages using the BLS CPI-U.

for the analysis. These CZs cover only 19% of the nation's land, but they cover 80% of the US workforce.⁷ The empirical specification is as follows:

$$\left(\frac{\text{USEN}}{\text{Population}} \right)_{it} = \alpha + \beta \left(\frac{\text{FEN}}{\text{Population}} \right)_{it} + \gamma X_{it} + \delta_i + \lambda_t + \varepsilon_{it} \quad (1)$$

where i is the CZ, and t is the time period ($t = 1990, 2000, 2007, 2010$, and 2015). For the main dependent and independent variables, the number of full-time employed US- and foreign-educated nurses⁸ per 1,000 population in a CZ i in each time period t is focused on. To compute full-time employment, we include nurses working at least 35 h/week and one-half of nurses working <35 h/week.

Similarly to Cortes and Pan (2014), we assume that the US-educated nursing labor force is a function of the number of full-time employed, foreign-educated nurses per 1,000 population and time-varying CZ-level characteristics (X_{it}). Time-varying CZ-level controls consist of proxies for demand and supply determinants. The demand-side factors include the share of the population aged ≥ 65 years, the log of average hourly wages to describe a CZ's income level, the number of physicians in the labor force per 1,000 population, and the number of Spanish speakers at home per 1,000 population. The supply-side factors of the US nursing labor market include the share of the population aged 25–29, 30–34, 35–39, 40–44, 45–49, 50–54, 55–59, and 60–64 years; the number of females in the labor force who have professional occupations,⁹ excluding RNs; the labor force participation of skilled married females; the share of skilled

⁷ Thus, 120 commuting zones, excluding areas with either <10 native nurses or <10 foreign-educated nurses from 1980 to 2015, cover 17% of the nation's mainland, but they cover 77% of the US workforce (Table A2 in Appendix).

⁸ For expositional convenience, we refer to the US-educated nurses and foreign-educated nurses as the "USENs" and "FENs", respectively.

⁹ Occupations are grouped by BLS, and it defines that most professional occupations require educational preparation (for lists of professional occupation, visit: <https://www.bls.gov/ncs/ocs/ocsm/commoga.htm>).

Table 2 Top 10 source countries for employed FENs in the United States, 1980–2015

1980 (N = 3,241)			1990 (N = 4,459)			2000 (N = 5,460)		
Birthplace	N	%	Birthplace	N	%	Birthplace	N	%
Philippines	883	27.25	Philippines	1,566	35.11	Philippines	1,767	32.37
Canada	354	10.91	Jamaica	344	7.72	India	398	7.29
India	199	6.15	Canada	298	6.69	Canada	373	6.83
Jamaica	195	6.01	India	270	6.05	Jamaica	355	6.51
Korea	148	4.56	Korea	154	3.46	Nigeria	217	3.97
England	107	3.29	Ireland	115	2.57	Korea	150	2.75
Ireland	101	3.11	England	102	2.29	Guyana/British Guiana	116	2.13
Thailand	74	2.28	Trinidad and Tobago	89	2.00	England	116	2.12
Trinidad and Tobago	64	1.99	Thailand	77	1.73	China	112	2.05
West Germany	59	1.83	Barbados	60	1.34	Trinidad and Tobago	96	1.77
Percentage of total FENs accounted for by top 10 source countries		67.38			68.96			67.79
2007 (N = 4,955)			2010 (N = 5,871)			2015 (N = 10,332)		
Birthplace	N	%	Birthplace	N	%	Birthplace	N	%
Philippines	1,792	36.17	Philippines	2,335	39.77	Philippines	3,910	37.84
India	421	8.49	India	476	8.11	India	797	7.72
Canada	251	5.07	Jamaica	2665	4.53	Nigeria	593	5.64
Nigeria	229	4.63	Nigeria	262	4.46	Jamaica	404	3.91
Jamaica	220	4.44	Canada	229	3.91	Canada	381	3.69
Korea	162	3.26	Korea	191	3.26	Korea	282	2.73
Haiti	142	2.86	China	145	2.47	China	232	2.25
China	122	2.47	Haiti	121	2.06	Haiti	203	1.97
Trinidad and Tobago	74	1.49	Guyana/British Guiana	70	1.20	Ghana	196	1.90
England	70	1.42	Cuba	70	1.19	Cuba	148	1.44
Percentage of total FENs accounted for by top 10 source countries		70.30			70.96			69.09

FENs, foreign-educated nurses.

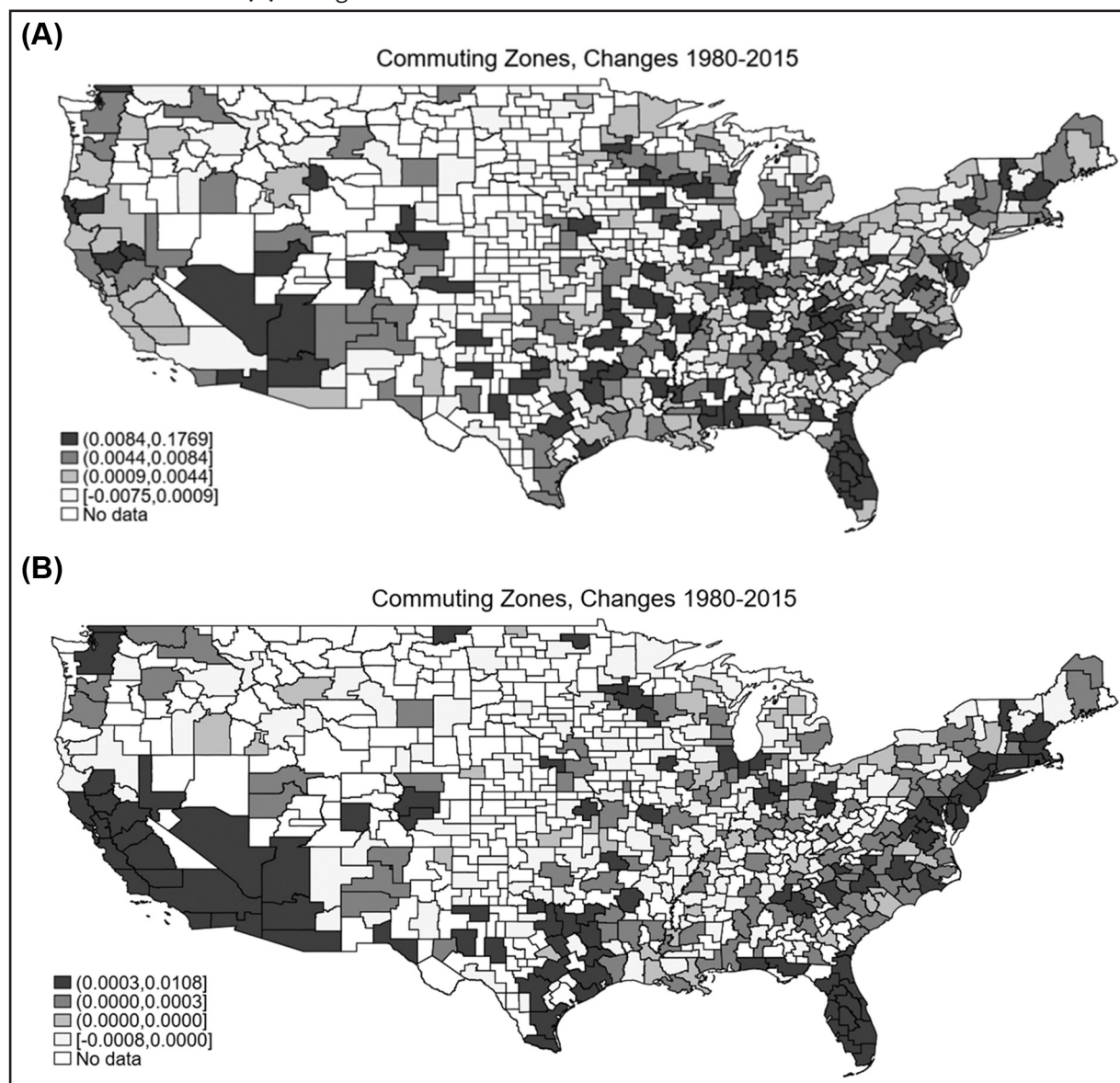
Source: The data are from the US Censuses and the American Community Survey (ACS) multiyear aggregates.

Notes: The Census samples and ACS sample for 2015 include 5% of the US population, while the ACS samples for 2007 and 2010 include 3% of the population. The samples for this table are restricted to employed foreign-educated registered nurses aged 25–70 years old.

whites in the labor force in the population; and the log average hourly wages of employed women who have received some college or more education, excluding RNs. CZ (δ_i) and year (λ_t) fixed effects are also included in the specification.

There are two widely recognized concerns with this strategy. First, the local markets are not closed, and natives may respond to the immigrant supply shock by moving to other areas. For example, domestic nurses in a CZ that received many immigrant nurses may escape the economic conditions by moving to locations with few immigrants. However, a native mobile response to immigration has not been strongly supported by empirical evidence. Card and Lewis (2007) argue that native outmigration in response to an inflow of immigrants appears

Figure 1 Changes in the number of registered nurses as a share of the initial population. **(A)** US-educated nurses and **(B)** Foreign-educated nurses.



Note: The data are from the US Censuses and the American Community Survey multiyear aggregates. The samples are restricted to employed registered nurses aged 25–70 years old, and we plot the maps for the US mainland only. These maps show that growth in number of foreign-educated nurses is not randomly distributed across the United States.

to be relatively small. Second, immigrants are not randomly distributed across labor markets. Immigrants tend to select locations where previous immigrants have settled because they could lower the cost of job searching and moving to a new place given the availability of information networks (Munshi 2003). Figure 1 shows the geography of the change in the number of employed nurses as a share of the initial population for the period 1980–2015, indicating the CZs with larger increases of RNs with darker shades of gray. The change in number of native nurses as a share of the initial population is less concentrated in specific areas than for the number of foreign-educated RNs. Several CZs in California, Texas, and the East Coast show the largest values for internationally educated nurses. If the areas where immigrants cluster have done well over time periods, this produces a spurious correlation between immigration

and area outcomes. For example, a positive correlation indicates that immigrants choose to live in areas where the labor outcomes are relatively good.¹⁰ This correlation could obscure the hypothesized effects of the inflow of foreign-educated nurses on their counterparts even though the regression model includes a vector of area fixed effects.

To control for this possible endogeneity bias, the tendency of foreign-educated nurses to settle in an area with a large group of immigrants from the same country of origin is commonly used. The instrument is an interaction between the historical distribution of skilled migrants, excluding RNs, across US CZs and the national inflow of foreign-educated nurses aged 25–70 years old in the labor force. Formally, the instrument for the number of foreign-educated nurses in a CZ i and year t is as follows:

$$\tilde{m}_{it} = \sum_c \frac{\text{Skilled Immigrants}_{ci,1980}}{\text{Skilled Immigrants}_{c,1980}} * \Delta FEN_{t,-i} \quad (2)$$

where c refers to the country of birth, i the CZ, and t time period ($t = 1990, 2000, 2007, 2010$, and 2015). An immigrant is identified based on the country of birth, and a skilled immigrant is defined as an individual who reports having at least an Associate's degree and being in the labor force. The first term in the interaction is the fraction of skilled immigrants from the same country of origin in a CZ i at reference date 1980, and the second term is the total number of newly arrived foreign-educated nurses from that country of birth between t and $t - 1$ at the national level, being the net contribution of CZ i to the national inflow. There is a potential concern that a few large areas drive the national import of nurses, and the national inflow of foreign-educated nurses is not orthogonal to the local demand conditions. To reduce this issue, we exclude the contribution of each observation's area to the national inflows in each time period. A justification of this “past settlement instrument” is that location choices in 1980 of skilled immigrants, excluding RNs, are exogenous to changes in the demand for foreign-educated nurses over time periods, and that a change in the national inflow of foreign-educated nurses in a given period is not endogenous to local conditions.

Estimates for the first-stage regression of the foreign-educated nurses per 1,000 population in a CZ on the instrument (the predicted number of foreign-educated nurses in the CZ per 1,000 population) are presented in Table 3. The estimates are statistically significant and robust to the inclusion of the controls and fixed effects. The coefficients on the instrument for the 1990–2015 time period (first five columns) and the 2000–2015 time period (last five columns) indicate that as the predicted number of foreign-educated nurses in a CZ increases by 10, approximately 3–6 foreign-educated nurses would enter into the CZ. In the whole samples, we do not have a weak instrument problem. Stock and Yogo (2002) report that a first-stage F statistic > 8.96 of the Stock and Yogo threshold on the 15% tolerable bias level is sufficient to reject the null hypothesis of a weak instrument.

Table 4 presents the estimates of the relationship between the importation of foreign-educated nurses and the employment of native-educated nurses in Eq. (1). Panel A reports the OLS estimates, and Panel B displays the IV estimates for the displacement regression. All regressions are weighted by the CZ's population, and standard errors are clustered at the CZ level. The difference between Columns (1)–(5) and (6)–(10) is the exclusion of observations

¹⁰ Cadena and Kovak (2016) demonstrated that location choices of low-skilled Mexican-born immigrants in the United States are strongly influenced by changes in local labor market conditions.

Table 3 The first-stage regressions

	Dependent variable: Foreign-educated nurses per 1,000 population									
	1990–2015					2000–2015				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Predicted foreign-educated RNs per 1,000 population	2.414*** (0.604)	0.521** (0.220)	0.296** (0.166)	0.574* (0.308)	0.241 (0.348)	2.493*** (0.628)	0.369** (0.214)	0.232* (0.183)	0.362 (0.415)	0.241 (0.348)
Controls		X	X	X	X		X	X	X	X
Year FE	X	X	X	X	X	X	X	X	X	X
Area FE			X	X	X			X	X	X
Pre-Great Recession				X					X	
Great Recession and Post-Great Recession					X					X
F-statistics	496.73	32.05	10.21	23.76	2.35	341.64	20.63	10.23	5.43	2.35
Observations	700	700	700	420	280	560	560	560	280	280
R ²	0.453	0.817	0.943	0.967	0.973	0.410	0.813	0.947	0.977	0.973

RN, registered nurse; FE, fixed effect.

Source: The data are from the US Censuses and the American Community Survey multiyear aggregates.

Notes: The dependent variable in the first-stage regressions is the number of foreign-educated nurses aged 25–70 years as a fraction of a whole population in a commuting zone. The instrument is constructed by using the historical distribution of skilled immigrants (no restrictions on age or labor force status), excluding those who are registered nurses, across commuting zones in 1980 to allocate the national inflow of foreign-educated nurses to each commuting zone. All specifications are weighted by the whole population in the commuting zone. Standard errors in parentheses are clustered at the commuting zone level. Significance is indicated by the symbol * at the 10% level, ** at the 5% level, and *** at the 1% level.

from 1990 (or the 1990 sample).¹¹ The OLS estimates are negative and statistically significant without the CZ fixed effects, and the magnitudes with control variables indicate that the inflow of 10 internationally educated nurses in a CZ causes the displacement of 5–6 native-educated nurses. However, the estimates become positive and statistically insignificant in the preferred specification [Columns (3) and (8)], which includes controls and two fixed effects. The OLS estimates are likely to be confounded by demand or supply shocks to the US nursing market, and thus, cautious interpretation is needed.

To identify exogenous labor shocks, the IV strategy is used. Panel B reports the 2SLS estimates, wherein we instrument for the number of full-time employed foreign-educated nurses per 1,000 CZ individuals using the past settlement instrument [Eq. (2)]. The IV estimates are negative with the inclusion of controls and year fixed effects. The magnitudes range from –3.018 to –1.902, indicating that for every foreign-educated RN who enters a CZ, the number of native-educated nurses decreases by 2–3. We include area fixed effects to circumvent the issue that the baseline geographic sorting of foreign-educated nurses originating in a country c was partly determined by preexisting regional difference in employment opportunities. The IV estimates are positive and significantly different from zero with the full sample [Columns (3) and (8)], and the magnitudes imply that for every foreign-educated nurse who enters a CZ, approximately 1–2 native nurses are employed. The results indicate that the instrument is likely

¹¹ The reason for estimating with two different samples is to compare the latter results with the outcomes obtained by using a multiple instrumentation procedure.

Table 4 Displacement effects of foreign-educated RNs on US-educated RNs

	Dependent variable: US-educated nurses per 1,000 population									
	1990–2015					2000–2015				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
OLS										
Foreign-educated nurses per 1,000 population	–1.730***	–0.636**	0.215	–0.020	0.605	–1.816***	–0.466*	0.205	–0.035	0.605
	(0.347)	(0.250)	(0.286)	(0.261)	(0.381)	(0.339)	(0.254)	(0.263)	(0.398)	(0.381)
Observations	700	700	700	420	280	560	560	560	280	280
R ²	0.390	0.778	0.932	0.954	0.968	0.390	0.790	0.946	0.975	0.968
2SLS (single instrument)										
Foreign-educated nurses per 1,000 population	–1.988***	–1.902***	2.182**	0.107	0.970	–2.223***	–3.018*	1.878*	0.237	0.970
	(0.465)	(0.737)	(0.995)	(0.740)	(1.487)	(0.476)	(1.734)	(1.355)	(1.495)	(1.487)
Observations	700	700	700	420	280	560	560	560	280	280
R ²	0.383	0.746	0.909	0.954	0.967	0.374	0.664	0.931	0.975	0.967
Controls		X	X	X	X		X	X	X	X
Year FE	X	X	X	X	X	X	X	X	X	X
Area FE			X	X	X			X	X	X
Pre-Great Recession				X					X	
Great Recession and Post-Great Recession					X					X

RN, registered nurse; OLS, ordinary least squares; 2SLS, two-stage least squares; FE, fixed effects.

Source: The data are from the US Censuses and the American Community Survey multiyear aggregates.

Notes: The dependent variable is the number of full-time employed US-trained nurses aged 25–70 years per 1,000 population in a commuting zone, and the main independent variable is the number of full-time employed, internationally trained nurses aged 25–70 years per 1,000 population in a commuting zone. For the specification, the 2SLS model including controls and fixed effects is applied. The instrument is constructed by using the historical distribution of skilled immigrants, excluding those who are registered nurses, across commuting zones in 1980 to allocate the national inflow of foreign-educated nurses to each commuting zone. All specifications are weighted by the whole population in the commuting zone. Standard errors in parentheses are clustered at the commuting zone level. Significance is indicated by the symbol * at the 10% level, ** at the 5% level, and *** at the 1% level.

to be confounded by unobserved demand and supply shocks, thereby justifying the use of the multiple instrumentation procedures.

Because our results are very different from those of Cortes and Pan (2014), who found large employment displacement effects of foreign-born nurses on native-born nurses, we examine the source of the difference (the results are available from the authors by request). We conclude that the difference is driven by the use of the definition of “foreign educated” instead of “foreign born” for immigrant nurses. We found negative effects of the supply of foreign-born

nurses on the supply of US-born nurses using the IV strategy. The difference was not driven by our inclusion of the most recent years of data. We found no difference between the Great Recession and the post-Great Recession periods (Table 4). We also concluded that the difference in results was not driven by using CZs instead of MSAs as the geographic area of analysis. We found a positive effect of foreign-educated nurses on US-educated nurses and a negative effect of foreign-born nurses on US-born nurses when using metropolitan areas as the unit of analysis. The definition of immigrant nurses makes a difference for the results.

We additionally investigate the groups of native nurses that are the most affected by the employment of foreign-educated nurses. Tables 5 and 6 present the effects by different age groups and education levels, respectively. Only the 2SLS model including controls and fixed effects is applied for the specification. Table 5 shows that there is little evidence of displacement effects of native RNs in response to the influx of foreign-educated RNs, except for the youngest native nurses. The magnitude of the coefficient for US-educated nurses aged 25–29 suggests that for every 10 foreign-educated nurses who enter a CZ, approximately eight to nine native-educated nurses are employed in the CZ. It is intuitive given that foreign-educated nurses are likely to be composed of relatively older nurses, and newly educated native nurses are positively affected by the foreign-educated ones. With respect to education levels, we find positive and significant effects for US-educated RNs with a graduate degree. This result is not surprising

Table 5 Displacement effects of foreign-educated RNs on US-trained RNs by age

	Dependent variable: US-educated nurses per 1,000 population								
	1990–2015								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Age, years	25–29	30–34	35–39	40–44	45–49	50–54	55–59	60–64	65–70
Foreign-educated nurses per 1,000 population	0.818**	–0.155	0.387	–0.057	0.394	0.218	0.164	0.331	0.081
	(0.380)	(0.314)	(0.383)	(0.269)	(0.292)	(0.294)	(0.302)	(0.303)	(0.105)
Observations	700	700	700	700	700	700	700	700	700
R ²	0.631	0.757	0.727	0.792	0.793	0.847	0.877	0.802	0.709
	2000–2015								
	25–29	30–34	35–39	40–44	45–49	50–54	55–59	60–64	65–70
Foreign-educated nurses per 1,000 population	0.906**	–0.068	0.431	–0.514	–0.047	0.040	0.135	0.569	0.125
	(0.761)	(0.391)	(0.594)	(0.489)	(0.450)	(0.397)	(0.429)	(0.545)	(0.181)
Observations	560	560	560	560	560	560	560	560	560
R ²	0.497	0.736	0.703	0.783	0.808	0.824	0.863	0.743	0.691

RN, registered nurse; 2SLS, two-stage least squares.

Source: The data are from the US Censuses and the American Community Survey multiyear aggregates.

Notes: The dependent variable is the number of full-time employed US-trained nurses aged 25–70 years per 1,000 population by age groups in a commuting zone, and the main independent variable is the number of full-time employed internationally trained nurses aged 25–70 years per 1,000 population in a commuting zone. For the specification, the 2SLS model including controls and fixed effects is applied. The instrument is constructed by using the historical distribution of skilled immigrants, excluding those who are registered nurses, across commuting zones in 1980 to allocate the national inflow of foreign-educated nurses to each commuting zone. All specifications are weighted by the whole population in the commuting zone. Standard errors in parentheses are clustered at the commuting zone level. Significance is indicated by the symbol * at the 10% level, ** at the 5% level, and *** at the 1% level.

Table 6 Displacement effects of foreign-educated RNs on US-trained RNs by education

	Dependent variable: US-educated nurses per 1,000 population									
	1990–2015					2000–2015				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Less than high school	High school	Associate's degree	Bachelor's degree	Graduate degree	Less than high school	High school	Associate's degree	Bachelor's degree	Graduate degree
Foreign-educated nurses per 1,000 population	0.019 (0.039)	0.207 (0.249)	0.840 (0.829)	0.158 (0.668)	0.658* (0.431)	0.024 (0.053)	0.175 (0.288)	0.715 (0.105)	0.041 (0.730)	0.924** (0.647)
Observations	700	700	700	700	700	560	560	560	560	560
R ²	0.421	0.890	0.853	0.900	0.755	0.383	0.878	0.902	0.901	0.724

RN, registered nurse; 2SLS, two-stage least squares.

Source: The data are from the US Censuses and the American Community Survey multiyear aggregates.

Notes: The dependent variable is the number of full-time employed US-trained nurses aged 25–70 years per 1,000 population by education levels in a commuting zone, and the main independent variable is the number of full-time employed internationally trained nurses aged 25–70 years per 1,000 population in a commuting zone. For the specification, the 2SLS model including controls and fixed effects is applied. The instrument is constructed by using the historical distribution of skilled immigrants, excluding those who are registered nurses, across commuting zones in 1980 to allocate the national inflow of foreign-educated nurses to each commuting zone. All specifications are weighted by the whole population in the commuting zone. Standard errors in parentheses are clustered at the commuting zone level. Significance is indicated by the symbol * at the 10% level, ** at the 5% level, and *** at the 1% level.

given that native nurses with a graduate degree are specialists who are not direct competitors with foreign-educated nurses who typically have a baccalaureate degree. Differences in educational attainment reduce the competition between US- and foreign-educated workers and add to overall complementarity (Borjas 2003; Ottaviano and Peri 2006; Wolla 2014).

The IV estimates are suggestive of the positive association between foreign-educated nurses and native nurses with area fixed effects, and we investigate the potential role of wages to explain the reason for the effects. It is theoretically expected that the influx of immigrant workers would lower the hourly wages of domestic employees, but empirical findings from the literature on the wage effects of foreign workers on their counterparts show a wide range of inconsistency, from negative to positive effects (Borjas and Katz 2007; Card and Peri 2016). The effects of immigration in nursing may differ from those observed for workers in general or in other occupations. In the US nursing market, foreign-educated nurses might earn more than native nurses because they are more willing to work under undesirable conditions, such as night shifts. In addition, >20% of domestic nurses work part time (see Table 1).

Table 7 reports the two separate results for wages. Panel A investigates the hourly wages of employed native nurses, whereas Panel B focuses on the hourly wages of the restricted sample that includes only full-time employed US-educated nurses. The IV method is used in both Panel A and Panel B. The estimates are mixed and do not point to a systematic association. Large changes in the magnitudes are not observed between Panel A and Panel B, supporting the view that employment status is not the only driving factor in determining hourly wages. We generally fail to find any significant effect of foreign-educated nurses on native wages, similar to Cortes and Pan (2014) and Kaestner and Kaushal (2012).

Overall, these findings suggest that the positive employment effects between US- and foreign-educated nurses within a CZ are largely driven by complementarity across age groups and education levels or by no harmful wage effect of the entry of foreign-educated nurses into the US nursing markets.

4.2 Multiple instruments

Although spatial variation in the concentration of immigrants has been commonly used to identify their labor market impact, Jaeger et al. (2018) point out that the conventional instrument can still result in biases. The problem stems from the interplay of general equilibrium adjustments and a correlation between immigrants' country of origin and their settlement patterns. They argue that a single instrument may conflate the short-run wage impacts of immigrant arrivals with the long-run responses to previous supply shocks. If the short-term effects are dominated by the long-run effects, it is common to find different signs on the estimates.

To solve this issue, they introduce the "multiple instrumentation" procedure. By limiting the inclusion of past immigrant inflows to one lag, the empirical specification is as follows:

$$\left(\frac{\text{USEN}}{\text{Population}} \right)_{it} = \alpha + \beta_1 \left(\frac{\text{FEN}}{\text{Population}} \right)_{it} + \beta_2 \left(\frac{\text{FEN}}{\text{Population}} \right)_{it-1} + \gamma X_{it} + \delta_i + \lambda_t + \varepsilon_{it} \quad (3)$$

where i is the CZ, and t is the time period ($t = 2000, 2007, 2010$, and 2015).¹² The term β_1 captures the impact of hiring foreign-educated nurses on domestic nurses in the short

¹² To avoid a mechanical relationship between the current inflows of foreign-educated nurses at time t and the lagged instrument, the base year should be strictly prior to $t - 1$ (Jaeger et al. 2018).

Table 7 Wage effects of foreign-educated RNs on US-educated RNs

Dependent variable: Log (average hourly wages of US-educated nurses)										
	1990–2015					2000–2015				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Employed US-educated nurses (2SLS – single instrument)										
Foreign-educated nurses per 1,000 population	0.218***	0.232	–0.141	–0.007	–0.091	0.230***	0.389	–0.119	0.048	–0.091
	(0.046)	(0.169)	(0.135)	(0.084)	(0.242)	(0.049)	(0.290)	(0.173)	(0.119)	(0.242)
Observations	700	700	700	420	280	560	560	560	280	280
R ²	0.532	0.632	0.931	0.963	0.977	0.361	0.212	0.935	0.971	0.977
Full-time employed US-educated nurses (2SLS – single instrument)										
Foreign-educated nurses per 1,000 population	0.210***	0.202	–0.096	–0.035	0.025	0.220***	0.342	–0.071	–0.010	0.025
	(0.039)	(0.142)	(0.109)	(0.081)	(0.161)	(0.041)	(0.249)	(0.134)	(0.129)	(0.161)
Observations	700	700	700	420	280	560	560	560	280	280
R ²	0.587	0.691	0.941	0.960	0.978	0.420	0.332	0.942	0.966	0.978
Controls		X	X	X	X		X	X	X	X
Year FE	X	X	X	X	X	X	X	X	X	X
Area FE			X	X	X			X	X	X
Pre-Great Recession				X					X	
Great Recession and Post-Great Recession					X					X

BLS, Bureau of Labor Statistics; CPI-U, Consumer Price Index for All Urban Consumers; USEN, US-educated nurses; 2SLS, two-stage least squares; FE, fixed effects.

Source: The data are from the US Censuses and the American Community Survey multiyear aggregates.

Notes: The dependent variable is the average log hourly wages of native nurses in a commuting zone, and the main independent variable is the number of full-time employed internationally trained nurses aged 25–70 years per 1,000 population in a commuting zone. Wages are deflated so that they are in terms of the 1999 wages using the BLS CPI-U. Panel A examines the hourly wages of employed USTNs (both part time and full time), while Panel B focuses on the hourly wages of only full-time employed USTNs. For the 2SLS regressions, the instrument is constructed by using the historical distribution of skilled immigrants, excluding those who are registered nurses, across commuting zones in 1980 to allocate the national inflow of foreign-educated nurses to each commuting zone. All specifications are weighted by the whole population in the commuting zone. Standard errors in parentheses are clustered at the commuting zone level. Significance is indicated by the symbol * at the 10% level, ** at the 5% level, and *** at the 1% level.

run, and β_2 captures the longer-term movement toward equilibrium in response to past supply shocks. Two instruments for the two regressors are as follows:

$$\sum_c \frac{\text{Skilled Immigrants}_{ct, 1980}}{\text{Skilled Immigrants}_{c, 1980}} * \Delta FEN_{ct, -i} \quad (4)$$

and

$$\sum_c \frac{\text{Skilled Immigrants}_{ct, 1980}}{\text{Skilled Immigrants}_{c, 1980}} * \Delta FEN_{ct-1, -i} \quad (5)$$

where c refers to the country of birth, i is the CZ, and t is the time period ($t = 2000, 2007, 2010$, and 2015). By instrumenting for foreign-educated nurses' inflows and lagged foreign-educated

nurses' inflows with the double instruments, the endogeneity of current and past inflows to current and past labor demand shocks are addressed.

Table 8 presents the results of the reduced form and the first-stage regressions. In the reduced form, the endogenous variables are expressed as functions of the exogenous variables. The base year is always 1980. A negative and statistically significant reduced-form relationship is found without a CZ fixed effect. However, the coefficients in the reduced form regressions become statistically insignificant when area fixed effects are included. We report the Sanderson–Windmeijer multivariate F -statistics for testing for weak instruments in a model with multiple endogenous variables. This statistic is informative about the maximum total relative bias of the 2SLS estimator (Sanderson and Windmeijer 2016).

Table 8 Reduced form and first stage results, 2000–2015 (multiple instrumentation)

	(1)	(2)	(3)	(4)	(5)
Reduced Form					
Past settlement	-1.945** (0.791)	-0.523* (0.285)	0.482 (0.353)	0.753 (1.843)	-0.461 (1.163)
Lagged past settlement	-4.004*** (0.838)	-1.218** (0.605)	0.233 (0.631)	0.854 (2.227)	1.915 (2.861)
First stages					
<i>Dependent variable: foreign-educated nurse inflows</i>					
Past settlement	0.961*** (0.178)	0.282** (0.171)	0.291** (0.194)	0.474 (0.674)	0.631 (0.570)
Lagged past settlement	1.705*** (0.466)	0.180 (0.205)	0.293 (0.256)	0.144 (0.761)	0.215 (1.160)
Sanderson–Windmeijer multivariate F -statistics	36.50 [0.000]	10.96 [0.000]	10.15 [0.000]	6.30 [0.059]	1.05 [0.307]
<i>Dependent variable: lagged foreign-educated nurse inflows</i>					
Past settlement	0.420* (0.216)	-0.088 (0.169)	-0.222 (0.216)	0.512 (0.558)	0.170 (0.570)
Lagged past settlement	2.046*** (0.527)	0.660*** (0.252)	0.492** (0.329)	0.110* (0.601)	-0.609 (1.239)
Sanderson–Windmeijer multivariate F -statistics	36.80 [0.000]	25.45 [0.000]	26.69 [0.000]	7.37 [0.008]	5.60 [0.458]
Controls		X	X	X	X
Year FE	X	X	X	X	X
Area FE			X	X	X
Pre-Great Recession				X	
Great Recession and Post-Great Recession					X

FE, fixed effects; OLS, ordinary least squares.

Source: The data are from the US Censuses and the American Community Survey multiyear aggregates.

Notes: The reduced form reports the slope coefficients from an OLS regression of the number of full-time employed native nurses aged 25–70 years per 1,000 population in a commuting zone on both instruments. The dependent variable in the first-stage regressions is the number of full-time employed foreign-educated nurses aged 25–70 years per 1,000 population in a commuting zone. The two instruments are constructed by using the 1980 distribution of skilled immigrants, excluding those who are registered nurses, across commuting zones to allocate the national inflow of foreign-educated nurses to each commuting zone. All specifications are weighted by the whole population in the commuting zone. Standard errors in parentheses are clustered at the commuting zone level. The p -values of the F -statistics are in brackets. Significance is indicated by the symbol * at the 10% level, ** at the 5% level, and *** at the 1% level.

Table 9 Displacement effects of foreign-educated RNs on US-educated RNs, 2000–2015

	Dependent variable: US-educated nurses per 1,000 population				
	(1)	(2)	(3)	(4)	(5)
2SLS (single instrument)					
Foreign-educated nurses per 1,000 population	–2.223*** (0.476)	–3.018* (1.734)	1.878* (1.355)	0.237 (1.495)	0.970 (1.487)
R^2	0.374	0.664	0.931	0.975	0.967
2SLS (multiple instruments)					
Foreign-educated nurses per 1,000 population	–1.837* (1.010)	–2.245 (1.701)	1.389 (0.797)	0.878 (1.890)	0.333 (1.899)
Lagged foreign-educated nurses per 1,000 population	–1.426* (0.552)	–1.236* (0.749)	–0.035 (0.825)	0.068 (1.439)	3.025 (1.602)
R^2	0.379	0.658	0.938	0.972	0.938
Controls		X	X	X	X
Year FE	X	X	X	X	X
Area FE			X	X	X
Pre-Great Recession				X	
Great Recession and Post-Great Recession					X

RN, registered nurse; FE, fixed effect; 2SLS, two-stage least squares.

Source: The data are from the US Censuses and the American Community Survey multiyear aggregates.

Notes: The dependent variable is the number of full-time employed US-trained nurses aged 25–70 years in the respective age group per 1,000 population in a commuting zone, and the main two independent variables are the number of full-time employed, internationally trained nurses aged 25–70 years per 1,000 population in a commuting zone and its lag. For the 2SLS regressions, two instruments are constructed by using the historical distribution of skilled immigrants, excluding those who are registered nurses, across commuting zones in 1980 to allocate the national inflow of foreign-educated nurses to each commuting zone. All specifications are weighted by the whole population in the commuting zone. Standard errors in parentheses are clustered at the commuting zone level. Significance is indicated by the symbol * at the 10% level, ** at the 5% level, and *** at the 1% level.

The null hypothesis is rejected, and the first-stage F -statistics are reasonably large with the full sample. The first-stage coefficients are statistically significant, and they help conclude that the past settlement instrument and its lag positively affect recent and past foreign-educated nurses' inflows.

If the composition of national inflows does not vary much over time, the two instruments can be highly correlated; the past settlement instrument and its lag are constructed using the same base period, and a difference between the two instruments comes only from variation over time in the composition of national inflows. The correlation across the 140 CZs between the instrument and its lag in 1980 is 0.661, which Jaeger et al. (2018) might classify as moderate rather than high levels of correlation, with the p -value equal to 0.000.¹³ The spatial distribution of immigrant inflows is stable over time, and we estimate separately the short- and long-run effect of foreign-educated nurses on the labor outcomes of native nurses over the period 2000–2015. In Table 9, the second-stage results are reported. For comparison, we also present the conventional (single) IV estimates of the effects of foreign-educated nurses' inflows on native

¹³ Jaeger et al. (2018) note the serial correlation from one decade to the next to show the importance of using the 1960 distribution as their base period for the instrument. On page 22, the correlation in country-of-origin shares between immigrants arriving in the 1960s and those arriving in 1970s is 0.59, whereas the correlations after 1980 are >0.90.

Table 10 Displacement effects of foreign-educated RNs on US-trained RNs by age, 2000–2015

	Dependent variable: US-educated nurses per 1,000 population								
	25–29	30–34	35–39	40–44	45–49	50–54	55–59	60–64	65–70
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
2SLS (single instrument)									
Foreign-educated nurses per 1,000 population	0.906**	–0.068	0.431	–0.514	–0.047	0.040	0.135	0.569	0.125
	(0.761)	(0.391)	(0.594)	(0.489)	(0.450)	(0.397)	(0.429)	(0.545)	(0.181)
R^2	0.497	0.736	0.703	0.783	0.808	0.824	0.863	0.743	0.691
2SLS (multiple instruments)									
Foreign-educated nurses per 1,000 population	0.533	–0.134	0.673	–0.346	0.003	–0.081	0.323	0.379	0.039
	(0.508)	(0.375)	(0.549)	(0.439)	(0.284)	(0.319)	(0.280)	(0.480)	(0.116)
Lagged foreign-educated nurses per 1,000 population	–0.488*	–0.048	0.175	0.122	0.036	–0.088	0.136	–0.138	–0.062
	(0.308)	(0.219)	(0.295)	(0.145)	(0.211)	(0.206)	(0.221)	(0.181)	(0.088)
R^2	0.721	0.734	0.648	0.811	0.810	0.824	0.843	0.795	0.721

RN, registered nurse; 2SLS, two-stage least squares.

Source: The data are from the US Censuses and the American Community Survey multiyear aggregates.

Notes: The dependent variable is the number of full-time employed US-trained nurses aged 25–70 years in the respective age group per 1,000 population in a commuting zone, and the two main independent variables are the number of full-time employed, internationally trained nurses aged 25–70 years per 1,000 population in a commuting zone and its lag. For the 2SLS regressions, two instruments are constructed by using the historical distribution of skilled immigrants, excluding those who are registered nurses, across commuting zones in 1980 to allocate the national inflow of foreign-educated nurses to each commuting zone. All specifications are weighted by the whole population in the commuting zone. Standard errors in parentheses are clustered at the commuting zone level. Significance is indicated by the symbol * at the 10% level, ** at the 5% level, and *** at the 1% level.

nurses in Panel A. The coefficients for the 2000–2015 time periods (Table 4) are only displayed to be consistent with the multiple instrument procedure. We then show the estimates of the effects of foreign-educated nurses' inflows and lagged foreign-educated nurses' inflows on the supply of US-educated nurses using Eq. (3) in Panel B.

The model provides predictions on the signs of the coefficients. The coefficients capture the employment impact of newly arrived foreign-educated nurses in the short run and the longer-term displacement effects in response to local shocks. We find that the short-run impact of recent arrivals of foreign-educated nurses on US nurses is positive but insignificant [Column (3) in Panel B]. The estimate is less positive than the corresponding conventional IV estimate in Column (3) in Panel A, and it is consistent with our expectation that estimates that do not control for the adjustment to past shocks are biased. We also find a negative and insignificant coefficient on the predicted lagged foreign-educated nurses, in keeping with the expectation that this coefficient captures the longer-term adjustment of the local nursing market to local supply shocks induced by foreign-educated nurses. The longer-term coefficient is nearly zero and suggests that US-educated nurses are not eventually affected by foreign nurse recruitment in the long-term trend of employment.

We use the double instruments to look at displacement effects for different age and education groups. The results are presented in Panel B of Tables 10 and 11, respectively. We find that the impacts of recent influxes of foreign-educated nurses on the youngest native nurses are

Table 11 Displacement effects of the foreign-educated RNs on US-educated RNs by education, 2000–2015

	Dependent variable: US-educated nurses per 1,000 population		
	Associate's degree	Bachelor's degree	Graduate degree
	(1)	(2)	(3)
2SLS (single instrument)			
Foreign-educated nurses per 1,000 population	0.715 (0.105)	0.041 (0.730)	0.924** (0.647)
R^2	0.902	0.901	0.724
2SLS (multiple instruments)			
Foreign-educated nurses per 1,000 population	0.771 (0.775)	−0.279 (0.939)	0.882* (0.497)
Lagged foreign-educated nurses per 1,000 population	0.041 (0.530)	−0.232 (0.380)	−0.030 (0.310)
R^2	0.900	0.895	0.734

RN, registered nurse; 2SLS, two-stage least squares.

Source: The data are from the US Censuses and the American Community Survey multiyear aggregates.

Notes: The dependent variable is the number of full-time employed, US-trained nurses aged 25–70 years in the respective education group per 1,000 population in a commuting zone, and the two main independent variables are the number of full-time employed, internationally trained nurses aged 25–70 years per 1,000 population in a commuting zone and its lag. For the 2SLS regressions, two instruments are constructed by using the historical distribution of skilled immigrants, excluding those who are registered nurses, across commuting zones in 1980 to allocate the national inflow of foreign-educated nurses to each commuting zone. All specifications are weighted by the whole population in the commuting zone. Standard errors in parentheses are clustered at the commuting zone level. Significance is indicated by the symbol * at the 10% level, ** at the 5% level, and *** at the 1% level.

positive but insignificant, whereas the lagged inflows of foreign-educated nurses that capture the longer-term effects displace US-educated nurses aged 25–29 years. In terms of education levels, inflows of the foreign-educated nurses are positively related with native nurses with a graduate degree in the short run. However, the lagged estimate is negative and insignificant. We also find little evidence that an inflow of foreign-educated nurses to a CZ causes a decline in the observed wages of native nurses. Panel A of Table 12 presents the single IV estimates of the effects of foreign-educated nurses' inflows on native wages, and Panel B reports the double IV estimates of the current and the past foreign-educated nurses' inflows on the wages of domestic nurses. The coefficients using the preferred specification that controls for time-varying characteristics and fixed effects [Column (3)] are positive and statistically significant in the long run with the full sample.

One caveat that is worth pointing out is that the double estimates are smaller or larger than their corresponding conventional IV estimates in absolute terms. It implies that estimates that do not control for the adjustment to past supply shocks induced by foreign-educated nurses' inflow are biased.

Table 12 Wage effects of foreign-educated RNs on US-educated RNs, 2000–2015

	Dependent variable: log (average hourly wages of US-educated nurses)									
	Employed USENs					Full-time employed USENs				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
2SLS (single instrument)										
Foreign-educated nurses per 1,000 population	0.230***	0.389	−0.119	0.048	−0.091	0.220***	0.342	−0.071	−0.010	0.025
	(0.049)	(0.290)	(0.173)	(0.119)	(0.242)	(0.041)	(0.249)	(0.134)	(0.129)	(0.161)
R ²	0.361	0.512	0.935	0.971	0.977	0.420	0.532	0.942	0.966	0.978
2SLS (multiple instruments)										
Foreign-educated nurses per 1,000 population	0.117**	0.198	0.043	0.008	−0.149	0.107***	0.169	0.105	0.060	−0.034
	(0.046)	(0.303)	(0.100)	(0.154)	(0.372)	(0.038)	(0.261)	(0.082)	(0.157)	(0.304)
Lagged foreign-educated nurses per 1,000 population	0.125**	0.306*	0.118**	−0.041	−0.277	0.125***	0.277*	0.127**	0.071	−0.278
	(0.051)	(0.184)	(0.060)	(0.108)	(0.694)	(0.046)	(0.161)	(0.061)	(0.120)	(0.160)
R ²	0.371	0.470	0.950	0.971	0.935	0.433	0.411	0.939	0.966	0.932
Controls		X	X	X	X		X	X	X	X
Year FE	X	X	X	X	X	X	X	X	X	X
Area FE			X	X	X			X	X	X
Pre-Great Recession				X					X	
Great Recession and Post-Great Recession					X					X

RN, registered nurse; 2SLS, two-stage least squares; BLS, Bureau of Labor Statistics; CPI-U, Consumer Price Index for All Urban Consumers; FE, fixed effects; USEN, US-educated nurses.

Source: The data are from the US Censuses and the American Community Survey multiyear aggregates.

Notes: The dependent variable is the average log hourly wages of native nurses in a commuting zone, and two main independent variables are the number of full-time employed, internationally trained nurses aged 25–70 years per 1,000 population in a commuting zone and its lag. Wages are deflated so that they are in terms of the 1999 wages using the BLS CPI-U. For the 2SLS regressions, the double instruments are constructed by using the historical distribution of skilled immigrants, excluding those who are registered nurses, across commuting zones in 1980 to allocate the national inflow of foreign-educated nurses to each commuting zone. All specifications are weighted by the whole population in the commuting zone. Standard errors in parentheses are clustered at the commuting zone level. Significance is indicated by the symbol * at the 10% level, ** at the 5% level, and *** at the 1% level.

5 Conclusion

This paper has investigated the employment responses of native nurses in the United States to a change in the number of employed foreign-educated nurses. Using the 1980–2000 US Censuses and the ACS multiyear aggregates obtained from the IPUMS-USA (Ruggles et al. 2017), the paper quantifies the displacement effects.

To examine the causal effects of migration of foreign-educated nurses on native nurses, the analysis first closely follows a simple linear model that Cortes and Pan (2014) used. Because

local markets are not closed and immigrants tend to settle in locations where previous waves have settled, the IV strategy and the OLS are implemented. The instrument for the number of full-time employed foreign-educated nurses is the interaction between the 1980 distribution of skilled immigrants by country across CZs and the national inflow of newly arrived foreign-educated nurses from the different countries. Cortes and Pan (2014) use the historical share of skilled immigrants and the stock of foreign-born nurses from the same country of origin in a given MSA to construct their instrument.

We fail to find displacement effect of an inflow of foreign-educated nurses on the number of native nurses by the OLS and IV methodologies with a single instrument. On the contrary, the IV estimates rather indicate that an increase in the number of native nurses might stem from an increase in foreign nurses educated abroad. The difference between our results for displacement and those of Cortes and Pan (2014) stems from the differences in definitions of immigrant nurses, with us using “foreign educated” and Cortes and Pan (2014) using “foreign born”. We explore the native groups that are most affected by foreign-educated nurses and observe that newly educated US nurses and the US-educated nurses with the highest education level benefit from complementarity. Turning to the possible factors that might drive employment effects of native nurses, we find little evidence that a change in native wages causes the positive effects.

The spatial distribution of immigrant inflows tends to be stable over time, and a single instrument is highly and serially correlated with responses to previous labor shocks. Thus, a multiple instrumentation procedure introduced by Jaeger et al. (2018) is implemented to separate the short- and long-term responses to recent foreign-educated nurses’ inflows. Under the preferred model specification with the double instruments, we find no significant effect of foreign-educated nurses on the employment of native nurses in both the short and long runs. We find marginally significant displacement effects on the youngest native nurses in the long run, whereas highly educated natives are positively affected by the foreign-educated nurses in the short run. We fail to find the negative impact of foreign-educated nurses on native wages but observe larger in magnitude, double IV estimates than the corresponding single IV estimates, which implies that researchers should control for dynamic adjustments to past local shocks. Taken together, the findings suggest that relying on foreign-educated nurses to fill gaps in the US health-care workforce does not harm the employment of native nurses, but rather the entry of foreign-educated nurses to the US nursing market causes an increase in native wages in the long run.

Abbreviations

RN, Registered Nurses; FEN, Foreign-educated Nurses; USEN, US-educated Nurses; IPUMS-USA, Integrated Public Use Microdata Series from the United States; ACS, American Community Survey; BLS, Bureau of Labor Statistics; CPI-U, The Consumer Price Index for All Urban Consumers; CZ, Commuting Zone; MSA, Metropolitan Statistical Area; OLS, Ordinary Least Squares; IV, Instrumental Variable; 2SLS, Two-Stage Least Squares; FE, Fixed Effects.

Declarations

Availability of data and materials

The data used in this article were obtained through IPUMS-USA (Ruggles et al. 2017) and are available online from the IPUMS-USA (<https://usa.ipums.org/usa/>). Additional replication materials can be obtained from Hyeran Chung, Department of Agricultural and Consumer Economics, University of Illinois at Urbana-Champaign, 1301 W. Gregory Drive, Urbana, IL 61801 or email to hchung53@illinois.edu

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

HC analyzed and interpreted the empirical results and was a major contributor in writing the manuscript. MA edited the manuscript. We had a regular weekly meeting, read and approved the final manuscript.

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Appendix

Table A1 List of the 140 commuting zones (CZs)

CZ	State	Metro status	CZ	State	Metro status
302	Tennessee	Mixed	19600	New Jersey	Metro
401	North Carolina	Mixed	19700	Pennsylvania	Metro
500	North Carolina	Mixed	19800	Delaware	Metro
900	North Carolina	Mixed	19902	Maryland	Mixed
1100	North Carolina	Mixed	20001	Maine	Mixed
1203	North Carolina	Mixed	20003	Maine	Nonmetro
1701	North Carolina	Mixed	20100	Maine	Mixed
1900	North Carolina	Mixed	20200	Vermont	Mixed
2000	Virginia	Mixed	20302	Vermont	Nonmetro
2400	Virginia	Metro	20401	Rhode Island	Metro
2500	Virginia	Mixed	20500	Massachusetts	Metro
2700	Mississippi	Mixed	20600	New Hampshire	Mixed
3003	Mississippi	Mixed	20800	Massachusetts	Metro
3300	Louisiana	Mixed	20901	Connecticut	Mixed
3901	Louisiana	Mixed	21501	Minnesota	Metro
4200	Arkansas	Mixed	23100	Wisconsin	Mixed
5202	Tennessee	Metro	23500	Illinois	Mixed
5600	Tennessee	Metro	23801	Illinois	Metro
6000	Alabama	Mixed	23900	Illinois	Mixed
6700	Florida	Metro	24100	Wisconsin	Mixed
6800	Florida	Mixed	24300	Illinois	Metro
6900	Florida	Mixed	24400	Illinois	Mixed
7000	Florida	Mixed	24701	Missouri	Mixed
7100	Florida	Mixed	24802	Illinois	Mixed
7200	Florida	Metro	28401	Colorado	Mixed
7300	Florida	Metro	28900	Colorado	Metro
7400	Florida	Mixed	29301	Kansas	Mixed
7500	Florida	Mixed	29502	Missouri	Mixed
7600	Florida	Mixed	30601	Texas	Mixed
7800	Florida	Mixed	30802	Texas	Mixed
7900	Florida	Mixed	31201	Texas	Mixed
8202	South Carolina	Mixed	31301	Texas	Mixed
8401	Georgia	Mixed	31401	Texas	Mixed
8800	Georgia	Mixed	31600	Texas	Mixed
8900	Georgia	Mixed	31700	Texas	Mixed
9100	Georgia	Mixed	31800	Texas	Mixed
9400	Georgia	Mixed	31900	Texas	Mixed
9701	Georgia	Mixed	32000	Texas	Mixed
9900	Florida	Mixed	32100	Texas	Mixed
10900	Florida	Mixed	32201	Texas	Nonmetro
11101	Alabama	Mixed	32801	Texas	Mixed

(Continued)

Table A1 Continued

CZ	State	Metro status	CZ	State	Metro status
11302	Maryland	Metro	32900	Texas	Metro
11304	Maryland	Mixed	33000	Texas	Mixed
11600	Michigan	Mixed	33100	Texas	Mixed
11700	Michigan	Metro	33300	Texas	Mixed
11900	Michigan	Mixed	33803	Oklahoma	Mixed
12200	Michigan	Mixed	34102	Alaska	Mixed
12501	Ohio	Mixed	34701	Hawaii	Metro
12701	Ohio	Mixed	34901	New Mexico	Mixed
13501	Ohio	Mixed	35001	Arizona	Mixed
13600	Indiana	Mixed	35100	Arizona	Mixed
14200	Indiana	Mixed	35600	Hawaii	Nonmetro
14900	Indiana	Metro	36100	Utah	Mixed
15200	Ohio	Mixed	37000	California	Mixed
15900	Ohio	Mixed	37100	California	Metro
16300	Pennsylvania	Mixed	37200	California	Metro
16400	Ohio	Mixed	37300	California	Mixed
16600	Virginia	Mixed	37400	California	Mixed
17400	Pennsylvania	Mixed	37500	California	Metro
17600	Virginia	Mixed	37604	Nevada	Mixed
17700	New York	Mixed	37700	California	Mixed
17800	New York	Nonmetro	37800	California	Metro
17900	New York	Mixed	37901	Nevada	Mixed
18000	New York	Mixed	38000	California	Metro
18600	New York	Mixed	38200	California	Metro
18800	Pennsylvania	Mixed	38300	California	Mixed
19100	Pennsylvania	Mixed	38601	Washington	Mixed
19300	New York	Mixed	38801	Oregon	Metro
19400	New York	Metro	38901	Oregon	Mixed
19500	New Jersey	Metro	39400	Washington	Mixed

Notes: Metro status indicates whether the individual resided within a metropolitan area and, for individuals in metropolitan areas, whether the individual resided within or outside of a central/principal city. If a commuting zone lies only partially within a metropolitan area or central/principal city, then its metro status is mixed.

Table A2 Numbers of commuting zones with few nurses

		1990	2000	2007	2010	2015
USEN	Zero	0	0	0	0	0
	>0 & <5	5	5	0	3	22
	>0 & <10	5	9	3	3	39
FEN	Zero	215	180	197	193	217
	>0 & <5	40	41	32	36	85
	>0 & <10	66	63	50	48	109

USEN, US-educated nurses; FENs, foreign-educated nurses.

Notes: The data are from the US Censuses and the American Community Survey multiyear aggregates. The samples are restricted to employed registered nurses aged 25–70 years old. The table shows the numbers of commuting zones with few nurses across the United States.