Medical Worker Migration and Origin-Country Human Capital: Evidence from U.S. Visa Policy

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Abstract: We exploit changes in U.S. visa policies for nurses to measure the origin-country human capital response to international migration opportunities. Combining data on all migrant departures and postsecondary institutions in the Philippines, we show that nursing enrollment and graduation increased substantially in response to greater U.S. demand for nurses. The supply of nursing programs expanded. Nurse quality, measured by licensure exam pass rates, declined. Despite this, for each nurse migrant, 9 additional nurses were licensed. New nurses switched from other degree types, but graduated at higher rates than they would have otherwise, increasing the human capital stock in the Philippines. JEL: O15, F22, J61.

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1. Introduction

Many developed countries, including the United States, face a shortage of health care workers, particularly nurses. To fill these gaps, these countries often recruit foreign-born nurses (Cortes and Pan, 2014). Despite the many benefits of migration for human capital formation (Yang, 2008; Dinkelman and Mariotti, 2016; Theoharides, 2018), a long theoretical literature in economics asserts that recruitment of high-skilled workers leads to a scarcity, or brain drain, of these professionals in the country of origin (Bhagwati and Hamada, 1974; Bhagwati and Rodriguez, 1975; Docquier et al., 2008). In the case of health care workers, their departure may contribute to poor health outcomes for the local population (Bhargava and Docquier, 2008). In contrast, alternative models of human capital formation propose that emigration and high prospective returns to skill in foreign countries lead to skill acquisition, or brain gain, at home (Stark et al., 1997; Mountford, 1997; Beine et al., 2001). Despite the theoretical prevalence of the brain drain and brain gain debate, little causal evidence exists, particularly in the context of health care professionals.

In this paper, we exploit a pair of plausibly exogenous migration policy changes to examine the effect of demand for foreign-born health care workers on the stock of health care workers and educated labor in the country of origin. In 2000, the U.S. dramatically expanded the availability of visas for foreign nurses and their families, but in 2007, suddenly reduced visa availability back to pre-2000 levels. The 2000 expansion altered the migration prospects of many nurses, especially those from the Philippines, which is the world's largest supplier of foreign nurses and supplies approximately 40% of foreign-born nurses in the U.S. (Cortes and Pan, 2015; Huang, 2020). We examine the effects of the abrupt expansion and subsequent contraction of nursing visas to the U.S. on postsecondary education decisions in the Philippines. We measure effects on both the demand for and supply of education, by looking at changes in postsecondary enrollment and graduation, the number of postsecondary nursing programs, and nursing licensure exam pass rates.

We use an event study methodology to compare educational outcomes in historically high versus low nurse migrant-origin provinces in the Philippines before and after the policy changes. This approach leverages migrant networks as an important determinant of where and in what occupation migrants work (Munshi, 2003; Theoharides, 2018). Due to these networks, not all geographic areas of the Philippines were affected equally by the policy changes, and the changes in nursing visa availability had a larger effect in provinces that historically specialized in nurse migration. To help address the concern that historically high and low nurse migration provinces may differ in important ways, such as access to health care or nursing education, we include a set of baseline controls, most notably domestic nurses per capita in the province, interacted with year fixed effects. This control allows us to isolate the impact of foreign, as opposed to domestic, demand for nurses. We find no evidence that educational attainment was trending

differentially in high relative to low nurse migration provinces before the policy changes. We use a new administrative dataset that includes the province of origin and country of destination for all nurse migrants. We match these province-year-level migration data with administrative records on enrollment, graduation, and nurse licensure exam pass rates for the universe of postsecondary institutions in the Philippines.

We show that nurse migration to the U.S. rose substantially in high relative to low nurse migration provinces following the visa expansion in 2000, and then fell suddenly in 2007 when visa availability contracted. Postsecondary enrollment and graduation in nursing programs increased dramatically in response to greater opportunities to work in the U.S, and then returned to near pre-2000 levels following the visa contraction. While women account for 76% of nursing students in the Philippines, the enrollment and graduation responses were only somewhat smaller for men, and thus in percent terms, substantially larger than for women. Leveraging the two opposite-signed policy shocks improves identification beyond a standard differences-in-differences analysis by allowing for a falsification check of alternative hypotheses for the increases in education post-2000. The inverted U-shaped pattern of results that we find is challenging to attribute to concerns about differential province-specific trending by high versus low nurse migration areas.

The supply of nursing programs quickly expanded to accommodate the increase in demand for nursing education. The supply response was concentrated among private schools, largely through nursing programs opening at existing private institutions, rather than the opening of new nursing institutions. The enrollment response was driven by provinces with a greater elasticity of the supply of schooling, as measured by the fraction of private institutions without nursing programs. Marginal nursing graduates passed the Philippine Nursing Licensure Exam at a lower rate, but despite this lower pass rate, the increase in licensed nurses far exceeded the number of departing nurses: for each additional nurse who went abroad, approximately 9 new nurses were licensed in the Philippines. Our results imply that increases in nurse migration from the Philippines actually increased the number of nurses in the country, indicating a brain gain of health care workers.

We examine the effects of the policy changes on enrollment and graduation in other degree programs to determine whether increased migration prospects for nurses spurred new students to obtain postsecondary education or, instead, caused students to shift from other fields of study. While these results are relatively imprecise, they suggest that nursing enrollees primarily switched to nursing from other fields. This result helps to explain our large enrollment effects by clarifying that we are not estimating the elasticity of overall education to migration opportunities. Rather, the policy changes examined here were occupation-specific, and individuals might be more elastic in switching between fields of study than making the extensive margin decision to enroll in higher education. Further, while the

probability of securing a visa is low, the returns to U.S. nurse migration are substantial: nurses in the U.S. earn approximately 13 times more than college-educated workers in the Philippines and receive legal status for their families in the U.S.[1]

While the enrollment effects were driven primarily by students switching from other degree types, students persisted to graduation at higher rates, leading to an overall increase in college graduates in the Philippines. We show that most nursing graduates who never migrated on a U.S. nursing visa did not find other migration opportunities, though many appeared to find nursing jobs in the Philippines. For other nursing graduates, these nursing jobs were not an option because they did not pass the licensure exam. If individuals acted rationally when making their education decision, then they were ex ante better off regardless of their labor market outcomes. However, their choice may not have been rational if they were, for instance, misinformed about the probability of migration. Additionally, individuals switching degree type could have created negative externalities for the Philippines if this led to labor market shortages in other important fields. While understanding the potential welfare implications is beyond the scope of this paper, we aim to provide a well-identified and convincing estimate of the partial equilibrium effect of the U.S. visa policy changes.

We contribute to the long-standing literature on the brain drain and brain gain debate by providing the first causal microeconomic estimates of the effect of medical worker migration on educational attainment in migrant-origin countries. Our results provide further support for models of human capital formation where emigration and high prospective returns to skill in foreign countries lead to skill acquisition at home (Stark et al., 1997; Mountford, 1997; Beine et al., 2001) rather than human capital depletion (Bhagwati and Hamada, 1974; Bhagwati and Rodriguez, 1975). Previous empirical evidence is mixed.[2] On the macro side, some studies analyzing cross-country data find overall evidence of brain drain across the developing world (Docquier et al., 2008), while others find evidence of brain gain (Beine et al., 2008), including for medical workers (Clemens, 2007). On the micro side, several natural experiments provide evidence of brain gain in both low-skilled (Batista et al., 2012; Shrestha, 2017; Dinkelman and Mariotti, 2016; Theoharides, 2018) and high-skilled (Chand and Clemens, 2019; Khanna and Morales, 2019) settings.[3]

[1] The mean annual wages during the expansion period for a nurse in the U.S. were USD $56,940 (United States Bureau of Labor Statistics), while the mean purchasing-power parity adjusted wages of college-educated labor in the Philippines were USD $4,339 (Philippine Labor Force Survey).

[2] See Gibson and McKenzie (2011) and Docquier and Rapoport (2012) for reviews of the literature.

[3] For low-skilled workers, Shrestha (2017) finds that the recruitment of Nepalese men into the British Army raised educational attainment by as much as one year. Batista et al. (2012) use household survey data in Cape Verde to determine that increases in the probability of future migration eventually lead to higher rates of intermediate schooling completion. Dinkelman and Mariotti (2016) exploit a natural experiment in Malawi to show that in communities with the easiest access to migrant jobs, human capital increased substantially. Theoharides (2018) finds that increases in demand for migrants from the Philippines led to increased high school enrollment. On the high-

These studies focus on the overall enrollment response across all fields in primary, secondary, or postsecondary education. Two notable exceptions are Chand and Clemens (2019), who find differential impacts on enrollment in fields awarded visa points to Australia versus not, and Khanna and Morales (2019), who examine skill-specific migration by looking at the Indian and U.S. IT sectors and demand for computer science degrees. When migration opportunities are for highly specialized migrants, the supply of postsecondary education may not be able to respond as readily due to the skill-specific nature of the training. Similar to Khanna and Morales (2019), we document that brain gain is possible in a specialized field, but we focus on health care, where the supply of training is thought to be particularly sticky (Docquier and Marfouk, 2006; Gibson and McKenzie, 2011). Beyond documenting an increase in educational attainment, we provide the first explicit evidence of increases in the supply of postsecondary education in the brain drain versus gain literature.

More broadly, our estimates provide an empirical test of human capital theory (Becker, 1962; Schultz, 1961) by examining the response of educational investment to an exogenous increase in the returns to education. Large, plausibly exogenous changes to the returns to education are rare, and our paper adds evidence to the literature of well-identified tests of human capital theory, such as Jensen (2010), Shastry (2012), Abramitzky and Lavy (2014), and Kuka et al. (2020), in a migration setting.

Our contributions are in large part due to the unique nature of our administrative data. In addition to facilitating an analysis of the supply of postsecondary schooling and nurse quality, our data measure skilled migrant flows more accurately than most previous studies, which typically measure changes in the stock of educated individuals in the destination country to estimate skilled migration from a given origin country. Such calculations may overstate brain drain if many individuals acquire education *after* they migrate. For example, Özden and Philipps (2015) show that almost half of African-born doctors were trained outside of their birth country. Further, studies that use origin-country survey data will miss the migration of entire households, which is common for skilled migrants. Our data overcome both of these concerns because they include the universe of all permanent migrant departures as well as each migrant's field of work and educational attainment.

The migration policy changes we examine in this paper provide a unique opportunity to examine the debate about brain drain versus brain gain among health care professionals. Key to our findings of brain gain is that the supply of schooling was able to respond to accommodate increased demand. Such a response may not be possible in all contexts, for example in sub-Saharan Africa, where the postsecondary education system may not expand as readily in response to increased demand (Bhargava and Docquier,

skilled side, and Clemens (2019) exploit political shocks in Fiji to demonstrate that the mass departures by Indo-Fijians subsequently led this group to invest more heavily in education. Khanna and Morales (2019) show that the H1-B visa program in the U.S. induced Indians to switch to computer science degrees.

2008; Gibson and McKenzie, 2011). Yet, our finding that the supply response was primarily due to existing institutions adding nursing programs suggests that countries with an established system of postsecondary institutions may find it possible to meet foreign demand by adding new programs, which may require less new infrastructure and present fewer hurdles than opening new institutions. While our results may not generalize to all cases, they provide some evidence that for low- to middle-income countries seeking to use skilled migration as a development tool, the human capital stock and the domestic supply of health care workers will not be depleted.

2. Background

2.1 The Philippines and U.S. Nurse Migration

With over 11% of its population living abroad, the Philippines is one of the top migrant-origin countries in the world. In the early 1970s, due to employment opportunities abroad, Ferdinand Marcos institutionalized the overseas employment program through the 1974 Labor Code, with the goal of facilitating labor migration as a development strategy.[4] Nursing was a key occupation for many of the early migrants in this program, and as a result, today the Philippines is the world's top origin country for foreign nurses (Huang, 2020), including to OECD countries (OECD, 2007). The U.S. is the most common destination for Filipino migrant nurses, and departures to the U.S. were a major driver of changes in Filipino nurse migration between 1990 and 2014 (Figure 1).

The origins of Filipino nurse migration can be traced to the U.S. colonial period in the Philippines (1898-1946), as detailed in Choy (2006). During this period, the U.S. established an Americanized training hospital system, with particular emphasis on nursing education. As a result, nursing schools developed to resemble institutions in the U.S. in terms of curriculum, training, and culture. A unique aspect of the Americanized nursing curriculum was the emphasis on both grammatical and colloquial English, even relative to other English-speaking colonies.[5] During the colonial period, Filipino nurses came to the U.S. on short exchanges and training missions. However, these flows increased dramatically in the 1950s and 1960s with the formation of the Exchange Visitor Program (EVP) for nurses, a two-year training and cultural exchange program. Many Filipino EVP nurses desired to stay in the U.S. permanently, though few pathways existed at the time. Following the Immigration Act of 1965,

[4] Numerous other developing countries in Asia facilitate labor migration as a development strategy. For instance, in 1977 in India, the government of Kerala set up the Overseas Development and Employment Promotion Consultants (ODEPC) to facilitate overseas migration, and it continues to operate today. India is the second-highest migrant origin country for nurses globally (Oda et al., 2018). Bangladesh formed the Bureau of Manpower, Employment and Training in 1976 to help workers migrate as part of its development plan. Sri Lanka developed the Bureau of Foreign Employment in 1985, and asked the International Labor Organization in 2008 to formulate a National Labour Migration Policy for Sri Lanka with revisions in 2015 (ILO, 2020). The 2008 International Migration Outlook Sri Lanka specifically highlights the recruitment of nurses.

[5] In 1920, 5% of the nursing licensure exam was devoted to testing English language skills.

permanent nurse migration to the U.S. became possible, and by 1967, the Philippines became the top origin country for nurses globally.

Today, Filipinos are still the largest group of foreign nurses in the U.S. Cortes and Pan (2015) find that Filipinos work in more demanding settings (hospitals) and with more demanding schedules (shiftwork), relative to U.S.-born nurses. They are much more likely to have a four-year degree than U.S.-born nurses. Even after controlling for differences in demographics, education, and work experience, Cortes and Pan find a wage premium for Filipinos, which they attribute to quality differences of Filipino nurses.

Nurse migration to the U.S. is a very appealing labor market opportunity for Filipino nurses. Relative to working in the Philippines, salaries are almost 13 times higher in the U.S. In addition, nurse migrants to the U.S. have the added benefit of legal status in the U.S. for their family members, which is not the case for many of the other countries to which Filipino nurses migrate or for most lower-skilled migration opportunities.

Migrant networks are an important determinant of migration patterns in the Philippines (Theoharides, 2018), and such networks appear even more critical for nurse migration (Choy, 2006). Choy (2006) outlines the importance of nursing school friends and classmates in determining migration patterns for Filipino nurses. Prospective migrant nurses often submitted visa applications as a batch with groups of friends. As a result of these migrant networks, certain provinces are more likely to send nurses to the U.S. Appendix Table 1 lists the 20 provinces with the highest rates of nurse migration to the U.S. in 1990, which is the first year of our data. The inclusion of several provinces in this list is unsurprising, given the history of Filipino migration to the U.S. Ilocos Norte, Ilocos Sur, Pangasinan, and La Union are places where mass emigration of Filipinos to the U.S. originated as a result of recruitment from Hawaiian sugar plantations in the early 1900s. In addition, Zambales, Pampanga, and Tarlac are where the U.S. established military bases at the end of World War II.[6] Today these provinces all remain more connected to the U.S. as a destination for migrants.

2.2 Recent U.S. Visa Policy for Nurses

Foreign nurses, particularly Filipino nurses, continue to represent a significant portion of the U.S. nursing labor force. The most common channel for foreign nurses to enter the U.S. market is through employment-based visas (EB-3 visas). Opportunities to migrate under temporary work permits for nurses are generally limited (DHS, 2008). Unlike temporary visas, employment-based visas allow individuals to permanently reside in the U.S. and to bring family members, who also obtain the same legal status. A worker must be sponsored by an employer for the visa but is not obligated to remain with the same

[6] For a full discussion of the history of these areas with respect to the U.S., see Scalabrini Migration Center (2011).

employer. U.S. immigration law provides 140,000 employment-based visas annually for workers, plus additional visas for spouses and children (Jasso et al., 2010). Visas for first- and second-preference workers (persons with extraordinary ability and professionals who hold advanced degrees, respectively) are processed first, then a portion of the 140,000 is allocated to EB-3 visas. Nurses belong to the third-preference category, but they typically experience a shorter visa processing time than other skilled professionals in this category. The U.S. Department of Labor designates nursing as a "Schedule A" occupation, meaning that there is a shortage of U.S. workers who are able, willing, qualified, and available.

It is by no means, however, easy to migrate to the U.S. as a nurse from the Philippines. The most important barrier is that visas are usually not available. Immigration rules stipulate that no country may be allocated more than 7% of the total number of immigrant visas per fiscal year. Since visa applications from the Philippines far exceed the 7% per-country limit each year, wait times to get a visa often span several years. Foreign nurses must also pass the National Council Licensure Examination (NCLEX) and an English proficiency test (TOEFL), as well as their home country's licensure examination to practice as registered nurses in the U.S. (Aiken, 2007). In the Philippines, nurses must have a bachelor's degree in nursing, which takes four years to obtain, to take the local licensure exam.

Several changes in U.S. immigration policy affected nurse migration from the Philippines in the 2000s. The American Competitiveness in the 21st Century Act of 2000 (AC21) loosened per country limits in visa allocations when part of the 140,000 annual employment-based visas would otherwise go unused. This immediately benefitted oversubscribed countries like China, Mexico, India, and the Philippines. The rule change cut wait times and allowed visas to be immediately issued to workers from these places. AC21 further recaptured 130,137 visas that had gone unused in 1999 and 2000. These visas were immediately available for employment-based visa applications (Jasso et al., 2010). In addition, the Real ID Act of 2005 made 50,000 unused visas from 2001-2004 available, allocating them to Schedule A occupations. The combination of these policies led to the dramatic rise of nurse migration from the Philippines to the U.S. from fewer than 2,000 nurse migrants in 2000 to approximately 7,000 in 2006 (Figure 1). This was an unprecedented period in Filipino nurse migration to the U.S., with minimal wait times for a visa.

Then, in February 2007, processing for EB-3 visas suddenly went into retrogression. The U.S. Citizenship and Immigration Services (USCIS) defines "visa retrogression" as a situation in which many more people apply for visas in a particular category than there are visas available. The 180,137 unused visas had all been claimed, and processing of Schedule A visas stopped. As a result, in 2007, the number of visas processed for nurses from the Philippines fell from over 7,000 to approximately 2,000 and never returned to the level it reached during the expansion. This decline was sudden and unanticipated, and even

U.S. immigration officials reported to Congress that they could not have predicted this abrupt change (USCIS, 2007). These changes in visa policy did not affect non-nurses attempting to migrate from the Philippines to the U.S. Nurse migration to other destinations remained essentially unchanged during the expansion period (Figure 1).[7]

2.3 Brain Drain or Brain Gain?

With such high rates of nurse migration, the Philippines provides a compelling example of a place where one might anticipate a shortage of domestically employed nurses. Indeed, Filipino policymakers expected as much when nurse migration suddenly picked up in response to the U.S. visa expansion in 2000. "Sadly, this is no longer brain drain, but more appropriately, brain hemorrhage of our nurses," remarked the former Secretary of the Department of Health, Dr. Jaime Galvez-Tan. "Very soon, the Philippines will be bled dry of nurses." (Asia Times, 2003).

Despite this concern, however, postsecondary enrollment and graduation data from the Philippine Commission on Higher Education (CHED) suggest an opposite outcome. Following the increase in U.S. visa availability, total four-year enrollment in nursing programs rose from 90,000 in 2000 to over 400,000 in 2006, before declining again in 2007 (Figure 2a).[8] The number of new nursing graduates shows a similar pattern, though with a four-year lag due to the time it takes to complete a nursing degree.[9] The number of graduates grew slowly during 2003 and 2004 before rapidly increasing until 2009. In 2010, 4 years after the contraction of visas, graduates declined. (Figure 2b). Comparing nursing graduates to the number of nurse migrants from the Philippines to the U.S., migrants are a small fraction of the number of new nursing graduates. This suggests that increased demand for nurses from abroad may not have caused a drain on human resources, but rather increased the supply of nurses remaining in the Philippines.

3. Data

We use a new and unique administrative dataset on all permanent migrant departures from the Philippines from 1990 to 2013. The data are from the Commission on Filipinos Overseas (CFO), the government agency responsible for registering emigrants and strengthening the ties of the diaspora with the homeland. The CFO requires all emigrants who plan to move abroad on a permanent immigrant visa to register before they depart. Our dataset includes demographics, place of birth, usual address, country of destination, education, course of study, and profession for all individuals who left for abroad on a

[7] Non-nurse migration from the Philippines increased during the expansion period. We show that our results are not driven by these changes.

[8] Note that student enrollment counts include enrollment across all four years of college.

[9] Note that even with a 100% graduation rate, graduation should be one quarter the size of enrollment, because enrollment includes all four years of postsecondary education.

permanent visa. As a result, we can accurately measure the number of skilled professionals leaving each Philippine province annually and track the outflow of nurses.

We calculate province-level migration rates for nurses by aggregating departures in each province-year and dividing by the working-aged (18-60) population in each province-year. We define nurses as those who have obtained a nursing degree or whose usual work is as a professional nurse. More detail on these data and the other datasets used in this paper is in Online Appendix A.

We obtained administrative data on postsecondary enrollment, graduation, and number of nursing programs from 1990 to 2013 from the Commission on Higher Education (CHED). The data include annual school-level counts of enrollees and graduates, disaggregated by program of study. The enrollment counts include students in all four years of college.[10] We aggregate these data at the province-level and calculate rates of enrollment and graduation for nurses and other disciplines by dividing by the college-aged population (18-21) in each province. We also calculate the number of nursing programs in each province-year.

Finally, we compiled data on the number of examinees and passers by institution on the Philippine Nursing Licensure Exam (NLE), which is administered by the Philippine Professional Regulation Commission (PRC). A nursing graduate must pass the NLE in order to practice nursing in the Philippines or to apply for jobs abroad. The NLE is composed of 500 multiple choice questions spread across five subsections. To pass, an examinee must have a general average of 75% across the five subsections, and a score of 60% or better on each of the five subsections. The exam is offered two times per year. In order to take the exam, individuals must have a bachelor's degree in nursing. We collected hard-copy documents from the PRC in Manila on the number of examinees and the number who passed the NLE by institution from 1990 to 2016. We aggregate institution-level data on examinees and passers to create province-year-level examination and pass rates.

Table 1 presents summary statistics of the variables used in our analysis overall and by high and low nurse migration provinces. We identify high (low) nurse migration provinces as those with above (below) median U.S. nurse migration rates at baseline (1990). Our sample includes 74 provinces, which are defined to use consistent geographic boundaries over the sample period.[11] Panel A shows summary statistics for the full sample period. The average province has 75 migrants per 100,000 working-aged individuals, while on average there are 3.9 nurse migrants per 100,000. The average province-level postsecondary enrollment rate out of the college-aged population is 21.4%, while the rate of enrollment in nursing programs is 1.54%. Total and nurse graduation rates are on average 3.79% and 0.36% of the

[10] Unfortunately, enrollment counts by grade of study are not available in most years.
[11] We treat the National Capital Region (NCR), which is composed of the four districts of Metro Manila, as one province since students commonly travel across the metro area for postsecondary education.

province's college-aged population, respectively. Provinces have an average of 4.39 institutions offering nursing degrees, the majority being private institutions. On average, 0.072% of the province population takes the NLE each year, while 0.031% of the population passes the exam.

To provide evidence on how high and low nurse migration provinces may have differed at baseline, Panel B shows means for our outcomes of interest prior to the U.S. visa policy changes. High nurse migration provinces have higher rates of migration overall and higher rates of postsecondary enrollment, graduation, and access to nursing programs. Our analysis includes province fixed effects to account for any fixed differences between high and low nurse migration provinces. We address other possible concerns about endogeneity stemming from these differences in the discussion of our empirical strategy in Section 4.

4. Empirical Strategy

To identify the causal effect of U.S. demand for Filipino nurses on human capital accumulation in the Philippines, we exploit the two sudden and opposite-signed shocks to visa policy that expanded and then restricted nurse migration to the U.S. While the aggregate national changes over time in nurse migration, nursing degree enrollment, and graduation presented in Section 2 provide suggestive evidence about the impacts of the U.S. visa policy changes, other factors that affected these outcomes could have changed in the Philippines over time.

We isolate the causal impacts of the policy changes from any other factors by exploiting the importance of migrant networks as determinants of international migration patterns (Munshi, 2003; Theoharides, 2018). This is based on the idea that provinces that historically had a larger flow of nurse migrants to the U.S. should be disproportionately exposed to the policy changes compared to provinces that had a smaller flow of nurse migrants at baseline. Our empirical strategy designates provinces with high baseline nurse migration rates as the treatment group and provinces with low baseline nurse migration rates as the control group.

We estimate an event study model that incorporates both the visa expansion and visa contraction. Formally, we estimate the following equation:

$$Y_{pt} = \sum_{\tau \neq 1999} \beta_\tau \, High_{p,1990} D_t^\tau + X_{p0}\gamma_t + \alpha_p + \gamma_t + \varepsilon_{pt} \qquad (1)$$

where Y_{pt} is a measure of nurse migration or education in province p, year t. $High_{p,1990}$ is equal to one for provinces with above median nurse migration in 1990, and zero for provinces with below median baseline nurse migration. D_t^τ is a binary variable equal to one if the year of observation t equals the specific year, τ, and zero otherwise. We omit the interaction term in 1999 (the year prior to the visa expansion) in order to identify the model.

$X_{p0}\gamma_t$ are baseline province characteristics interacted with year fixed effects, γ_t. These allow for time-varying effects of pre-policy characteristics that are correlated with both the variable *High* and our outcomes over the sample period. In particular, because we want to isolate variation in the responsiveness of nursing education to the U.S. demand shocks, we control for baseline province-level domestic nurses per capita interacted with year fixed effects.[12,13] This control alleviates concerns that differential impacts of changes in domestic demand for nurses could bias our results. Province fixed effects, α_p, and year fixed effects, γ_t, account for province-specific and year-specific omitted variables, respectively. Standard errors are clustered at the province level.

The β_τ's capture the differential changes in outcomes by year for high versus low nurse migration provinces relative to the omitted year, 1999. The β_τ's after 2000 provide the effect of visa expansion, while the β_τ's after 2007 provide the effect of visa contraction, allowing the effect of each policy on our outcomes of interest to evolve flexibly. The β_τ's prior to 2000 provide evidence on whether our outcomes were changing differentially in high versus low nurse migration provinces prior to the policy change. In order to interpret our estimates as causal, these coefficients should be small and statistically insignificant.

Our identification strategy is similar in spirit to a shift-share design. A recent literature has directed scrutiny at the necessary assumptions for causal identification using such strategies (Adao et al., 2019; Borusyak et al., 2020; Goldsmith-Pinkham et al., 2020).[14] In our case, given the use of shares from a single industry (nursing) and the presence of a pre-period, the empirical strategy reduces to conventional difference-in-differences, and we can test the plausibility of the identifying assumption in the standard ways (Borusyak et al., 2020, pg. 23; Goldsmith-Pinkham et al., 2020). We discuss falsification exercises below to argue for the validity of the identifying assumption.

We also estimate a pooled event study model, which reduces the number of estimated parameters and thus allows for easier interpretability and increased statistical precision. Formally, we estimate:

$$Y_{pt} = \beta^{postexp} High_{p,1990} 1(t \geq t^*_{2000}) + \beta^{trendexp} High_{p,1990} 1(t > t^*_{2000})(t - t^*_{2000})$$
$$+\beta^{postcon} High_{p,1990} 1(t \geq t^*_{2007}) + \beta^{trendcon} High_{p,1990} 1(t > t^*_{2007})(t - t^*_{2007})$$
$$+\beta^{trend} High_{p,1990}(t - t^*_{1999}) + \alpha_p + \gamma_t + X_{p0}\gamma_t + \varepsilon_{pt} \qquad (2)$$

[12] Additionally, $X_{p0}\gamma_t$ includes baseline values for the average female employment rate, the average male employment rate, the average age in the province, and the fraction female. We expand the set of controls in Section 5.4 and show that the results are generally robust to their inclusion. We calculate all controls from the 1990 Philippine Census.

[13] We exclude time-varying characteristics, as they could be affected by the policy changes.

[14] In Adao et al. (2019) and Borusyak et al. (2020), identification is based on exogeneity of the shocks, while the shares are allowed to be endogenous. In Goldsmith-Pinkham et al. (2020), identification comes from the exogeneity of the shares. However, when a pre-period is present, they argue that the empirical strategy can still be valid even if the shares are correlated with the levels of the outcomes since the strategy examines differential changes in the outcome based on differential baseline exposure.

where t^*_{2000} and t^*_{2007} represent the years of the expansion and contraction of visas, respectively. The coefficients $\beta^{postexp}$ and $\beta^{postcon}$ represent the change in outcomes in high relative to low nurse migration provinces in the years of the visa expansion and visa contraction, respectively. $\beta^{trendexp}$ and $\beta^{trendcon}$ capture delayed effects and can be interpreted as annual changes in outcomes in high relative to low nurse migration provinces after the initial year of the policy. β^{trend} estimates the changes in outcome variables in high relative to low nurse migration provinces prior to the policy change in 2000, and $\beta^{trend} \neq 0$ would suggest differential trending in high versus low nurse provinces prior to the policy change. All other variables are defined as in equation 1. All of our event-study figures show the event-study coefficients and standard errors from equation 1 with the results from equation 2 overlaid.

The key identifying assumption for both models is that, in the absence of the visa expansion and contraction, high nurse migration provinces would not have experienced differential changes in outcomes compared to low nurse migration provinces. The included controls interacted with year fixed effects, $X_{p0}\gamma_t$, particularly the control for baseline domestic nurses per capita, reduce concerns about underlying differences in trends by high and low migration provinces. We find no evidence of differential pre-trends for any of our outcomes. Additionally, the visa expansion and subsequent contraction yield an inverted U-shaped pattern of coefficients which is unlikely to be explained by a spurious correlation with underlying differences between high and low nurse migration areas. Finally, we find that non-nursing disciplines decline in enrollment during the period of nursing enrollment expansion. If the nursing enrollment results were driven by differential trends in overall education for high and low nurse migration provinces, then we would expect enrollment in other fields to follow a similar pattern to nursing enrollment.

One potential source of bias is cross-province migration within the Philippines for postsecondary nursing education. For instance, if individuals from low nurse migration provinces enroll in nursing school in high nurse migration provinces, this will overstate the enrollment effects. Ideally, we would calculate nursing enrollment rates for only students who are enrolled in their home province, but the CHED data do not allow for this sort of calculation. Instead, we explore cross-province migration for post-secondary education using the Philippine Census. The Philippine Census has three available waves during the expansion and contraction period: 2000, 2007, and 2010. The timing of these Census years is particularly convenient for our analysis: the 2000 data represent pre-expansion enrollment patterns, the 2007 data represent post expansion and pre-contraction enrollment patterns, and the 2010 data represent post contraction enrollment patterns. These three waves allow us to determine the importance of cross-province migration for college education overall as well as whether this sort of migration responded to the policy changes. The Census does not include information on the type of degree a postsecondary student is obtaining, so we are unable to disaggregate cross-province migration for nursing degrees versus other types of degrees.

Appendix Table 2 shows rates of cross-province migration. Approximately 6% of all postsecondary students attend in a province other than the one in which they reside. This appears quite stable across the 2000, 2007, and 2010 Census waves. Columns 2 through 5 decompose this national rate into rates of cross-province migration between low and high nurse migration provinces. Most migration for college is between high nurse migration provinces (Column 4), which is not a concern for our estimates. Upward bias could arise if students move from low nurse migration provinces to attend school in high nurse migration provinces, but this is only the case for about 1.3% of all postsecondary students. Despite this low rate, in Appendix B we conduct bounding exercises to address potential bias in our estimates that could arise due to migration for education, finding that such bias explains only a trivial portion of our effects under reasonable, but conservative assumptions.

A remaining threat to the validity of our estimates is a simultaneous policy change that differentially affected high relative to low nurse migration provinces. For instance, if the health care system expanded in high nurse migration provinces at the same time as the policy expansion, we might incorrectly attribute the effects on nurse enrollment and graduation to U.S. visa policy, when it was actually due to changes in demand in the Philippines. Appendix Table 3 shows the numbers of hospitals and community clinics, called Barangay Health Stations, in the Philippines from the early 1990s through 2010. These are the main employers of nurses, and their numbers appear to be relatively stable during the period of the U.S. visa policy changes. This suggests that there were no major changes to the health care system that might bias our results. Further, we collected data on all health policy legislation in the Philippines since 1954, and find no major policy changes that would differentially impact high and low nurse migration provinces and occurred at the same time as the U.S. visa policy changes (WHO, 2011; WHO, 2018).[15] Finally, our results could be biased by simultaneous changes in migration policy or demand for non-nurse migrants that differentially affected high versus low nurse migration provinces. In Section 5.4, we add controls for demand for non-nurse migrants and show that our results are robust to including them.

[15] The 2011 and 2018 WHO Health in Transition reports for the Philippines document all health-related legislative changes since 1954. Two policy changes occurred near the time of the U.S. visa policy changes: 1999 Health Sector Reform Agenda and 2002 repeal of the Philippine Nursing Act of 1991. The Health Sector Reform Agenda provided better linkages between provincial and national hospitals, and it made the national health insurance program more attractive (Philippine Department of Health, 1999). The repeal of the Philippine Nursing Act of 1991 changed the guidelines for how many individuals serve on the Board of Nursing and added requirements for refresher courses after three failures of the national licensure exam. Neither policy change should affect demand for nurses and neither should be correlated with our treatment variable, *High*.

5. Results

5.1. Effects on Nurse Migration and Nursing Education

We first estimate the effect of the visa expansion and contraction on the migration rate of nurses to the U.S. Figure 3 presents the results: the solid line represents the $\beta_\tau's$ from the event study (equation 1), with 95% confidence intervals shown by dotted lines. The dashed line shows the results of the pooled event study (equation 2). The two grey vertical lines represent the 2000 and 2007 policy changes.

Following the policy change in 2000, nurse migration started to increase in high nurse migration provinces relative to low nurse migration provinces. Consequently, in 2007 when visas were restricted, the nurse migration rate dropped suddenly. These results confirm that changes in U.S. visa policy had a larger impact in provinces with historically high nurse migration to the U.S.[16] We report the coefficients from the pooled specification in Column 1 of Table 2. In 2000, nurse migration jumped by 1.21 migrants per 100,000 working-aged individuals in high relative to low nurse migration provinces, resulting in an over 39% increase based on the pre-policy nurse migration sample mean of 3.07 nurses per 100,000. Following the initial jump, nurse migration increased by approximately 0.76 nurses per 100,000 each year in high relative to low nursing provinces until 2007. In 2007, nurse migration dropped by 4.20 nurses per 100,000, and continued to fall in the period after 2007 by 0.44 nurses per year.

Nurse migration had a slight downward trend before the 2000 policy change in high relative to low nurse migration provinces. This pre-trend is relatively stable over the decade before the policy change, and it is of the opposite sign and much smaller in magnitude than the sudden and large positive effects following the visa expansion. This is because, before the visa expansion, nurse migration in historically low nurse migrant-origin provinces was very slowly catching up to the high nurse migration provinces. The small and stable opposite-signed pre-trend suggests that it is not likely that the sudden changes in nurse migration to the U.S. following the visa expansion and contraction were due to differential trending by high and low nurse migration provinces.

We now turn to the effects on nursing school enrollment. We find that enrollment rates in nursing programs in high relative to low nurse migration provinces increased, and then decreased, following the policy changes in 2000 and 2007, respectively (Figure 4a). Similar to aggregate nursing enrollment in the Philippines (Figure 2a), nursing enrollment started to increase in 2000 in high relative to low nurse migration provinces. At its peak in 2006, the effect of the visa expansion on nursing enrollment is more than 3 percentage points (off a pre-period mean of 1.15 percent), before gradually declining to zero after the onset of visa restrictions in 2007.[17] This inverted U-shaped pattern of results in response to the

[16] The larger standard errors in the post-period are due to a substantial increase in variance in the outcome variables after 2000.

[17] One might have expected a sudden decline in nursing enrollment after the contraction if currently enrolled nursing students immediately switched to other degree programs or dropped out. However, this gradual decline is consistent

expansion and contraction is difficult to explain as due to differential trending across high and low nurse migration provinces.

The pooled event study follows the same pattern (Table 2). Nursing enrollment increased by 0.58 percentage points per year following the initial (statistically insignificant) jump of 0.038 percentage points in 2000. To interpret the magnitude of the effect, consider that the average increase in the enrollment rate during the seven-year visa expansion period was 1.48 percentage points per year.[18] Given an average pre-period enrollment rate of 1.15%, nurse enrollment increased by 129% in high relative to low nurse migration provinces. This is a large effect, though not surprising given the aggregate enrollment numbers in Figure 2a. The visa contraction in 2007 led to an immediate drop in nurse enrollment of 0.72 percentage points. Enrollment continued to decline by 0.97 percentage points per year through 2013, until the increase in enrollment in high relative to low nurse migration provinces disappeared. The coefficient on the pre-trend is small and statistically insignificant, implying that high migration provinces were not experiencing a differential trend in enrollment prior to the visa expansion.

Nursing enrollment in the Philippines is overwhelmingly female (76% nationally in the pre-period). However, the percentage of male enrollees increased from 24% in the pre-period to 30% of enrollees in the expansion period. Given this shift, we next explore the effects of the policy changes on enrollment by gender. The results are shown graphically in Figures 5a and b. Both male and female enrollment exhibit a similar inverted U-shaped pattern as in Figure 4a. While the raw effect is larger for women, because male enrollment rates in nursing were considerably lower prior to the visa expansion (0.27% of the college-aged population compared to 0.95% for women), the magnitude of the results in percent terms is larger for men. Men experienced a 1.84% increase in nursing enrollment while women experienced a 1.06% increase (Appendix Table 4).[19] This difference is statistically significant at the 1% level, indicating that while both men and women increased their enrollment in nursing programs, men experienced a larger shift.

Although the visa expansion dramatically increased enrollment, the marginal enrollees will not contribute to the supply of nurses if they do not persist to graduation. Figure 4b shows the corresponding event study analysis for graduation rates, and the results reflect the same pattern as the enrollment rates. We find that there were large increases in nurse graduation after visas for nurses increased, but that the

with current nursing students continuing toward their degree, while new potential nursing students enroll in other degree types.

[18] We calculate the average annual effect during the expansion period by adding up the effect of the policy change in each year from 2000 to 2006 and dividing by 7. As an example of how we calculate the effect for each year, the effect in 2001 is: 0.038+0.582*(2001-2000)+(-0.076)*(2001-1999)=0.468 percentage points. Alternatively, one could use the specification in equation 1 and add up the coefficients for 2000 to 2006 and divide by 7. The effect sizes are very similar in magnitude.

[19] These magnitudes are calculated as in footnote 18, but using the estimated coefficients from Appendix Table 4.

effect manifests approximately four years after visas were made available, consistent with the four years it takes to finish postsecondary nursing school. Nurse graduations decreased after the contraction, again with a four-year lag.[20] Because it takes four years to persist to graduation, we estimate the pooled event study assuming the expansion and contraction each occurred four years later (2003 and 2010, respectively, rather than 2000 and 2007). As with nursing enrollment, we find no evidence of a statistically significant pre-trend in nursing graduation.

Were there enough additional nursing graduates due to the visa expansion to replenish the supply of nurses who migrated to the U.S.? In the seven-year period from 2003 through 2009, the average effect on nurse graduation was 0.33 percentage points.[21] Given an average pre-period nursing graduation rate of 0.13%, the visa expansion led to a 247% increase in nurse graduates following the policy change. The average high nurse migration province had 270 nursing graduates per year before the expansion, so the visa expansion led to an increase of 666 new nursing graduates in high relative to low nurse migration provinces. With an average of 32 new nurse departures in high relative to low nurse migration provinces during the post-expansion period, this suggests that, for each additional nurse who goes abroad to the U.S., 21 additional students graduate from nursing school.

While this is a huge effect, consider the aggregate nurse migration and nurse graduation data shown in Figures 1 and 2. For the Philippines overall, nurse migration increased from 1,207 in 1999 to 7,323 in 2006, while nursing graduates increased from approximately 11,313 in 2002 to 113,484 at the peak in 2009. These nationwide increases are not necessarily causal, but they can help put into perspective the huge scale of increases in nursing enrollment and graduation during this period relative to the still dramatic, but much smaller-scale, increases in nurse migration. Further, in Appendix C, we conduct a back-of-the-envelope calibration of a standard utility function, showing that under reasonable levels of risk aversion, many individuals would choose to enroll in a nursing degree rather than an alternative degree type despite the low migration probability due to the high returns to nurse migration.

In terms of gender composition, similar to enrollment, both men and women increased graduation from nursing programs four years after the expansion, and decreased graduation from such programs following the contraction (Figures 5c and d). The effects are again larger in percent terms for males (4.52%) than females (1.96%), and this difference is statistically significant at the 1% level (Appendix Table 4). For each new nurse migrant that goes abroad, there are an additional 13 female graduates and 8

[20] One reason nursing students might persist to graduation despite the reduction in migration opportunities is due to the low return of completing only part of a college degree, as shown in Beam et al.'s (2020) audit study of employers in the Philippines.

[21] The average annual effect is calculated as described in footnote 18. In this case, for 2005, the effect is: -0.058+0.126*(2005-2003)+(0.002)*(2005-2002)=0.20 percentage points. We calculate these effects for 2003 to 2009 and average them.

male graduates in high relative to low nurse migration provinces. While nursing has long been a gendered occupation in the Philippines, the high returns to nursing as a result of the visa expansion led to a shift in the gender composition of both enrollees and graduates.

5.2. Effects on the Supply of Nursing Programs

Although the potential for brain gain has long been touted as a possibility, one concern for specialized occupations like nursing is that even if individuals aspire to obtain nursing education due to increased returns to human capital, they may not be able to do so if the supply of schooling does not respond in specialized occupations (Docquier and Marfouk, 2006). We now explore whether and to what extent the supply of nursing programs in the Philippines responded to accommodate the increased demand for nursing education. Following the 2000 visa expansion, we find that the number of nursing programs increased substantially in high relative to low nursing provinces (Figure 6).[22] The increase occurred gradually, with 0.4 new programs per year through 2007 (Table 2), or 9.7% per year based on a pre-period sample mean of 4.13 programs. Again, we see no evidence of differential pre-trends in the number of nursing programs.

85% of nursing programs in the Philippines are privately operated. As such, we find that the large expansion of nursing programs is driven by increases in private institutions (Table 2 and Figure 6). However, there is also a marginally statistically significant increase in the number of public programs. While the effect on public institutions is smaller in magnitude, in percentage terms this represents a 17% increase in the number of public nursing programs compared to a 8.7% increase in private programs. These results suggest that nursing enrollment and graduation were able to increase in response to U.S. visa policy because the supply of nursing programs, both public and private, were nimble enough to respond to increased demand.

Was the increased supply of nursing programs due to new nursing institutions opening or due to existing institutions adding nursing programs? This question has implications for external validity, as it may be easier for low-income countries to expand program offerings at existing postsecondary institutions than open entirely new institutions. We explore this in Appendix Figure 1 for private institutions, since the majority of the supply increases were due to increases in private programs. The effects appear to be driven by existing institutions adding nursing programs, with essentially no response in terms of new nursing institutions. This result is important when considering the conditions under which such brain gain effects are possible: the Philippines did not respond through the creation of entirely new nursing schools, but rather through adding new programs in institutions that previously did not engage in nursing education.

[22] Unfortunately, the CHED data do not include information on program capacity, so we cannot examine if existing programs expanded.

The ability of the Philippines to increase the supply of nursing programs in order to accommodate increased demand for nursing education suggests that the postsecondary schooling supply elasticity is a key contextual factor that allowed for the brain gain effects that we find. To explore the extent to which our effects vary by the supply elasticity, we next examine heterogeneity in our results by the province-level postsecondary schooling supply elasticity. Since the expansion of programs occurred primarily in institutions without existing nursing programs (as opposed to in entirely new institutions), we create a measure of elasticity that is the share of private institutions without nursing programs out of the total number of private institutions in the pre-period. A larger share should indicate that the supply is more elastic, since there are more institutions where nursing programs can be added. We then examine effects on nursing enrollment separately for those provinces above and below the median value of this share (0.80).

The results are shown in Appendix Figure 2. Panel a shows the effects on nursing enrollment for provinces with a more elastic supply of programs, while Panel b shows the effects in less elastic provinces. The results appear to be driven by places with a more elastic supply. In less elastic places, there is little to no enrollment response. This reinforces the notion that an elastic postsecondary schooling supply is key to the brain gain effects that we find. However, it is worth noting again that the supply response does not require the creation of entirely new institutions, but rather the ability of countries to expand their existing institutions to include new in-demand programs.

5.3. Effects on the Number of Licensed Nurses and Nursing Exam Pass Rates

In order to work as a nurse in the Philippines or to migrate abroad, all nursing graduates must pass the Philippine Nursing Licensure Examination (NLE). While the U.S. expansion of visas led to a large increase in the number of nursing graduates, these new graduates will only contribute to the nursing labor force if they are able to pass the NLE exam. We examine the effect of the policy changes on province-level NLE pass rates using our event study framework (equation 1).[23] Figure 7 shows the effect on the number of NLE passers out of the college age population (blue circles), indicating that in high relative to low nurse migration provinces, the number of passers out of the college aged population increased. Similar to the graduation results, the effects occur with a lag since it takes four years for students induced to attend nursing school by the policy changes to obtain their degree and take the exam, though earlier nursing graduates who previously did not take or did not pass the exam may respond immediately. There is no evidence of differential trending prior to the visa expansion.

[23] One possible response to the huge influx of nursing graduates would be to make the test easier. Because nurses migrating to the United States must also pass the National Council Licensure Examination (NCLEX), little incentive exists for the Philippines to make it easier to pass the local exam. If the test did become easier (or harder) over time, this will not bias the difference-in-differences estimates since the NLE is a national exam.

To assess the magnitude of this response, we estimate the effect of the policy expansion by regressing passers out of the population on the interaction of an indicator for high nurse migration provinces and an indicator for the post-period (2000 and onward).[24] On average, high migration provinces compared to low nurse migration provinces experienced an annual increase in licensed nurses out of the college-aged population of 0.148 percentage points, which is significant at the 1% level (Appendix Table 5, row 1).[25] With a pre-period rate of 0.18%, this effect is equivalent to an 80% increase in the number of licensed nurses in high relative to low provinces, or 293.1 newly licensed nurses per year on average. With 32 new nurse migrants on average in these provinces, there are 9 newly licensed nurses for each new nurse migrant. This substantial gain in the number of licensed nurses as a result of the visa expansion suggets a brain gain of health care professionals.

5.3.1. Effects on Nurse Quality

While the Philippines gained licensed nurses, not all new graduates induced by the visa expansion passed the exam. Given the large increases in both new nursing graduates and nursing programs, one important question is whether the marginal nursing graduate is less likely to pass the exam. New graduates may be less-skilled, either because the new nursing programs are less rigorous or because the students themselves are weaker. While ideally we would estimate the effect of the policy changes on the pass rate (number of passers/number of examinees), this analysis is complicated by the fact that not all provinces have examinees in every year. For these province-year observations, the pass rate is undefined. Dropping these provinces from the analysis alters the composition of the treatment and control groups relative to our previous analysis, primarily by removing province-year observations from the control group. In order to include all provinces in the sample, we estimate two regressions: 1) the number of passers out of the population regressed on the interaction of an indicator for high nurse migration provinces and an indicator for the post-period (2000 and onward) and 2) the number of examinees out of the population regressed on the same interaction term. The event study estimates shown in Figure 7 indicate the lack of pre-trends for both outcome variables. We then divide the estimated coefficient for passers out of the population (0.148) by the estimated coefficient for examinees out of the population (0.385), both of which are statistically significant at the 1% level (Appendix Table 5, row 1). This quotient backs out the implied pass rate in the post-period for those induced to take the exam by the policy change: 38.5% (Column 3). We then test the null hypothesis that the implied pass rate is equal to

[24] This is a simpler difference-in-differences estimator than the pooled event study model, as we want to capture the effects on pass rates in a single parameter. As in the previous results, both regressions include province and year fixed effects as well as baseline controls interacted with year fixed effects.

[25] We also report coefficients of the effect of the policy changes on passers out of the population using our event study framework.

the pass rate in the pre-period (58%). We reject the null hypothesis at the 1% level that these pass rates are equal, indicating that pass rates declined following the expansion in U.S. nursing visas.[26]

We are unable to determine whether this decline in pass rates is because the new nursing programs are of lower quality or because the marginal student induced to attend nursing school is a weaker student.[27] We discuss potential labor market outcomes for unlicensed nursing graduates in Section 5.6.

5.4. Robustness

Our results provide evidence that the expansion of visas for foreign nurses increased the number of qualified nurses in the Philippines. A number of questions remain, and we test the robustness of our results to these concerns.

First, are the results contaminated by a simultaneous migration policy change that is correlated with treatment status? Table 1 shows that high nurse migration provinces also have high rates of non-nurse migration. Without random assignment of historical nurse migration networks, changes in demand for non-nurse migrants that differentially affected high versus low nurse migration provinces could bias the results. For instance, if high nurse migration provinces also have strong migrant networks for other occupations, and demand for migrants in these occupations occurred at the same time as the U.S. visa expansion, nursing enrollment may have risen due to increased remittances from these occupations, rather than due to the visa expansion. To address this, we estimate the results adding in the non-nurse migration rate at baseline interacted with year fixed effects. These controls allow for time-varying effects of baseline non-nurse migration and account for changes in migration policy or demand in other migrant networks.

The results are shown in Table 3. To conserve space and for ease of exposition, we estimate basic difference-in-differences specifications for our robustness checks (rather than the pooled event study model), where *Post Expansion* is a dummy variable equal to 1 in the year 2000 and after, and *Post Contraction* is a dummy variable equal to 1 in the year 2007 and after.[28] Panel A replicates the main results from Table 2 using this simpler difference-in-differences framework, revealing increases in the average nurse migrants per 100,000 working-aged individuals, enrollment rate, graduation rate, and number of nursing programs post-expansion in high relative to low nurse migration provinces. The coefficients on *Post Contraction x High* give the difference between the post-expansion level and the post-contraction level. These are smaller than the expansion effects and statistically insignificant for nurse

[26] Appendix Table 5 also uses the event study estimates to calculate the implied pass rate in each year in the post-period by dividing the coefficient on the interaction of *High* and a given year fixed effect in the passers/population regression by the same coefficient for the examinees/population regression. Beginning in 2006, the pass rates among the marginal test takers are statistically significantly lower than the pre-period pass rate.

[27] Additionally, individuals with nursing degrees who previously failed the exam or did not take the exam may now choose to take the exam at a higher rate, also potentially lowering the pass rate.

[28] The pooled estimates (equation 2) for all robustness checks are shown in Appendix Table 6.

migration, enrollment and graduation, which is consistent with the symmetric increase and subsequent decline shown in the event study figures.[29] The post-contraction effect for nurse programs is positive and significant, consistent with the prior result that those programs did not decline post-contraction. We add baseline non-nurse migration x year fixed effects to this specification (Table 3, Panel B). The results are robust to this additional control, though the effect on the number of nursing programs is no longer statistically significant. This alleviates concern that the results are driven by concurrent changes in migration policy or demand for other migrants that differentially affected high versus low nurse migration provinces.

Our second concern is if our results are driven by the inclusion of Metro Manila, which is one of the 74 provinces included in our sample. Manila has much higher rates of migration and postsecondary enrollment than anywhere else in the Philippines. We are concerned that the inclusion of this megacity may drive the results since Manila may be better positioned to respond nimbly to changes in demand for migration and education. In Table 3, Panel C, we show that the results are nearly identical when we exclude Metro Manila.

Third, we address whether differences in baseline educational composition and urbanity influence the results. Recall that differences in levels are accounted for by province fixed effects, and that all results include controls for baseline domestic nurses per capita times year fixed effects which likely account somewhat for educational differences. Still, baseline educational composition and urbanity may influence how educational outcomes evolved over time. We add to our main specification baseline average years of schooling for 25- to 64-year-olds and baseline fraction of households that live in urban areas in the province, both interacted with year fixed effects (Table 3, Panel D). Columns 1 through 3 show that the results for nurse migration, enrollment, and graduation are similar in magnitude and statistically significant. We cannot reject the null hypothesis that the point estimates are equivalent to our preferred specification (Panel A) for any of these outcomes. For the nurse program results, however, the coefficient is still positive, but far smaller in magnitude and no longer statistically significant. The attenuation of this point estimate is driven by Metro Manila. In Panel E, we include these additional controls and exclude Manila. After dropping Manila, the results are again unchanged for nurse migration, enrollment, and graduation, but are now large and statistically significant for nursing programs, as in Panel A (our preferred specification).

Manila is an extreme outlier in terms of both average years of schooling and urbanity, with approximately two more years of education at baseline than other high nurse migration provinces and 100% of households in urban areas. Manila is also an outlier in nursing programs, with a very high

[29] For example, note that in Figure 4a, the average level of nursing enrollment is nearly identical in the post-expansion and post-contraction periods.

number of programs, but also a very low percent growth given the high initial level. When education and urbanity controls are added, the event study compares nurse program growth in high versus low nurse migration provinces with similar levels of baseline education and urbanity. The very low nursing program growth in Metro Manila contrasts with the positive relationship between education, urbanity, and nursing program growth in other provinces, thus pulling down the overall nursing program point estimate, and producing the apparent null result. We prefer to include Manila in our sample, yet do not want the results to be driven by a single, outlier province. Thus, we exclude these controls from our preferred specification.

Next we examine whether high and low nurse migration provinces experience differences in economic growth during the sample period, thus leading to differences in educational outcomes. Our sample period includes both the Asian Financial Crisis in 1997 and the Global Financial Crisis in 2008. Depending on the industrial composition of different geographic areas of the Philippines, these crises, as well as other macroeconomic events, may have had differential impacts in high versus low nurse migration provinces. To account for this potential threat, we group the Philippines into three super regions (north, central, and south), which represent the three major island groups: Luzon (where Manila is located), Visayas, and Mindanao. We then include island times year fixed effects as controls. All of our estimates are robust to the inclusion of these fixed effects (Panel F), though the nurse program results are no longer significant. Overall, this suggests that differences in economic growth or any other factor across island regions are not driving our results.

Finally, while we choose to separate provinces into high versus low nurse migration, we alternatively could use a continuous measure of the baseline nurse migration rate as our second difference, rather than the binary treatment variable, *High.* We take this approach and report results in Panel G, scaling the results so they can be interpreted as the impact of a one standard deviation increase in the baseline nurse migration rate. The results are similar in significance and magnitude to the results shown in our main specification (Panel A).

5.5. Effects on Enrollment and Graduation in Other Fields

A natural question is whether the visa expansion increased the overall human capital stock in the Philippines by inducing more individuals to attend and persist through college, or if it simply altered the choice of degree type for students who would have enrolled and persisted through college in the absence of the policy changes. We examine this by looking at non-nursing enrollment and graduation rates. We note that when looking at aggregate enrollment across the Philippines, non-nursing enrollment declined after the visa expansion and increased after the contraction (Figure 2a). This pattern is the opposite of nursing enrollment and suggests that individuals may have switched from other disciplines to nursing in response to the visa expansion. Turning to our event study framework, this potential switching behavior is

evident (Figure 8a), though the results are statistically imprecise. A simple difference-in-differences analysis, presented in Table 4, shows a statistically significant decline in enrollment in non-nursing fields in the expansion period (column 1).

Consistent with students switching to nursing from other fields of study, the results for total enrollment (nurse plus non-nurse) are flat and near zero during the visa expansion period (Figure 8b). In spite of the large increase in nursing students, the total number of students enrolled in college remains essentially unchanged. There is little evidence of differential pre-trends in either non-nursing or total enrollment.

We next examine both non-nursing and total graduation. While there were no overall increases in postsecondary enrollment due to the visa expansion, the policy could have affected the persistence rate of the marginal enrollee through college and therefore graduation. As with enrollment, aggregate graduation across the Philippines in non-nursing disciplines illustrates a u-shape pattern, declining following the expansion and then increasing following the contraction (Figure 2b). Turning to the event study framework, this U-shaped pattern in non-nurse graduation is no longer evident. Non-nurse graduation rates, while noisy, appear flat and close to zero during the sample period (Figure 8c). The coefficients in Table 4, Column 3 are also small in magnitude and not statistically significant. Total graduation rates, however, appear to increase due to the visa expansion (Figure 8d). This increase is driven by the period when nursing graduation can respond, which is four years after the initial expansion (2003-2009) due to the time necessary to complete a degree. To determine if there is a statistically significant increase in total graduation, we test the joint significance of the event study coefficients for 2003 through 2009. We reject the null hypothesis that they are jointly equal to zero (p-value=0.05). Table 4, Column 4 also shows a statistically significant increase in total graduation during the expansion from 2003 to 2009.

The null effect on total enrollment but increase in total graduation suggests that those in nursing degrees are now more likely to persist to graduation. This could either be because those switching to a nursing degree were more likely to persist to graduation than if they had enrolled in their counterfactual program or because those previously enrolled in nursing programs now persist through their education at a higher rate due to the higher returns. Were the graduation rates in the Philippines prior to the policy changes low enough to plausibly accommodate increased persistence rates as an explanation for the increase in total graduates? To explore this, we calculate the pre-period nationwide persistence rate as the number of graduates out of enrollees. Because we do not have enrollment data by class year, we divide the pre-period average number of graduates by one quarter of the pre-period average number of enrollees.[30] Approximately 74% of enrollees graduate from college in the pre-period. Total graduation

[30] Taking a quarter of the pre-period enrollment likely yields an overestimate since it assumes an equal number of enrollees across 4 years, but some enrollees will drop out as they progress through the degree.

increased by 0.475 percentage points (Table 4, Column 4). Given an average pre-period total graduation rate of 3.98%, the visa expansion led to an 11.9% increase in the graduation rate, or 558 new graduates per year in the average province. If the entire increase in total graduates was due to an increase in the persistence rate, then the 11.9% increase in total graduates in the expansion period would yield an 8.8 (=74%*0.119) percentage point increase in the share of enrollees that graduate, resulting in a persistence rate of 82.8%. This suggests that there was room for an increase in persistence to explain the increase in total graduates.

Was this increase of 558 graduates enough to increase the human capital stock in the Philippines, given that some new nursing graduates migrated to the U.S.? Recall that the visa expansion caused an increase of 32 new nurse migrants per year in the average province. This implies that rather than depleting the Philippines of college graduates as the brain drain hypothesis would suggest, the number of college graduates, and thus the human capital stock of college-educated labor in the Philippines, in fact increased.

5.6. What happens to nursing graduates who do not get a visa?

A remaining question is what happens to individuals in the Philippines who obtain a nursing degree but do not migrate to the U.S.? Do they migrate to other destinations? Do they work as nurses in the Philippines or work in some other occupation? Given the large excess response of nursing graduates to the visa expansion, the answers to these questions are important for understanding the overall effects of the policy changes on Filipino workers.

5.6.1. Migration

We first examine whether demand from other destinations for nurse migrants absorbed some of the newly licensed nurses. We calculate the non-U.S. nurse migration rate using the CFO data, and estimate the effect of the two visa policies in the event study framework. The results are shown in Appendix Figure 3. Non-U.S. nurse migration is largely flat and close to zero through the expansion and contraction of U.S. nurse visas. In 2008, nurse migration began to increase to other destinations, largely due to a change in Canadian immigration policy to prioritize visa applications based on shortages in the Canadian labor market. However, even with this increase in 2008, the number of nurses securing visas to other destinations was small relative to the increase in nursing graduates. In 2007, 632 nurses received visas to other destinations, peaking at 2,943 in 2012. Thus, while non-U.S. destinations may have provided jobs for some of the additional nursing graduates who do not migrate to the U.S. as nurses, a very small share of the newly graduated nurses would have benefited from migrating through these other channels.

Another labor market option for these recently graduated nurses is migration opportunities for lower-skilled positions, such as caregivers or domestic helpers, that leverage some skills learned in nursing programs (DeParle, 2019). These options generally operate through temporary labor contracts.

While we have detailed data on all temporary contract migrants from 1992 to 2009 from the Philippine Overseas Employment Administration (see Theoharides [2018] for more detail), province of origin is missing in 1999–2003, the period spanning the visa expansion, making it difficult to estimate our event study framework. To gain some insight into this question, we instead look at the total annual flows of domestic helpers and caregivers during our sample period. Neither occupation experienced a substantial increase in outflows during the period when nurses graduated at high rates (2005–2009). In fact, domestic helper migration fell dramatically during this time due to a ban of domestic helpers by Saudi Arabia. As such, it is unlikely that a large share of the supply of new nurses migrated from the Philippines to work in these other occupations.

5.6.2. Domestic Labor Market Outcomes

If the bulk of the additional nursing graduates were not migrating to other destinations to work as nurses or in lower-skilled occupations, a remaining question is: What are the occupational outcomes of nursing degree recipients who stay in the Philippines? Using the 1990, 2000, and 2010 Philippine Census, we examine if these individuals worked as nurses at home. Nationally, nurse and midwife employment increased slightly between 1990 and 2000 and substantially between 2000 and 2010 (Appendix Figure 4).[31] Of course, such an increase is not necessarily due to changes in U.S. visa policy. To attempt to estimate the causal impact of the visa expansion on domestic nurse employment, we employ a basic difference-in-differences strategy and estimate the following equation:

$$Y_{pt} = \boldsymbol{\beta_0} + \boldsymbol{\beta_1} High_{p,1990} Post_t + \alpha_p + \gamma_t + X_{p0}\gamma_t + \varepsilon_{pt} \qquad (3)$$

where Y_{pt} is the number of nurses in province *p*, year *t*, divided by the 1990 province population, and $Post_t$ is equal to 1 in 2010 and to 0 otherwise.[32] All other variables are defined as in equation 1.[33]

The number of Filipinos employed as nurses increased by 1.04 percentage points (SE=0.281) in response to the visa policy changes. Given that 1.26% of the province working-aged population worked as a nurse in the pre-period, this is an 83% increase in nurse employment. Based on the pre-period province average of 2,205 nurses, this yields an increase of 1,830 nurses in high relative to low nurse migration provinces. We check for pre-trends by restricting our analysis to the pre-period years, with 2000 treated as the "post" period. The coefficient in the check for pre-trends is small and not statistically significant (0.173, SE=0.137), indicating that this effect is not driven by differential trending in nurse

[31] Unfortunately, the 2000 Census does not allow us to separately identify nurses and midwives. In the 2010 Census, 85% of individuals in the nurse/midwife category were nurses, so it is likely that the majority of workers in this category in 2000 are also nurses.

[32] While the U.S. visa policy expansion occurred in 2000, we saw in Section 5.1 that nurse graduation occurred with a lag, and so we treat 2000 as the pre-period.

[33] Baseline domestic nurses per capita x year fixed effects are now excluded as controls since baseline domestic nurses per capita is encompassed in the outcome variable.

employment in high nurse migration provinces. While this basic difference-in-differences analysis using only three census years is not ideal, it certainly suggests that, rather than a brain drain, the Philippines appears to have employed significantly more nurses in response to the policy changes.

Given our prior result that there were 9 new licensed nurses for each additional nurse migrant, it is perhaps unsurprising that so many more individuals were working as nurses in the Philippines. Yet, how did the Philippines manage to employ so many additional nurses? Did the health system expand dramatically in high relative to low nurse migration provinces? As discussed in Section 4 and shown in Appendix Table 3, no substantial expansions to the hospital system or barangay health systems occurred during this time, so it seems unlikely that growth in the health care system could account for the increase in nurse employment.

Were these nurses filling previous shortages in the Philippines? Here, geography matters. In high nurse migration areas, shortages are unlikely. In fact, numerous news reports have discussed high levels of unemployment among those who obtained a nursing degree and were never able to migrate (Mateo, 2011). Low nurse migration areas, however, were often underserved. Capitalizing on this, the Philippines began the Registered Nurse for Health Enhancement and Local Service (RN HEALS) program during the late 2000s. The goal of this program was to address the shortage of nurses in underserved areas of the Philippines and to give training to unemployed nurses. The program consisted of six months working for rural health units and another six months of hospital service. The program hired approximately 20,000 nurses each year from areas with large surpluses of nurses (WHO, 2018). Because these nurses only serve temporarily, the Census counts them as nurses, but as part of their household in their home province. Thus, these workers account for almost 30% of the increase in nurses that we found using the Census data (1,830 nurse increase in 38 high nurse migration provinces, or 69,540 nurses).

Many other nurses work as "Professional Volunteer Nurses" (Rudin, 2013). These nurses pay a fee to hospitals in the Philippines under an official training program, essentially becoming part of the hospital staff but without pay. After three to six months, they receive a certificate of service, which they hope will give them the experience needed to migrate abroad (Marcus et al., 2014). While data are not available on the exact number of these nurses annually, thousands of licensed nurses do this each year (Mateo, 2011). Counted as nurses in the Census, these workers may constitute a significant portion of the increase in nurse employment.

Finally, what about those individuals who never work as nurses but completed a nursing degree? Ideally, we would examine the occupations and employment status of nursing degree recipients. Unfortunately, such data do not exist.[34] We turn to Department of Health reports, news articles, and

[34] While the Philippines has a quarterly Labor Force Survey (LFS), degree type is collected only during the pre-period (1992-2000), while detailed occupation type, such as nurse, is collected only during the post-period (2003-

interviews with nursing school staff to provide some suggestive evidence. These sources indicate that some nursing degree recipients are able to work in the health sector, albeit not as nurses. Similar to the RN HEALS program, the Department of Health capitalized on the surplus of nurses by creating a program to hire those with nursing degrees who never passed the licensure exam as Universal Health Care Implementers, Public Health Associates, and Family Health Associates (WHO, 2018). Other degree recipients worked in Business Process Outsourcing (BPO) and call centers (Marcus et al., 2014). Some call centers require a nursing degree, particularly those related to health or insurance (Tan, 2019), while for other call centers a college degree is required, but the particular degree type does not matter. Many nurses chose this option because the BPO industry provides better compensation (as high as triple the salary of a bedside nurse) (Uy, 2019).

So, what are the welfare implications of the large surge in nursing degree receipt due to the U.S. policy changes? It is worth acknowledging that if these students acted rationally in their decision to invest in nursing education, then even in the case that the vast majority ended up unemployed domestically, they would still be better off ex-ante. However, individuals may be acting irrationally, for example, if they were overestimating the probability of migrating as a nurse to the U.S. In addition, even if individuals are acting rationally and privately better off ex-ante, there could be negative externalities due to, for example, shortages in other fields students switched away from. Examining the labor market outcomes for the non-migrating nurse graduates can begin to shed light on these possible welfare consequences for the Philippines, and help us understand whether these workers were better off ex-post.

In terms of benefits, the Philippines gained more nurses, and many of these nurses worked in underserved areas. Those who migrated, whether as a nurse to the U.S. or another country, or in another occupation, experienced huge gains in wages and households in the Philippines benefited from remittances. For those who did not migrate, many found employment as nurses or in other high-paying jobs. In terms of costs, many nurses remained unemployed or in volunteer positions. They primarily switched to nursing from other fields, and while the total number of postsecondary graduates increased, it is unclear whether remaining in other fields would have resulted in better outcomes for their households or greater development impacts on the Philippines. While understanding the potential implications for welfare is beyond the scope of this paper, ultimately we aim to provide a well-identified and convincing estimate of the partial equilibrium effect of the U.S. visa policy changes.

present). As a result, there are no years of the LFS that include both detailed occupation and degree types, preventing us from conducting this analysis.

6. Conclusion

The debate surrounding the migration of medical workers from developing countries is highly controversial, particularly due to concerns about resulting adverse health outcomes in the country of origin (WHO, 2010; Bradby, 2014; Lema and Baldwin, 2020; Skladany, 2020). Yet, little causal evidence exists measuring the impacts of such migration on the origin-country human capital stock. In this paper, we exploit two migration policy experiments to provide evidence on the brain drain versus brain gain debate for health care professionals. We examine the effects of an abrupt expansion and subsequent contraction of visas for nurses migrating to the United States on postsecondary education decisions in the Philippines. We find that both enrollment in and graduation from nursing programs increased dramatically in response to increased U.S. demand for nurses and then fell when visas were restricted. The number of nursing programs rapidly expanded to accommodate the increased demand for nursing education, mainly through expansions in existing postsecondary institutions. Although students induced into nursing education passed the licensure exam at lower rates, the increase in licensed nurses overall was much larger than the increase in nurse migration: for each additional nurse who went abroad, 9 more nursing graduates passed the licensure exam.

Our results suggest that expanded migration opportunities did not deplete the stock of nurses in the Philippines, and in fact, the supply of nurses, as well as the total human capital stock of college-educated labor in the Philippines, increased. Our results may not translate to all settings, such as the most underdeveloped countries where postsecondary infrastructure may be unable to expand to meet demand, and such setting should be the subject of future research. However, our results provide useful evidence for many low- to middle-income countries seeking to emulate the Philippines' facilitation of labor migration: brain gain effects can dominate brain drain effects in the context of medical worker migration. These results highlight the potential for well-designed partnerships between receiving and origin countries. Such partnerships can, at least in principle, present an advantageous situation by allowing receiving countries to subsidize training for workers in origin countries while facilitating the migration of skilled workers (Clemens, 2015). That said, while we are able to contribute to the partial equilibrium policy debate surrounding medical worker migration, we are unable to quantify the total welfare effects of such migration. These general equilibrium effects should be the subject of future research examining the impacts of migration opportunities on migrant-origin countries.

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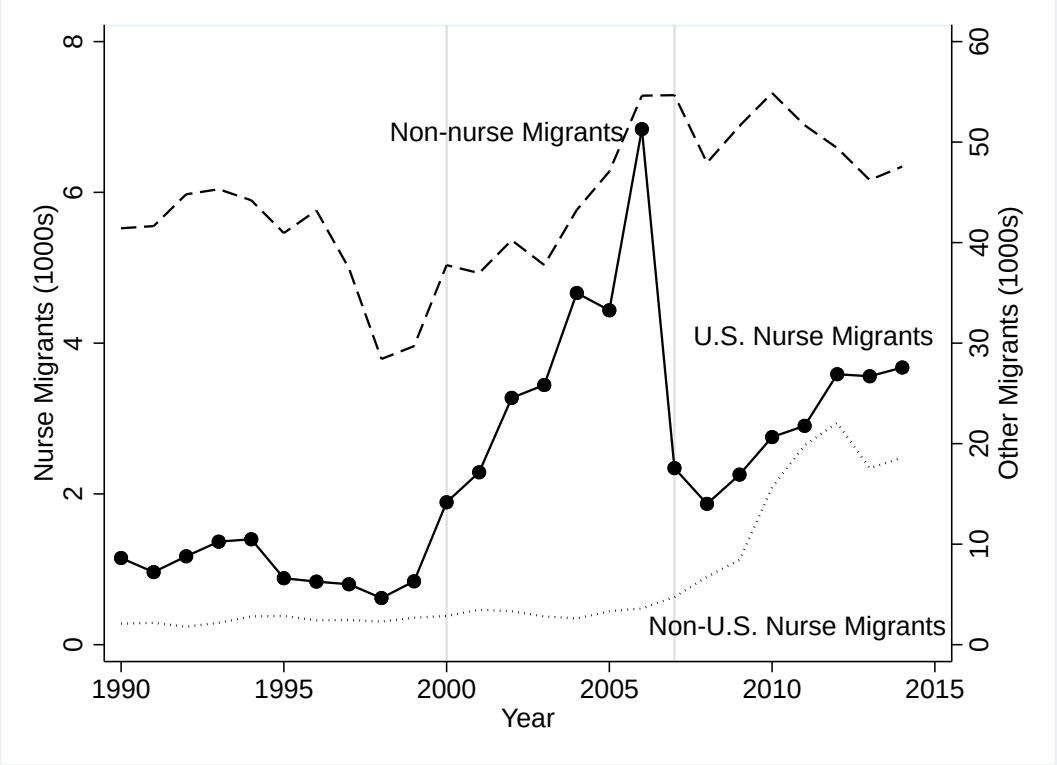
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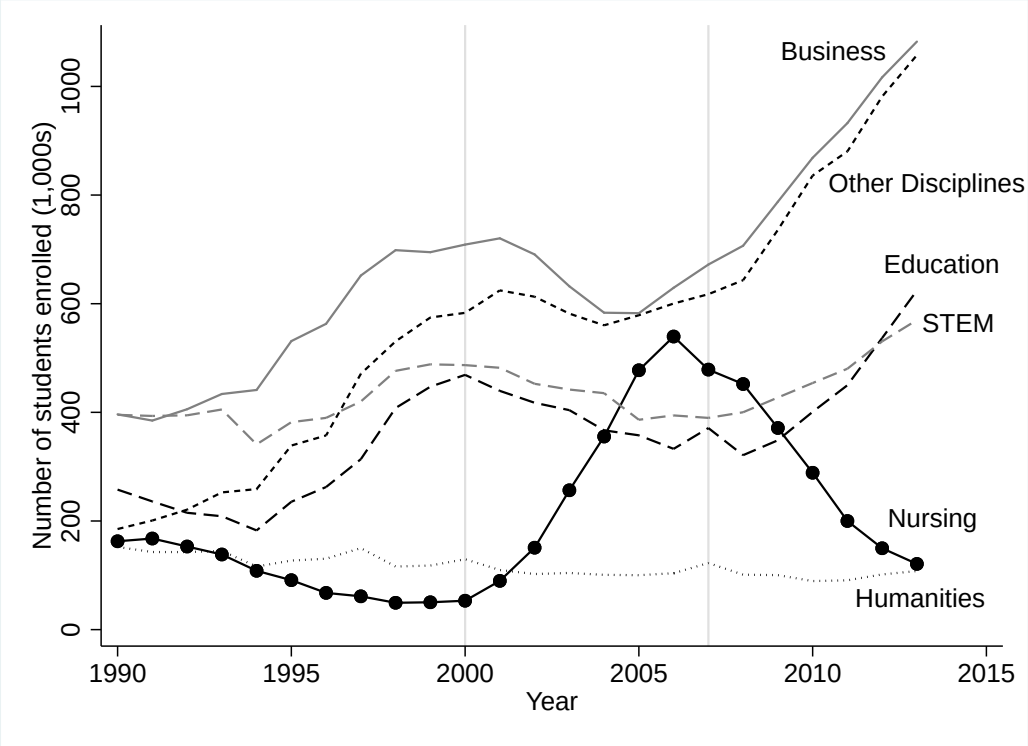
Figure 1: Number of Nurse Migrants and Other Migrants (1990-2014)



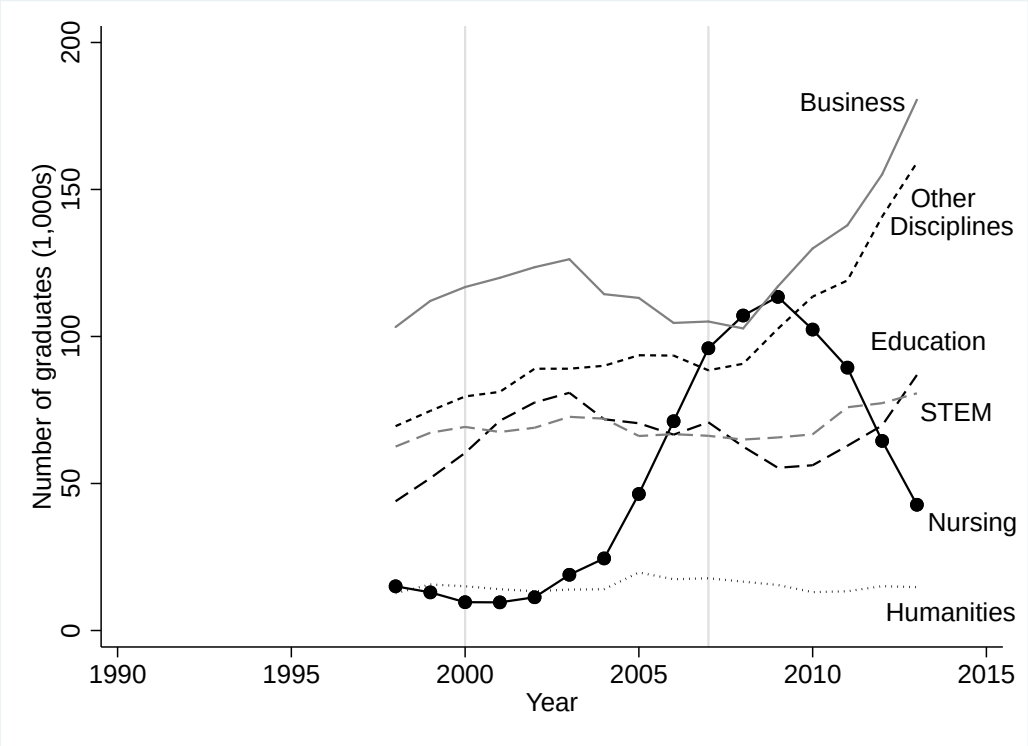
Notes: The solid line with circle markers and the dotted line show total nurse migrants to the U.S. and other destinations (left vertical axis) while the dashed line shows total non-nurse migrants (right vertical axis).
Source: CFO and authors' calculations.

Figure 2: Postsecondary Enrollment and Graduation by Discipline (1990-2013)

(a) Enrollment

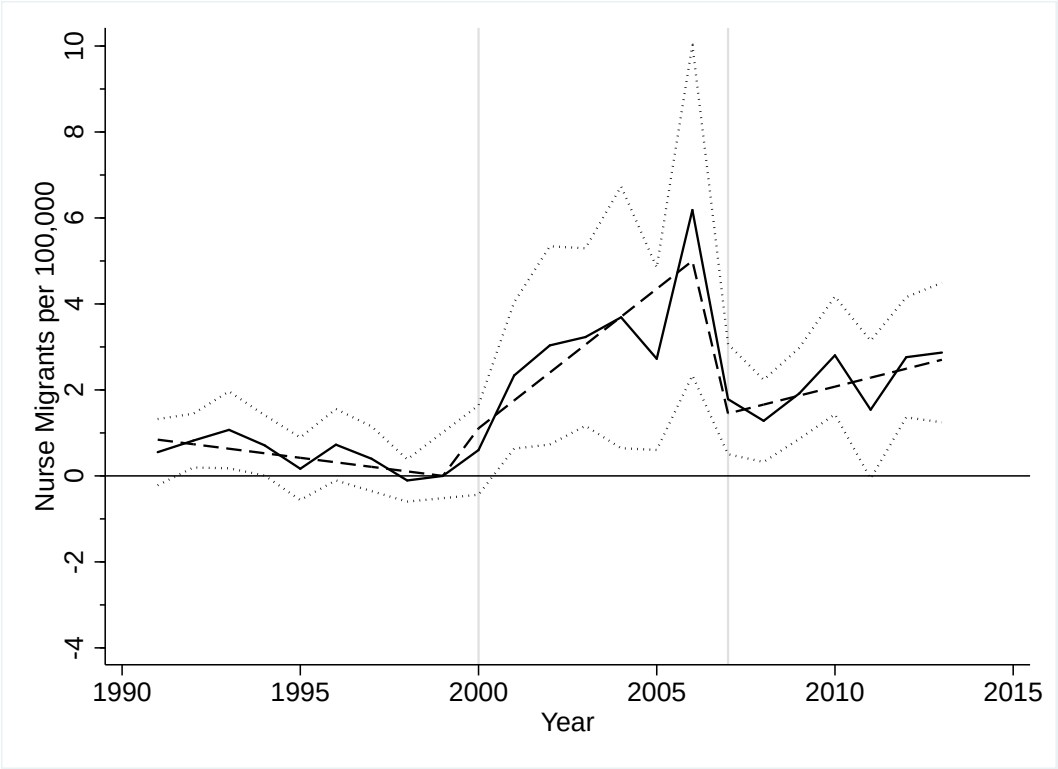


(b) Graduation



Notes: Enrollment includes all four years of postsecondary education. Graduation data are unavailable prior to 1998. The right axis shows the total number of enrollees and graduates across all fields, while the left axis shows the number disaggregated by field. Source: CHED and authors' calculations.

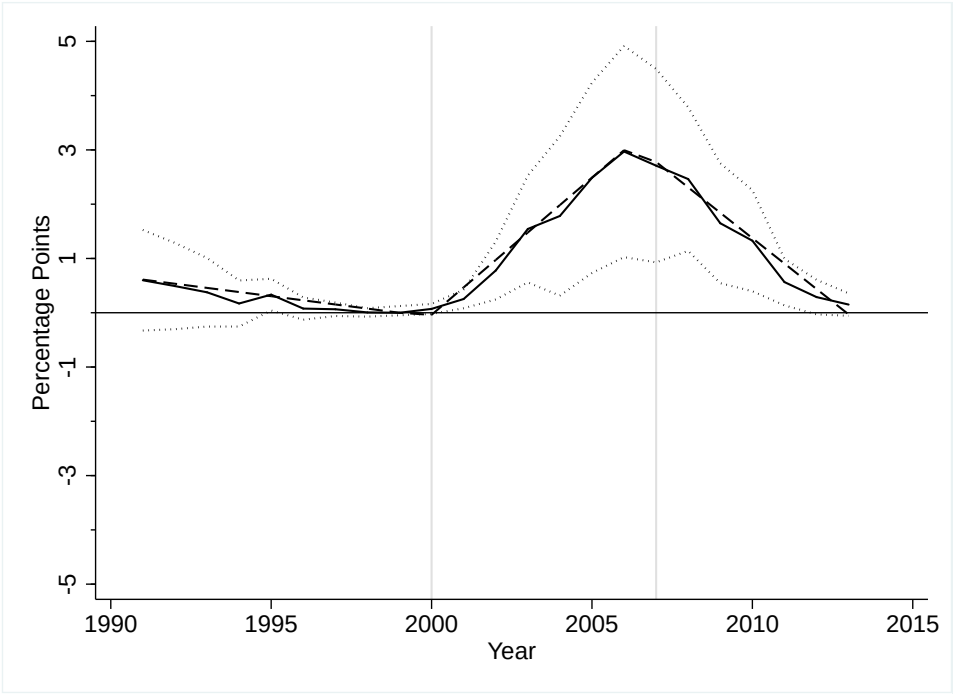
Figure 3: Effect of Visa Expansion and Contraction on U.S. Nurse Migration Rate



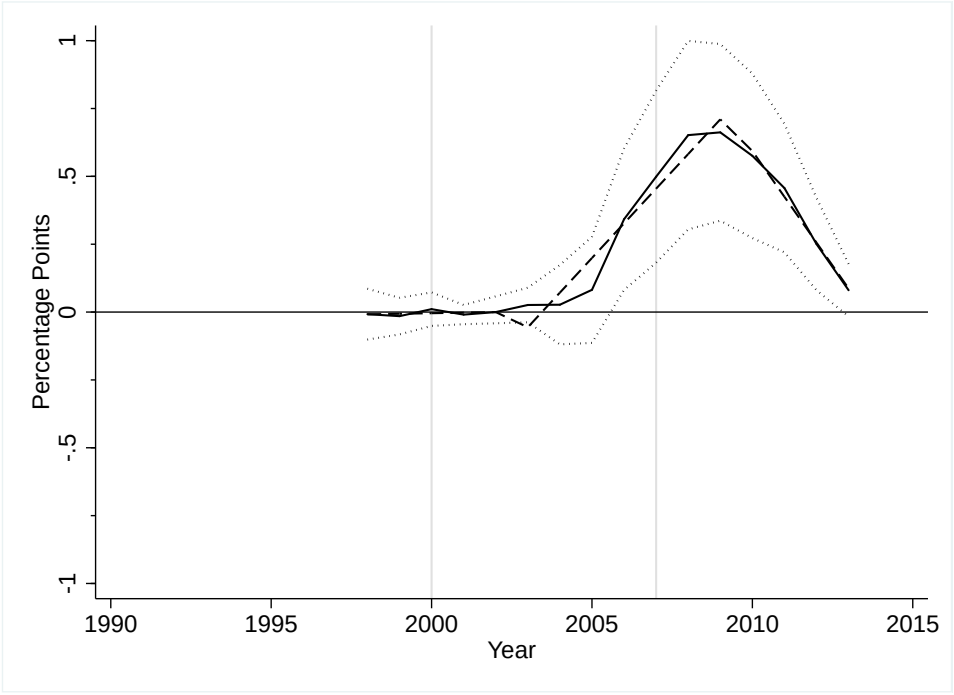
Notes: The solid line shows coefficients from the event study model (equation 1). The interaction with the indicator for 1999 is omitted to identify the model. 95% confidence intervals are shown by dotted lines. Dashed lines show the pooled model (equation 2). All specifications include province and year fixed effects, and baseline controls interacted with year indicators. Province-level baseline controls include: domestic nurses per capita, male employment rate (aged 25-64), female employment rate (aged 25-64), share female, and average age in the province. The sample includes 74 provinces. Standard errors are clustered by province. The p-value on the test of joint significance of pre-trends equals 0.01. The light grey vertical lines represent the visa expansion in 2000 and subsequent contraction in 2007.
Source: CHED, CFO, and authors' calculations.

Figure 4: Effect of Visa Expansion and Contraction on Nursing Enrollment and Graduation Rates

(a) Nursing Enrollment Rate



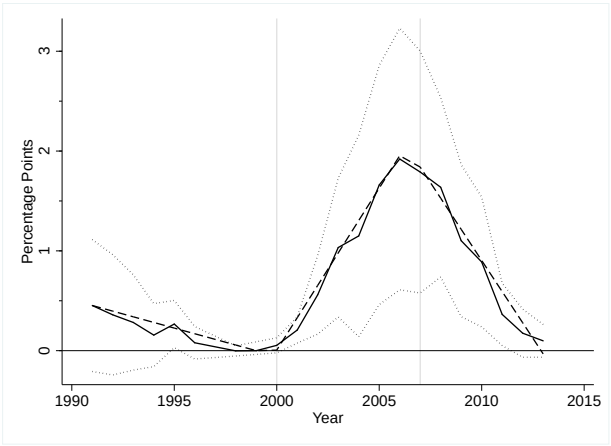
(b) Nursing Graduation Rate



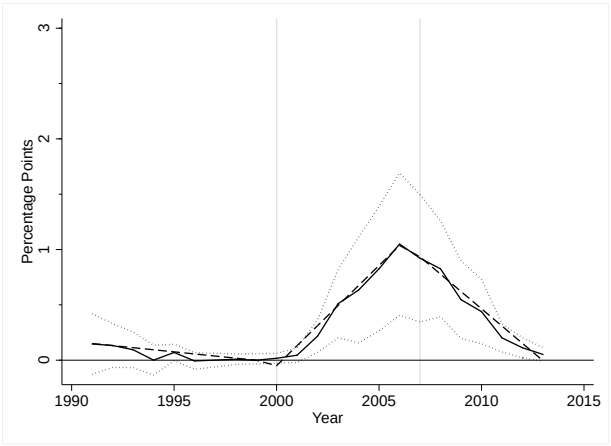
Notes: The solid line shows coefficients from the event study model (equation 1). The interaction with the indicator for 1999 is omitted to identify the model in Panel a and 2002 is omitted in Panel b since nurse graduation responds with a four-year lag. 95% confidence intervals are shown by dotted lines. Dashed lines show the pooled model (equation 2). All specifications include province and year fixed effects, and baseline controls interacted with year indicators as listed in Figure 3. The sample includes 74 provinces. Standard errors are clustered by province. The p-value on the test of joint significance of pre-trends equals 0.15 (panel a) and 0.87 (panel b). The light grey vertical lines represent the visa expansion in 2000 and subsequent contraction in 2007.
Source: CHED, CFO, Census, and authors' calculations.

Figure 5: Effect of Visa Expansion and Contraction on Nursing Enrollment and Graduation Rates by Gender

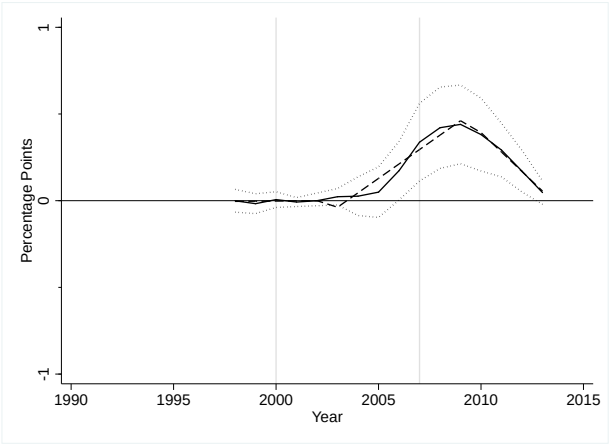
(a) Female Nursing Enrollment Rate



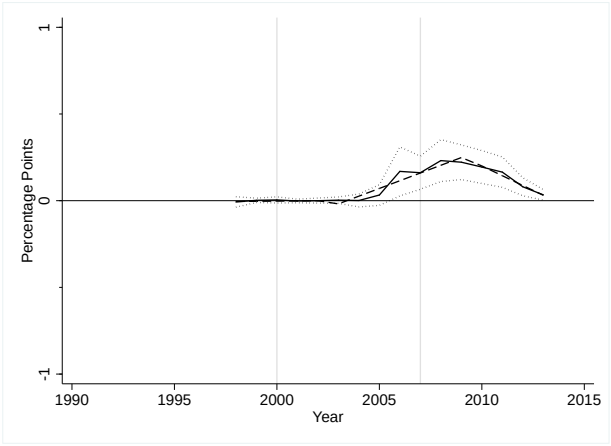
(b) Male Nursing Enrollment Rate



(c) Female Nursing Graduation Rate



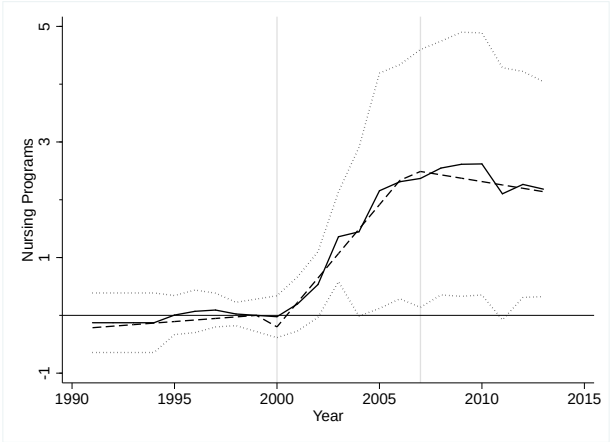
(d) Male Nursing Graduation Rate



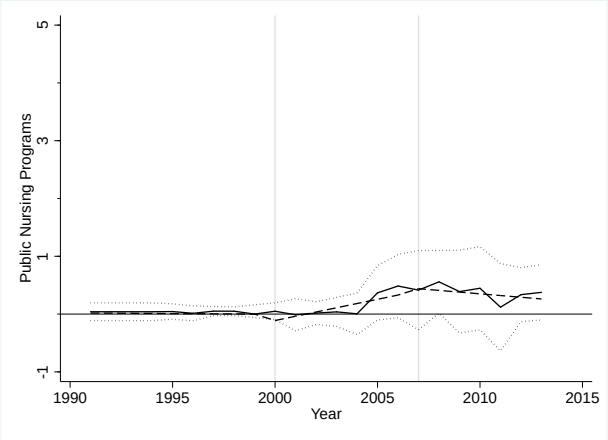
Notes: The solid line shows coefficients from the event study model (equation 1). The interaction with the indicator for 1999 is omitted to identify the model in Panels a and b and 2002 is omitted in Panels c and d since nurse graduation responds with a four-year lag. 1997 is missing in panels a and b because CHED did not collect enrollment data by gender in that year. 95% confidence intervals are shown by dotted lines. Dashed lines show the pooled model (equation 2). All specifications include province and year fixed effects, and baseline controls interacted with year indicators as listed in Figure 3. The sample includes 74 provinces. Standard errors are clustered by province. The p-value on the test of joint significance of pre-trends equals 0.17 (panel a), 0.12 (panel b), 0.88 (panel c), and 0.85 (panel d). The light grey vertical lines represent the visa expansion in 2000 and subsequent contraction in 2007.
Source: CHED, CFO, Census, and authors' calculations.

Figure 6: Effect of Visa Expansion and Contraction on Number of Nursing Programs

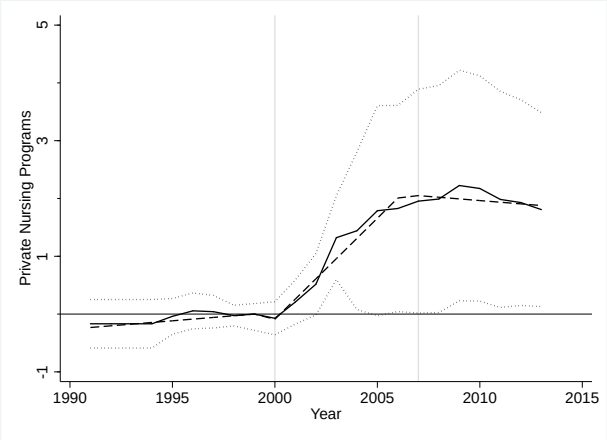
(a) Total Nursing Programs



(b) Public Programs

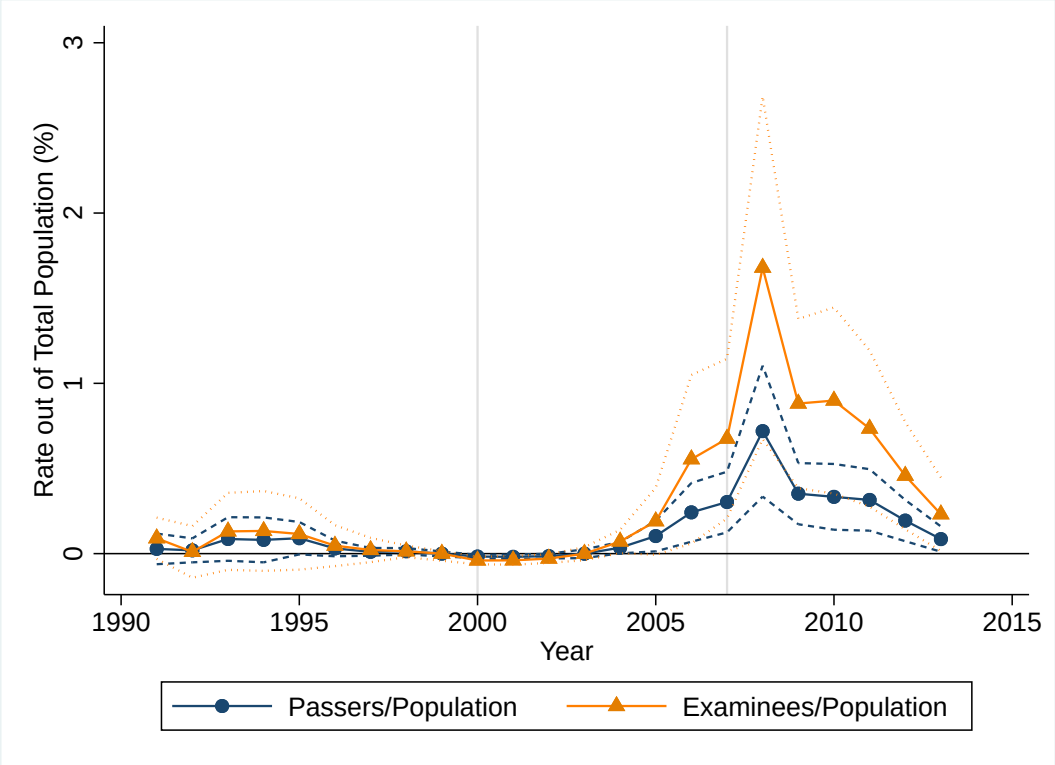


(c) Private Programs



Notes: The solid line shows coefficients from the event study model (equation 1). The interaction with the indicator for 1999 is omitted to identify the model. 95% confidence intervals are shown by dotted lines. Dashed lines show the pooled model (equation 2). All specifications include province and year fixed effects, and baseline controls interacted with year indicators as listed in Figure 3. The sample includes 74 provinces. Standard errors are clustered by province. The p-value on the test of joint significance of pre-trends equals 0.88 (panel a), 0.65 (panel b), and 0.76 (panel c). The light grey vertical lines represent the visa expansion in 2000 and subsequent contraction in 2007.
Source: CHED, CFO, and authors' calculations.

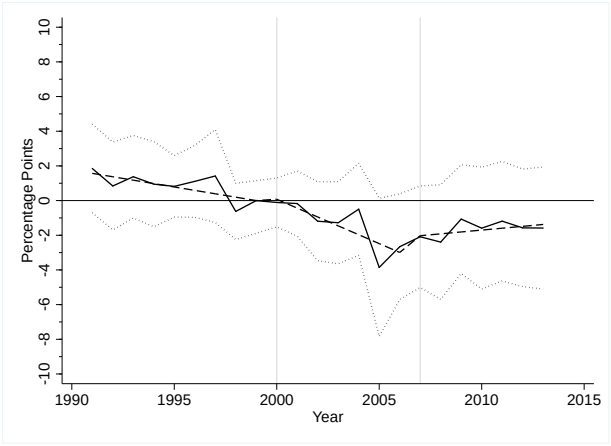
Figure 7: Effect of Visa Expansion and Contraction on Nursing Licensure Exam Pass Rates



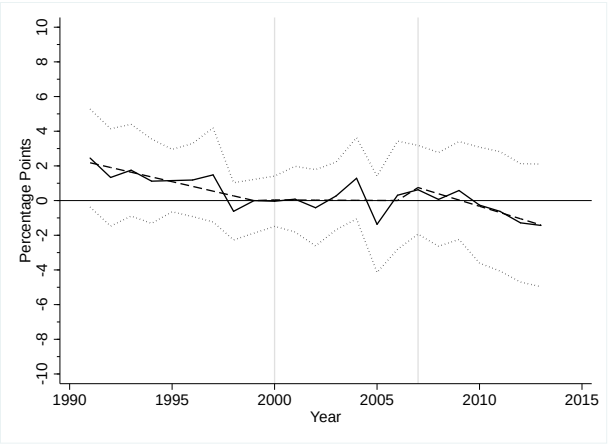
Notes: The orange line with triangle markers plots event study coefficients (equation 1) where the outcome is the number of examinees out of the college-aged population at baseline. 95% confidence intervals are shown by the dotted line. The blue line with circle markers plots event study coefficients (equation 1) where the outcome is the number of passers out of the college-aged population at baseline. 95% confidence intervals are shown by the dashed line. The interaction with the indicator for 1999 is omitted to identify the model. Controls are the same as Figure 3. The sample includes 74 provinces. Robust standard errors are clustered by province. The p-value on the test of joint significance of pre-trends equals 0.02 (pass rate) and 0.06 (examinee rate). The light grey vertical lines represent the visa expansion in 2000 and subsequent contraction in 2007. Source: CHED, CFO, PRC, and authors' calculations.

Figure 8: Effect of Visa Expansion and Contraction on Non-Nursing and Total Enrollment and Graduation Rates

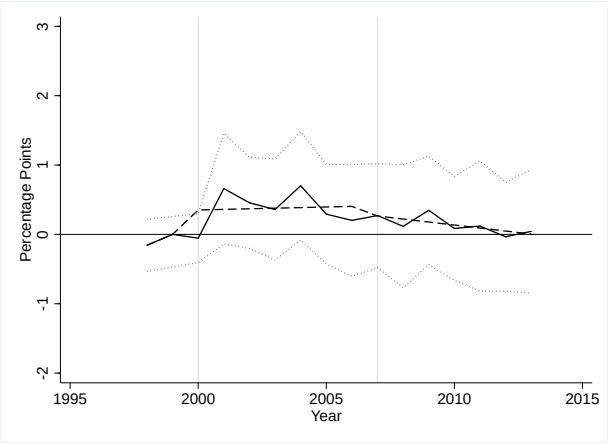
(a) Non-Nursing Enrollment Rate



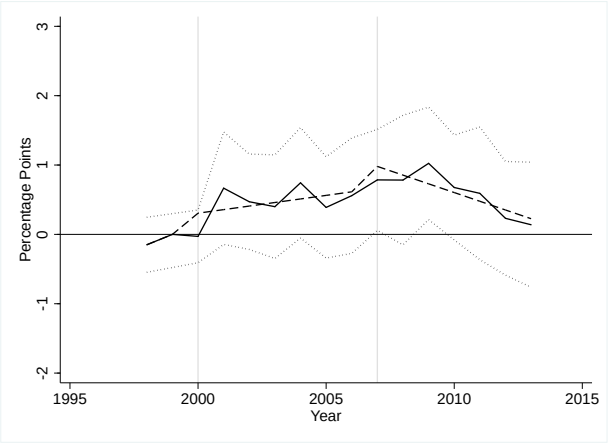
(b) Total Enrollment Rate



(c) Non-Nursing Graduation Rate



(d) Total Graduation Rate



Notes: The solid line shows coefficients from the event study model (equation 1). The interaction with the indicator for 1999 is omitted to identify the model. 95% confidence intervals are shown by dotted lines. Dashed lines show the pooled model (equation 2). All specifications include province and year fixed effects, and baseline controls interacted with year indicators as listed in Figure 3. The sample includes 74 provinces. Standard errors are clustered by province. The p-value on the test of joint significance of pre-trends equals 0.35 (panel a), 0.31 (panel b), 0.25 (panel c) and 0.29 (panel d). The light grey vertical lines represent the visa expansion in 2000 and subsequent contraction in 2007.
Source: CHED, CFO, Census, and authors' calculations.

Table 1. Summary Statistics

	Full Sample		High Nurse Migration Provinces		Low Nurse Migration Provinces	
	Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A. All Years						
Migrants Per 100,000						
Total	75.03	93.83	123.00	112.29	27.06	20.11
U.S. Nurse	3.89	5.46	6.17	6.54	1.61	2.55
Non-Nurse	69.88	89.48	114.89	107.89	24.88	18.11
Postsecondary Enrollment Rates (%)						
Total	21.41	12.53	24.84	14.39	17.98	9.14
Nurse	1.54	2.69	2.33	3.39	0.75	1.31
Other	19.87	11.07	22.51	12.45	17.22	8.71
Postsecondary Graduation Rates (%)						
Total	3.79	2.05	4.44	2.25	3.15	1.60
Nurse	0.36	0.57	0.55	0.70	0.17	0.30
Other	3.43	1.77	3.89	1.88	2.98	1.53
Number of Nursing Programs						
Total	4.39	8.94	7.01	11.89	1.77	2.24
Public	0.64	1.15	0.93	1.37	0.34	0.76
Private	3.75	8.16	6.08	10.91	1.43	1.84
Nursing Licensure Exam (%)						
Examinees/Population	0.072	0.155	0.112	0.199	0.032	0.075
Passers/Population	0.031	0.065	0.049	0.084	0.013	0.028
Panel B. Pre-Expansion						
Migrants Per 100,000						
Total	70.71	107.91	122.52	133.26	18.90	13.52
U.S. Nurse	1.81	2.50	3.07	2.93	0.55	0.87
Non-Nurse	68.36	105.60	118.61	130.79	18.12	12.86
Postsecondary Enrollment Rates (%)						
Total	17.40	12.39	21.18	14.27	13.59	8.63
Nurse	0.74	1.25	1.15	1.39	0.32	0.92
Other	16.67	11.62	20.03	13.39	13.27	8.22
Postsecondary Graduation Rates (%)						
Total	3.23	2.19	3.72	2.17	2.74	2.11
Nurse	0.11	0.18	0.16	0.19	0.05	0.15
Other	3.12	2.06	3.56	2.02	2.68	2.01
Number of Nursing Programs						
Total	2.49	5.02	4.13	6.63	0.85	1.09
Public	0.26	0.59	0.44	0.75	0.08	0.27
Private	2.23	4.66	3.68	6.19	0.77	0.98
Nursing Licensure Exam (%)						
Examinees/Population	0.026	0.044	0.041	0.046	0.012	0.037
Passers/Population	0.015	0.024	0.023	0.027	0.007	0.018
Number of Provinces	74		37		37	
Observations (All years)	1,702		851		851	

Notes: The sample includes all provinces in the Philippines based on 1990 geographic boundaries from 1991-2013 for the full sample and 1991-1999 for the pre-expansion sample. The unit of observation is the province-year. Graduation data are only available from 1998-2013. High (low) nurse migration provinces are those above or equal to (below) the median value of the U.S. nurse migration rate in 1990, as described in the text. Enrollment and graduation rates are calculated using the population 18-21 as the denominator, while the migration rate uses the working aged population (ages 18-60).
Source: CHED, CFO, PRC, and authors' calculations.

Table 2. Pooled Event Study Estimates of Effect of Visa Expansion and Contraction on Nursing Education Outcomes

	U.S. Nurse Migrants Per 100,000	Nursing Enrollment Rate	Nursing Graduation Rate	Number of Nursing Programs	Number of Private Nursing Programs	Number of Public Nursing Programs
	(1)	(2)	(3)	(4)	(5)	(6)
Post Expansion x High	1.211*	0.038	-0.058	-0.226	-0.118	-0.109
	(0.646)	(0.115)	(0.063)	(0.296)	(0.255)	(0.102)
Post Expansion x High x Trend	0.755***	0.582**	0.126***	0.396**	0.320*	0.076*
	(0.267)	(0.224)	(0.037)	(0.187)	(0.172)	(0.045)
Post Contraction x High	-4.200**	-0.723*	-0.244***	-0.270	-0.307	0.037
	(1.760)	(0.425)	(0.092)	(0.251)	(0.219)	(0.135)
Post Contraction x High x Trend	-0.441**	-0.974***	-0.297***	-0.481*	-0.378*	-0.103
	(0.217)	(0.318)	(0.066)	(0.250)	(0.219)	(0.064)
Trend x High	-0.105***	-0.076	0.002	0.027	0.029	-0.002
	(0.039)	(0.064)	(0.012)	(0.038)	(0.031)	(0.011)
Observations	1702	1670	1169	1702	1702	1702
Pre-period mean for high nurse provinces	3.068	1.149	0.133	4.126	3.685	0.441

Notes: Table reports estimates of the pooled event study model (equation 2). Post Expansion is a binary variable equal to 1 if the year is 2000 or later and Post Contraction is a binary variable equal to 1 if the year is 2007 or later for all outcomes except graduation. Because it takes four years to graduate from college, for nurse graduation (Column 4), Post Expansion is a binary variable equal to 1 if the year is 2003 or later, and Post Contraction is a binary variable equal to 1 if the year is 2010 or later. High is a binary variable for above median nurse migration to the U.S. in the base year 1990. The sample period is from 1991-2013 in all columns except Column 3, which is 1998-2013. Province and year fixed effects, as well as baseline controls interacted with year dummies as outlined in Figure 3 notes, are included in all specifications unless otherwise indicated. Robust standard errors are clustered at the province level. ***p<0.01, **p<0.05, *p<0.10.

Sources: CFO, CHED, Census, and authors' calculations.

Table 3. Effect of Visa Expansion and Contraction on Nursing Education Outcomes: Robustness Checks

	U.S. Nurse Migrants Per 100,000	Nursing Enrollment Rate	Nursing Graduation Rate	Number of Nursing Programs
	(1)	(2)	(3)	(4)
Panel A. Main specification				
Post Expansion x High	2.632**	1.177***	0.329***	1.176**
	(1.030)	(0.416)	(0.098)	(0.552)
Post Contraction x High	-0.977	-0.110	0.012	1.246*
	(0.792)	(0.136)	(0.060)	(0.628)
Panel B. Plus baseline non-nurse migration rate x year fixed effects				
Post Expansion x High	2.722***	1.113***	0.311***	0.870
	(1.005)	(0.402)	(0.093)	(0.577)
Post Contraction x High	-1.792**	-0.171	-0.076	0.686
	(0.798)	(0.137)	(0.062)	(0.641)
Panel C. Without Manila				
Post Expansion x High	2.596**	1.151***	0.323***	1.334***
	(1.048)	(0.419)	(0.099)	(0.380)
Post Contraction x High	-0.962	-0.107	0.013	1.406***
	(0.796)	(0.135)	(0.060)	(0.452)
Panel D. Plus additional controls x year fixed effects				
Post Expansion x High	3.137**	1.284**	0.290**	0.509
	(1.411)	(0.591)	(0.138)	(0.801)
Post Contraction x High	-1.789*	-0.094	0.025	0.346
	(1.061)	(0.156)	(0.072)	(0.815)
Panel E. Plus additional controls x year fixed effects, without Manila				
Post Expansion x High	3.029**	1.197**	0.268*	1.068**
	(1.404)	(0.577)	(0.138)	(0.411)
Post Contraction x High	-1.774*	-0.086	0.027	0.891**
	(1.057)	(0.151)	(0.074)	(0.446)
Panel F. Plus island x year fixed effects				
Post Expansion x High	3.230***	1.271***	0.367***	0.892
	(0.912)	(0.363)	(0.082)	(0.669)
Post Contraction x High	-1.449**	-0.166	-0.015	0.789
	(0.719)	(0.138)	(0.054)	(0.755)
Panel G. Continuous Treatment Measure: Baseline Nurse Migration Rate				
Post Expansion x Baseline	2.318**	0.985**	0.223***	0.814
Nurse Migration Rate	(1.030)	(0.415)	(0.076)	(0.651)
Baseline Nurse Migration	-0.287	-0.089	0.086	1.152*
Rate	(0.933)	(0.120)	(0.068)	(0.675)

Notes: An observation is the province-year. For Columns 1, 2, and 4, Post Expansion is a binary variable equal to 1 if the year is 2000 or later, while Post Contraction is a variable equal to 1 if the year is 2007 or later. Because it takes four years to graduate from college, for nurse graduation (Column 3), Post Expansion is a binary variable equal to 1 if the year is 2003 or later, and Post Contraction is a binary variable equal to 1 if the year is 2010 or greater. High is defined as in Table 2. All specifications include year and province fixed effects, and baseline controls interacted with year fixed effects as specified in Figure 3 notes. Panel B adds the baseline non-nurse migration rate x year fixed effects to Panel A. Panel C is the specification estimated in Panel A without Manila. Panels D and E add controls to Panel A: 1) average years of schooling for 25- to 64-year-olds and 2) the share of households that are urban, each times year fixed effects. Panel F adds island x year fixed effects to Panel A. Panel G interacts the post expansion and post contraction dummy variables with a continuous measure of the baseline nurse migration rate instead of the dummy variable High. The results are scaled to represent the effect of a one standard deviation increase in baseline nurse migration. Robust standard errors clustered at the province level are in parentheses. ***p<0.01, **p<0.05, *p<0.10.

Sources: CFO, CHED, Census, and authors' calculations.

Table 4. Effects of Visa Expansion and Contraction on Non-Nursing Enrollment and Graduation

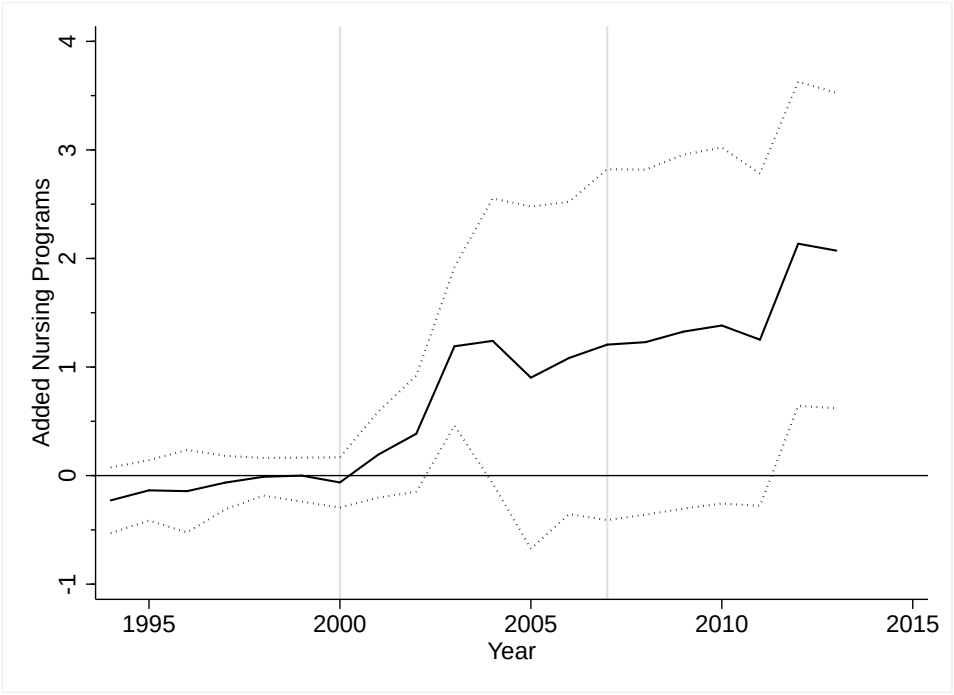
	Enrollment Rate Outcomes		Graduation Rate Outcomes	
	Non-Nurse	Total (Non-Nurse + Nurse)	Non-Nurse	Total (Non-Nurse + Nurse)
	(1)	(2)	(3)	(4)
Post Expansion x High	-2.249**	-1.072	0.146	0.475*
	(0.949)	(0.969)	(0.256)	(0.239)
Post Contraction x High	-0.239	-0.349	-0.277	-0.264
	(0.910)	(0.959)	(0.226)	(0.242)
Observations	1670	1670	1169	1169
Mean Dependent Variable	20.03	21.18	3.84	3.98

Notes: The table reports estimates from a basic DID model. Post Expansion is a binary variable equal to 1 if the year is 2000 or later for Columns 1 and 2 while Post Contraction is a variable equal to 1 if the year is 2007 or later. In Columns 3 and 4, because it takes four years to graduate from college, Post Expansion is a binary variable equal to 1 if the year is 2003 or later, and Post Contraction is a binary variable equal to 1 if the year is 2010 or greater. High is a binary variable equal to 1 for a high nurse migration province to the U.S. in the base year 1990. The sample period is from 1991-2013 in Columns 1 and 2 and 1998-2013 in Columns 3 and 4. Province and year fixed effects, as well as baseline controls interacted with year dummies as outlined in Figure 3 notes, are included in all specifications. Robust standard errors clustered at the province level are in parentheses.***p<0.01, **p<0.05, *p<0.10.

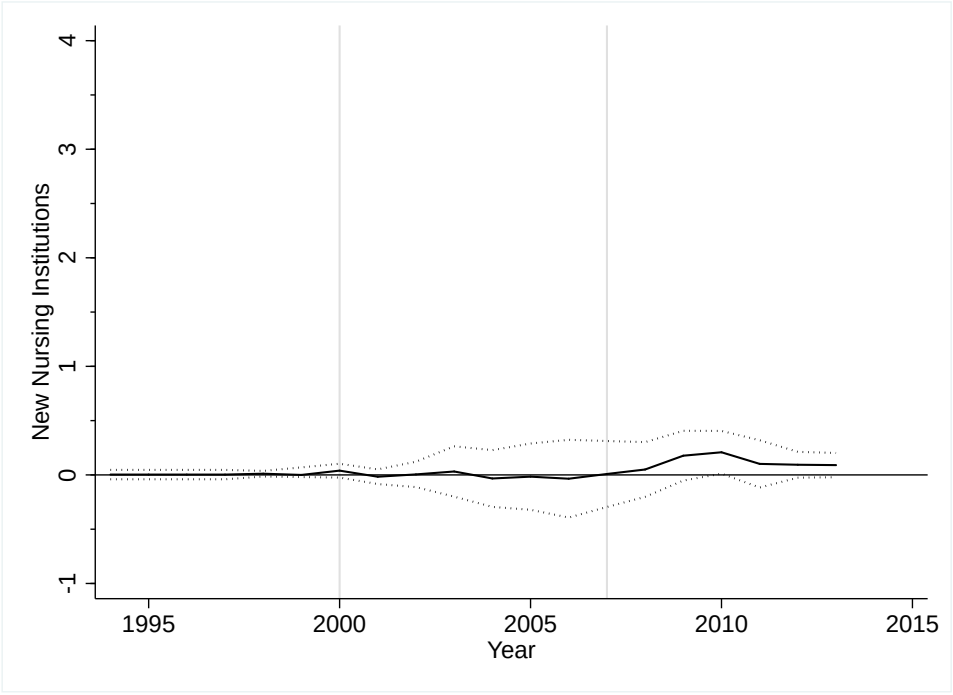
Sources: CFO, CHED, Census, and authors' calculations.

Appendix Figure 1: Effect of Visa Expansion and Contraction on Nurse Programs

(a) Nursing Programs Added to Existing Private Institutions



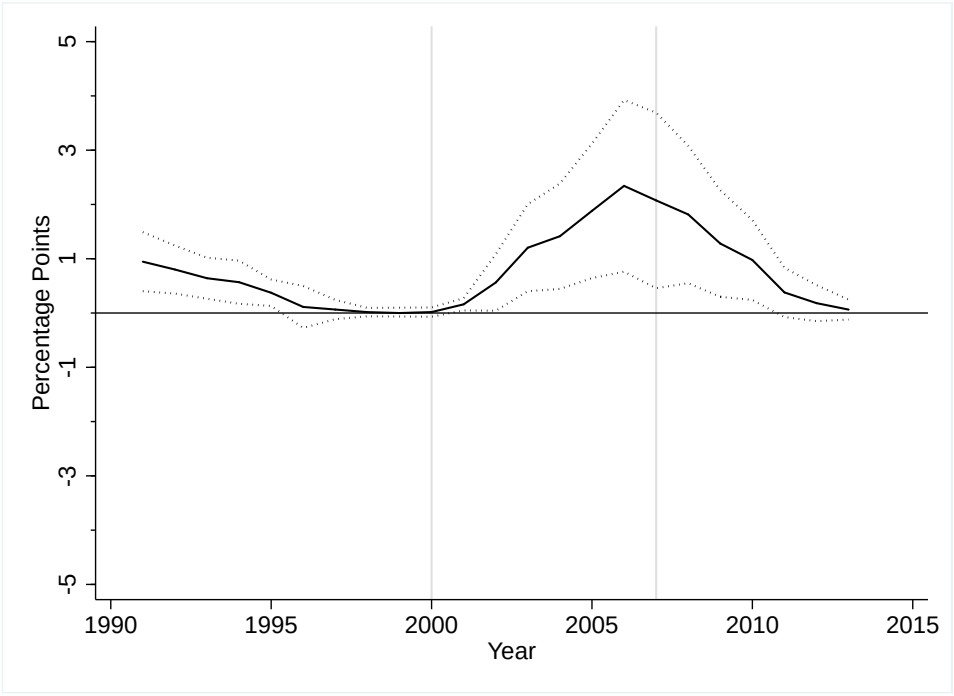
(b) New Private Nursing Institutions



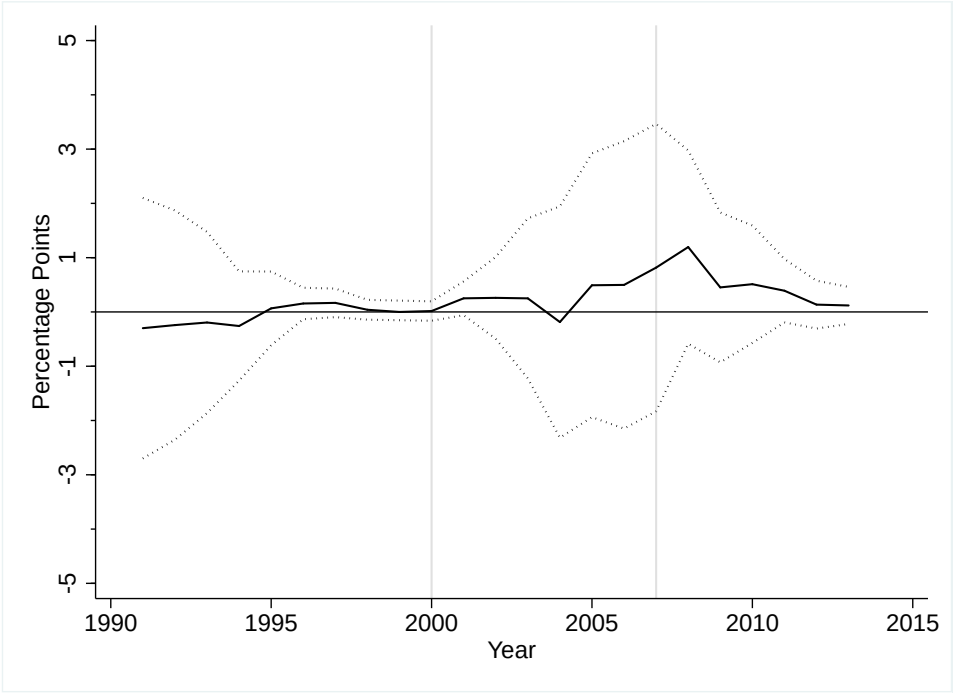
Notes: The solid line shows coefficients from the event study model (equation 1). The interaction with the indicator for 1999 is omitted to identify the model. 95% confidence intervals are shown by dotted lines. All specifications include province and year fixed effects, and baseline controls interacted with year indicators as listed in Figure 3. The sample includes 74 provinces. Standard errors are clustered by province. The light grey vertical lines represent the visa expansion in 2000 and subsequent contraction in 2007.
Source: CHED, CFO, Census, and authors' calculations.

Appendix Figure 2: Effect of Visa Expansion and Contraction on Nursing Enrollment by Supply Elasticity of Nursing Education

(a) More Elastic Supply

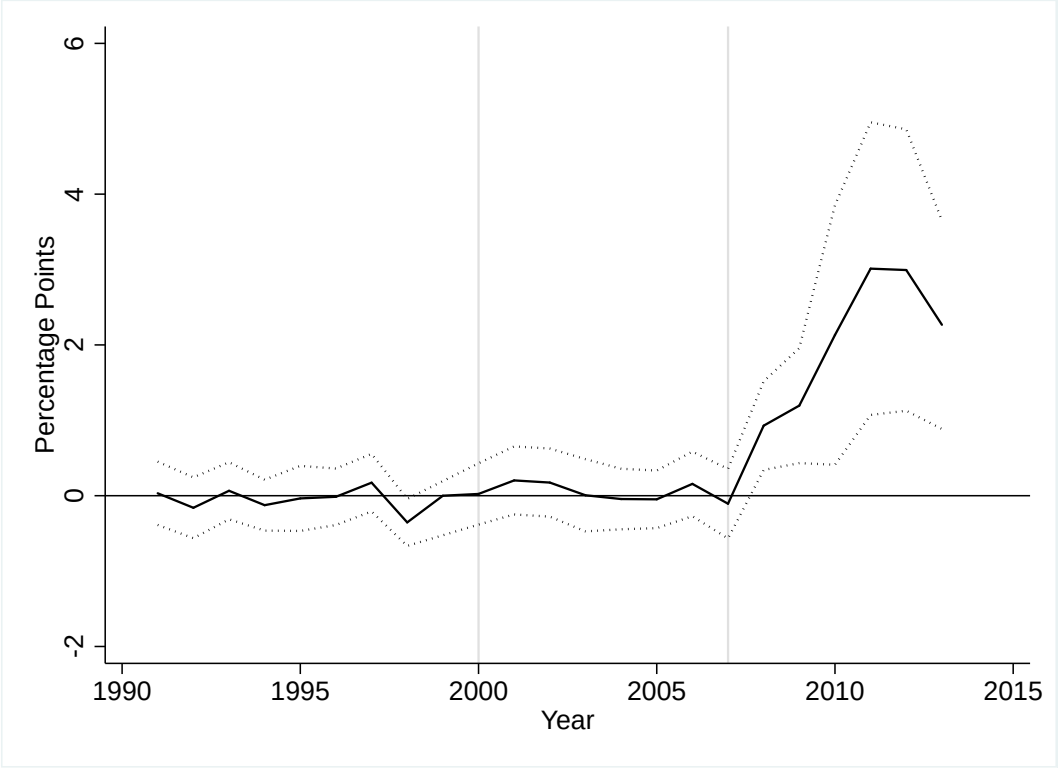


(b) Less Elastic Supply



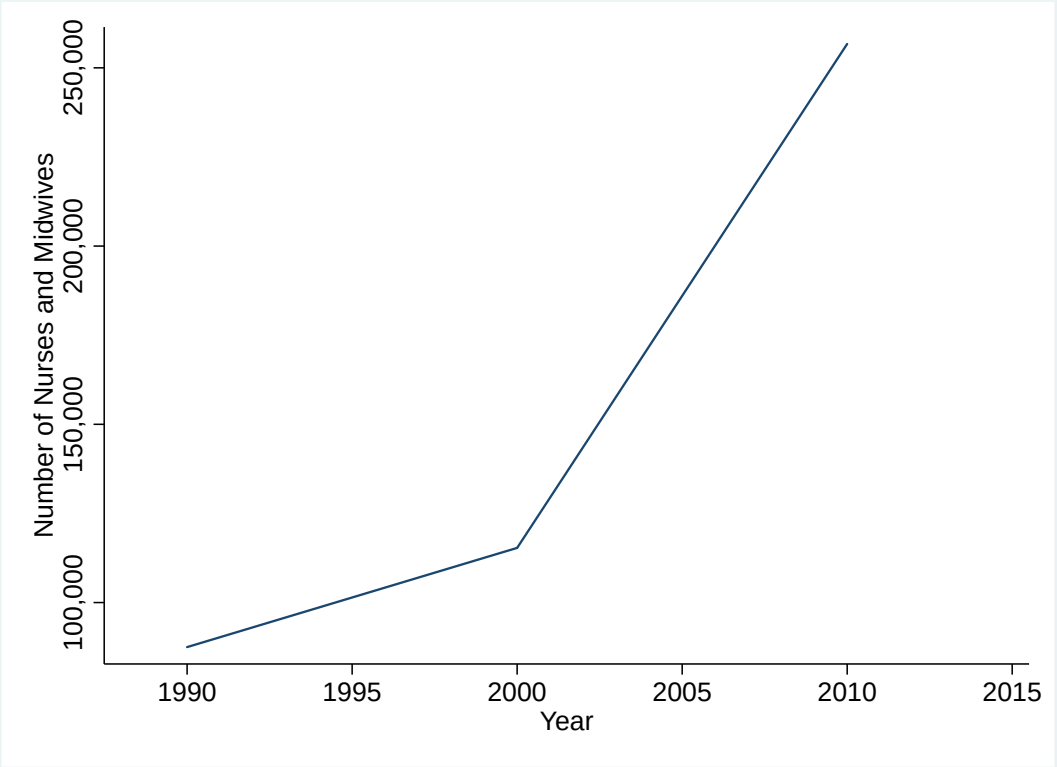
Notes: The supply elasticity is measured as the share of private institutions without nursing programs out of the total number of private institutions in the pre-period. A larger share indicates that the supply is more elastic, since there are more institutions where nursing programs can be added. Panel a includes provinces with above the median share, while panel b includes provinces with below the median share. The solid line shows coefficients from the event study model (equation 1). The interaction with the indicator for 1999 is omitted to identify the model. 95% confidence intervals are shown by dotted lines. All specifications include province and year fixed effects, and baseline controls interacted with year indicators as listed in Figure 3. The sample includes 74 provinces. Standard errors are clustered by province. The light grey vertical lines represent the visa expansion in 2000 and subsequent contraction in 2007.
Source: CHED, CFO, Census, and authors' calculations.

Appendix Figure 3: Effect of Visa Expansion and Contraction on Non-U.S. Nurse Migration



Notes: The solid line shows coefficients from the event study model (equation 1). The interaction with the indicator for 1999 is omitted to identify the model. 95% confidence intervals are shown by dotted lines. All specifications include province and year fixed effects, and baseline controls interacted with year indicators as listed in Figure 3. The sample includes 74 provinces. Standard errors are clustered by province. The p-value on test of joint significance of pre-trends equals 0.22. The light grey vertical lines represent the visa expansion in 2000 and subsequent contraction in 2007.
Source: CHED, CFO, Census, and authors' calculations.

Appendix Figure 4: Nurses and Midwives over Time



Notes: The graph shows the total number of nurses and midwives working in the Philippines based on the 1990, 2000, and 2010 Philippine Census of Population. Unfortunately, the 2000 Census does not allow us to separately identify nurses. In the 2010 Census, 85% of individuals in the nurse/midwife category were nurses.
Source: CFO and authors' calculations.

Appendix Table 1. List of Top 20 Nurse Migration Provinces to the U.S.

		Nurse Migrants to the U.S. per 100,000 in 1990
1.	Ilocos Norte	11.09
2.	Zambales	10.73
3.	Metro Manila	10.49
4.	Benguet	9.26
5.	Ilocos Sur	6.98
6.	Pangasinan	6.32
7.	La Union	6.07
8.	Cavite	5.85
9.	Iloilo	5.73
10.	Pampanga	4.90
11.	Tarlac	4.02
12.	Nueva Vizcaya	3.98
13.	Cebu	3.72
14.	Bataan	3.50
15.	Rizal	3.19
16.	Aurora	3.02
17.	Laguna	2.91
18.	Nueva Ecija	2.91
19.	Bohol	2.79
20.	Aklan	2.72

Notes: Rates are nurse migrants to the U.S. per 100,000 residents aged 18-60 in the province.
Source: CFO and authors' calculations.

Appendix Table 2. Rates of Cross-Province Migration for Postsecondary Education

Census Year	All	Low to High	High to Low	High to High	Low to Low
	(1)	(2)	(3)	(4)	(5)
2000	6.41	1.27	0.65	3.87	0.61
2007	6.21	0.88	0.19	4.47	0.64
2010	5.64	1.28	0.28	3.40	0.68

Notes: The rates of cross-province migration in Column 1 are calculated by dividing the nationwide number of college-aged individuals attending college in a province other than where they reside by the nationwide number of college-aged individuals attending school overall. Columns 2 through 5 decompose this national rate into rates of cross-province migration between low nurse and high nurse migration provinces. For instance, in Column 2, the rates are calculated by dividing the number of students from low nurse migration provinces attending school in high nurse migration provinces by the total number of college-aged individuals attending school overall. Columns 3 through 5 follow a similar construction.

Appendix Table 3. Hospitals and Barangay Health Stations Over Time

Year	Hospitals			Barangay Health Stations
	Total	Government	Private	
	(1)	(2)	(3)	(4)
1990	1,733	598	1,135	-
1991	1,663	562	1,101	10,683
1992	1,742	639	1,103	11,423
1993	1,632	537	1,095	11,072
1994	1,571	503	1,068	11,498
1995	1,700	589	1,111	11,646
1996	1,738	600	1,138	17,090
1997	1,817	645	1,172	13,096
1998	1,713	616	1,097	14,267
1999	1,794	648	1,146	14,416
2000	1,712	623	1,089	15,204
2001	1,708	640	1,068	15,107
2002	1,739	662	1,077	15,283
2003	1,719	662	1,057	14,490
2004	1,725	657	1,068	15,099
2005	1,838	702	1,136	15,436
2006	1,921	719	1,202	16,191
2007	1,781	701	1,080	16,219
2008	1,784	711	1,073	17,018
2009	1,821	723	1,098	-
2010	1,812	730	1,082	17,297

Notes: Table lists the total number of hospitals and Barangay Health Stations in the Philippines by year. Data on the number of BHS are unavailable in 1990 and 2009.
Source: Philippine Statistical Yearbook, 2012.

Appendix Table 4. Pooled Event Study Estimates of Effect of Visa Expansion and Contraction on Nursing Education Outcomes by Gender

	Nursing Enrollment Rate		Nursing Graduation Rate	
	Female	Male	Female	Male
	(1)	(2)	(3)	(4)
Post Expansion x High	0.062	-0.031	-0.039	-0.020
	(0.079)	(0.039)	(0.047)	(0.020)
Post Expansion x High x Trend	0.381**	0.200***	0.082***	0.043***
	(0.152)	(0.071)	(0.026)	(0.011)
Post Contraction x High	-0.438	-0.284**	-0.152**	-0.093***
	(0.292)	(0.138)	(0.069)	(0.026)
Post Contraction x High x Trend	-0.637***	-0.337***	-0.196***	-0.101***
	(0.212)	(0.106)	(0.045)	(0.022)
Trend x High	-0.057	-0.019	0.001	0.001
	(0.045)	(0.017)	(0.009)	(0.003)
Observations	1603	1603	1169	1169
Pre-period mean for high nurse provinces	0.926	0.271	0.108	0.025

Notes: Table reports estimates of the pooled event study model (equation 2). Post Expansion is a binary variable equal to 1 if the year is 2000 or later and Post Contraction is a binary variable equal to 1 if the year is 2007 or laterfor all outcomes except graduation (Columns 1 and 2). Because it takes four years to graduate from college, for nurse graduation (Columns 3 and 4), Post Expansion is a binary variable equal to 1 if the year is 2003 or later, and Post Contraction is a binary variable equal to 1 if the year is 2010 or later. High is a binary variable for above median nurse migration to the U.S. in the base year 1990. The sample period is from 1991-2013 in columns 1 and 2, and 1997 is omitted because CHED did not college enrollment data by gender in that year. The sample period is from 1998-2013 in columns 3 and 4. Province and year fixed effects, as well as baseline controls interacted with year dummies as outlined in Figure 3 notes, are included in all specifications unless otherwise indicated. Robust standard errors are clustered at the province level. ***p<0.01, **p<0.05, *p<0.10.

Sources: CFO, CHED, Census, and authors' calculations.

Appendix Table 5. Effect of Visa Expansion and Contraction on Nursing Licensure Exam Pass Rates

Year	Passers out of Population (1)	Examinees out of Population (2)	Pass Rate (Column 1/Column 2) (3)	P-value, col 3=0.58 (Pre-period pass rate) (4)
Average Effect (2000-2013)	0.148***	0.385***	0.385	0.000
	(0.043)	(0.106)		
2000	-0.017***	-0.040***	0.423	0.009
	(0.005)	(0.011)		
2001	-0.019***	-0.039***	0.475	0.393
	(0.007)	(0.013)		
2002	-0.014**	-0.029**	0.500	0.428
	(0.007)	(0.013)		
2003	-0.000	-0.000	1.361	0.991
	(0.013)	(0.020)		
2004	0.035**	0.071**	0.494	0.462
	(0.017)	(0.035)		
2005	0.103**	0.190*	0.543	0.575
	(0.046)	(0.101)		
2006	0.242***	0.554**	0.437	0.028
	(0.088)	(0.253)		
2007	0.303***	0.675***	0.449	0.021
	(0.091)	(0.239)		
2008	0.719***	1.679***	0.428	0.000
	(0.196)	(0.513)		
2009	0.352***	0.882***	0.399	0.000
	(0.092)	(0.254)		
2010	0.334***	0.899***	0.371	0.000
	(0.099)	(0.279)		
2011	0.315***	0.734***	0.430	0.000
	(0.092)	(0.234)		
2012	0.194***	0.458***	0.424	0.001
	(0.062)	(0.161)		
2013	0.085**	0.231**	0.370	0.002
	(0.038)	(0.110)		

Notes: An observation is the province-year, and the sample period is from 1991-2013. The first row of the table presents the coefficient on the interaction of the high nurse migration variable and a dummy variable equal to 1 in 2000 and later, and zero otherwise. This is the average effect of being in a high nurse migration province on the number passing the nursing licensure exam out of the college-aged population at baseline (Column 1) and on the number taking the nursing licensure exam out of the college-aged population at baseline (Column 2). The later rows show the results from the event study specification, and present the coefficients on each of the interactions of year and high from 2000 on. Column 3 calculates the implied pass rate by dividing Column 1 by Column 2. Column 4 presents the p-value from a test of equality of Column 3 and the pre-period pass rate of 58%. All specifications include year and province fixed effects, and baseline controls interacted with year fixed effects as specified in Figure 3 notes. Robust standard errors clustered at the province level are in parentheses. ***p<0.01, **p<0.05, *p<0.10.
Sources: CFO, CHED, Census, PRC, and authors' calculations.

Appendix Table 6. Robustness Checks of Effect of Visa Expansion and Contraction on Nursing Education Outcomes,

	U.S. Nurse Migration Rate (1)	Nursing Enrollment Rate (2)	Nursing Graduation Rate (3)	Number of Nursing Programs (4)
Panel A. Main specification				
Post Expansion x High	1.211*	0.059	-0.036	-0.338
	(0.646)	(0.112)	(0.066)	(0.250)
Post Expansion x High x Trend	0.755***	0.707**	0.142***	0.511***
	(0.267)	(0.272)	(0.043)	(0.173)
Post Contraction x High	-4.200**	-0.995*	-0.275***	-0.392
	(1.760)	(0.564)	(0.098)	(0.237)
Post Contraction x High x Trend	-0.441**	-1.153***	-0.325***	-0.624***
	(0.218)	(0.396)	(0.079)	(0.227)
Trend x High	-0.105***	-0.096	-0.001	0.045
	(0.039)	(0.063)	(0.012)	(0.035)
Panel B. Plus baseline non-nurse migration rate x year fixed effects				
Post Expansion x High	1.312**	0.082	-0.005	-0.108
	(0.649)	(0.113)	(0.064)	(0.327)
Post Expansion x High x Trend	0.728***	0.570***	0.098***	0.268
	(0.253)	(0.208)	(0.034)	(0.200)
Post Contraction x High	-4.699***	-0.763*	-0.272***	-0.317
	(1.709)	(0.397)	(0.094)	(0.255)
Post Contraction x High x Trend	-0.504**	-0.932***	-0.241***	-0.341
	(0.208)	(0.301)	(0.061)	(0.267)
Trend x High	-0.097**	-0.085	0.004	0.022
	(0.040)	(0.060)	(0.012)	(0.042)
Panel C. Without Manila				
Post Expansion x High	1.188*	0.033	-0.061	-0.264
	(0.652)	(0.116)	(0.064)	(0.244)
Post Expansion x High x Trend	0.753***	0.576**	0.124***	0.478***
	(0.271)	(0.225)	(0.038)	(0.123)
Post Contraction x High	-4.173**	-0.717*	-0.242**	-0.310
	(1.782)	(0.422)	(0.093)	(0.216)
Post Contraction x High x Trend	-0.438*	-0.959***	-0.294***	-0.591***
	(0.222)	(0.320)	(0.067)	(0.157)
Trend x High	-0.106***	-0.076	0.002	0.021
	(0.038)	(0.064)	(0.012)	(0.047)
Panel D. Plus additional controls x year fixed effects				
Post Expansion x High	1.381*	0.005	-0.057	0.392
	(0.829)	(0.152)	(0.092)	(0.373)
Post Expansion x High x Trend	0.825**	0.521	0.103**	0.141
	(0.338)	(0.315)	(0.048)	(0.277)
Post Contraction x High	-5.220**	-0.717	-0.191	-0.065
	(2.361)	(0.587)	(0.116)	(0.355)
Post Contraction x High x Trend	-0.572**	-0.921**	-0.258***	-0.103
	(0.282)	(0.447)	(0.082)	(0.363)
Trend x High	-0.090*	-0.036	0.006	-0.038
	(0.046)	(0.083)	(0.016)	(0.050)

Continued on next page.

Appendix Table 6. (continued)

Panel E. Plus additional controls x year fixed effects, without Manila				
Post Expansion x High	1.307	-0.012	-0.062	0.263
	(0.807)	(0.152)	(0.095)	(0.273)
Post Expansion x High x Trend	0.816**	0.499	0.098**	0.427***
	(0.350)	(0.314)	(0.048)	(0.155)
Post Contraction x High	-5.156**	-0.697	-0.179	-0.220
	(2.393)	(0.566)	(0.117)	(0.261)
Post Contraction x High x Trend	-0.565*	-0.872*	-0.245***	-0.487***
	(0.294)	(0.442)	(0.080)	(0.179)
Trend x High	-0.091*	-0.037	0.006	-0.060
	(0.047)	(0.086)	(0.016)	(0.069)
Panel F. Plus island x year fixed effects				
Post Expansion x High	1.005*	0.141	-0.013	-0.012
	(0.600)	(0.091)	(0.057)	(0.366)
Post Expansion x High x Trend	0.864***	0.638***	0.128***	0.267
	(0.226)	(0.181)	(0.032)	(0.235)
Post Contraction x High	-5.475***	-0.757*	-0.263***	-0.282
	(1.501)	(0.396)	(0.084)	(0.282)
Post Contraction x High x Trend	-0.567***	-1.057***	-0.304***	-0.295
	(0.185)	(0.262)	(0.056)	(0.304)
Trend x High	-0.046	-0.099**	-0.000	0.013
	(0.036)	(0.045)	(0.010)	(0.044)
Panel G. Continuous Treatment Measure: Baseline Nurse Migration Rate				
Post Expansion x Baseline Nurse	1.595*	1.130**	0.064	0.231
Migration Rate	(0.856)	(0.483)	(0.068)	(0.188)
Post Expansion x Baseline Nurse	0.416***	0.092	0.071***	0.135*
Migration Rate x Trend	(0.124)	(0.063)	(0.020)	(0.068)
Post Contraction x Baseline Nurse	-2.462	-0.374	-0.239**	-0.389
Migration Rate	(1.521)	(0.310)	(0.094)	(0.285)
Post Contraction x Baseline Nurse	0.000**	-0.000	0.000	-0.001*
Migration Rate x Trend	(0.000)	(0.000)	(0.000)	(0.000)
Trend x Baseline Nurse Migration	-0.066*	-0.053	-0.009	0.022
Rate	(0.037)	(0.046)	(0.009)	(0.038)

Notes: An observation is the province-year. Table reports estimates of the pooled event study model (equation 2). All variables are as defined in Table 2. All specifications include year and province fixed effects, and baseline controls interacted with year fixed effects as specified in Figure 3 notes. Panel B adds the baseline non-nurse migration rate x year fixed effects to Panel A. Panel C is the specification estimated in Panel A without Manila. Panels D and E add controls to Panel A: 1.) average years of schooling for 25-to 64-year-olds and 2.) the share of households that are urban, each times year fixed effects. Panel F adds island x year fixed effects to Panel A. Panel G uses the continuous measure of the baseline nurse migration rate instead of the binary variable *High.* The results are scaled to represent the effect of a one standard deviation increase in baseline nurse migration. Robust standard errors clustered at the province level are in parentheses. ***p<0.01, **p<0.05, *p<0.10.

Sources: CFO, CHED, Census, PRC, and authors' calculations.

Appendix Table 7. Coefficients of Relative Risk Aversion and Certainty Equivalents

Value of γ	0.5	1.2	1.5	2	2.5
Value of w_{CE}	6,205	5,091	4,844	4,565	4,374

Notes: The values of the certainty equivalent w_{CE} are calculated using equation 3 under the various values of the coefficient of relative risk aversion, γ.

Online Appendix

Medical Worker Migration and Origin-Country Human Capital: Evidence from U.S. Visa Policy

Paolo Abarcar and Caroline Theoharides

Appendix A: Data Construction

This data appendix outlines the technical details for the construction of the datasets used in this paper. Our final dataset includes province-year-level data on migration rates, postsecondary education, and nursing licensure exam pass rates.

In all datasets, we use consistent geographic boundaries based on 1990 province definitions. The sample excludes the provinces of Tawi-Tawi and Sulu due to low rates of reporting. The poor data quality from these provinces is typical in data from the Philippines, and is likely due to the decades old conflict between the Philippine government and local leaders in the two provinces. We treat Metro Manila as a single province. Metro Manila is composed of four administrative districts, which make up the National Capital Region (NCR). It is typical to either treat Metro Manila as a single province, as we do here, or as four separate provinces. We treat Manila as a single province because it is common for students to travel around the metro area for postsecondary education.

A1. Migration Data

The migration data are from the Commission on Filipinos Overseas (CFO), a government agency responsible for registering emigrants and strengthening the ties of the diaspora with the homeland. All emigrants who plan to move abroad on permanent immigrant visas are required to register with the CFO before leaving. We obtained administrative data on all permanent migrants who departed from the Philippines from 1990 to 2013. The data are recorded from a mandatory pre-departure form, and include information on demographics, birthplace, usual address, country of destination, education, course of study, and profession for each migrant. Migrants cannot obtain exit clearance without filling out this form in its entirety. 1,565,635 individual, permanent migration episodes occurred between 1990 and 2013.

We define nurse migrants as those who had obtained at least a bachelor's degree in nursing or whose usual work was as a professional nurse prior to migration. All other migrants were classified as non-nurse migrants. We then calculated province-level migration rates for nurses overall, nurses to the U.S., and non-nurses by counting individuals within each group who were of working age (18 to 60 years old), and dividing it by the working age population in each province-year. The working age population in each province-year was computed from the 1990, 1995, 2000, 2010, and 2015 Philippine Census data. We interpolated working-age population counts for years in between these censuses by using population growth rates for each province, which we also computed from the Census data.

A2. Postsecondary Education Data

The postsecondary education data are from the Commission on Higher Education (CHED), the government agency responsible for oversight of the postsecondary education system in the Philippines.

We obtained institution-level administrative data on the number of enrollees and graduates in each academic year from 1991 to 2013, disaggregated by program of study.

To calculate rates of enrollment and graduation for nursing and other disciplines, we count the number of 1.) enrolled students taking these courses and 2.) graduates of these courses in each province-year. We identify the course using the program of study information in the data. We then divide these counts by the college-age population to calculate enrollment and graduation rates. We computed the college-age population in each province-year from the 1990, 1995, 2000, 2010, and 2015 Philippine Census data. We interpolated college-age population counts for years in between these censuses by using population growth rates for each province as computed from the Census data.

This dataset includes 1,702 province-year level observations. We drop 32 observations for the enrollment rate because of lack of reporting by institutions in the province. This yields a sample of 1,670 province-year enrollment rates, with 1.8% of the original sample missing. Graduation data are only available from 1998 onwards. 15 province-year level observations are missing due to lack of reporting by institutions (1.3%). Institutions that offered other types of degrees but began offering nursing programs during our sample period are counted as new nursing programs in the year the nursing program began.

To determine the number of nursing schools in each year, we counted the number of schools offering nursing programs in each province and year. Schools were classified as offering a nursing program if they reported students enrolled in or graduating from such a program. If a school did not appear in the data for a single year, we assumed that this is because the school failed to submit their data for that year, and so we include the school in our final province-year count of programs. This affected less than 1% of observations.

A3. Nursing Licensure Exam Data

The Philippine Nursing Licensure exam is administered by the Philippine Professional Regulation Commission (PRC). The PRC administers licensure exams in a wide variety of disciplines such as accounting, engineering, and nursing. The nursing licensure exam is offered in 12 locations around the Philippines two times per year. The results of the exam are published in the newspaper, and show the pass rates for each nursing school as well as individual scores on the exam. To qualify as a nurse, an individual must correctly answer 75% of questions.

We obtained reports from the PRC on the number of examinees and the number of passers of the exam by institution-month-year from 1990-2015. The month is when the exam was administered, usually June and November. The reports from 1990-2005 were only available in hard copy, while the reports from 2006 to 2015 were available as electronic PDFs. We then encoded these documents to create an institution-month-year dataset. We cleaned the data so that institution names were consistent over time. This included both name changes of institutions over time as well as spelling errors in the reports.

Geographic information about each institution is not included in the PRC reports. Since our unit of analysis is the province-year, we assigned each institution to its province and aggregated the monthly data in order to calculate exam pass rates at the province level. To account for measurement error, we replaced the number of examinees and the number of passers with the average of the preceding and succeeding years if a given observation is three times above or below the preceding and succeeding years. 2.1% of the observations for number of examinees, and 2.9% of observations for the number passed are replaced with the average following this rule.

A4. Calculating Wages and Probabilities for Utility Function Calibration

To calculate the wages used in our back-of-the-envelope calibration, we use data from the 2004-2006 Philippine Labor Force Survey (LFS). We are limited to these years of the expansion period because they are the only years that include data on both wages in the Philippines and detailed occupation codes, such as nursing. Wage data are only available from 2001 onward, while detailed occupation codes are available from 2004 onward. We calculate the wages earned by nurses in the Philippines ($w_{N,PH}$) by averaging wages for all individuals working as nurses. To calculate the wages of individuals who have a nursing degree but do not work as nurses ($w_{NO,PH}$), we are limited by the fact that we only know the broad degree type which includes all individuals with bachelor's degrees in medical fields, engineering, and architecture. As such, we calculate wages for all individuals with this degree type who are not working in an occupation in these fields. This means that we include wages of, for instance, an engineer, who is not working in an engineering field. Note that individuals with degrees beyond a bachelor's (such as doctors) are excluded. We include wages equal to zero for anyone with this degree type who is not working. Finally, to obtain wages for individuals who do not enroll in a nursing degree ($w_{O,PH}$), we calculate the average wage for all workers with a bachelor's degree who are not working in nursing. We again include wages equal to zero for anyone with this degree type who is not working. All wages are converted from Philippine pesos to U.S. dollars using PPP exchange rates. Wages are reported as daily wages, and we convert these to annual wages by assuming individuals work 20 days per month for 12 months. We use wage data from the U.S. Bureau of Labor Statistics to determine average wages for nurses in the U.S. ($w_{N,US}$). We average these wages over 2004 to 2006 in order to match the time period of the LFS wages.

To calculate the relevant probabilities, we calculate $p_{N,US}$ by first determining the number of nurses migrating from the Philippines to the U.S. during the expansion years (2000 to 2006), which is 26,835. We divide this by the total stock of individuals with nursing degrees in Philippines. To obtain the total stock, we average the total number of individuals with a nursing degree in each year from 1992-2000 LFS. In LFS waves prior to 2001, we have data on the detailed degree type (specifically nursing degree) which we do not have in the data from 2001 onward. Because there could be individuals with a nursing degree who are outside the age range for migration, we calculate the stock based on the 5^{th} to 95^{th} percentile of ages, or ages 26 to 58. This results in a stock of 420,732 people with a nursing degree. Dividing 26,835 by 420,732 yields $p_{N,US}$=0.06. To determine $p_{N,PH}$, we obtain the average number of individuals working as nurses in the Philippines from the 2000 and 2010 Philippine Censuses, or 186,012. We divide this by the total stock of individuals with nursing degrees, such that $p_{N,PH}$=0.442.

Appendix B: Bounding Exercises for Internal Migration for Education

As we discussed in Section 4, one potential source of bias is cross-province migration for nursing education from low to high nurse migration provinces. While total rates of cross-province migration for postsecondary education from low to high provinces are small (Appendix Table 2), in this section we bound our estimates to address this concern. To begin, consider that the impact of the visa expansion on nursing enrollment in high relative to low nurse migration provinces represents an additional 3,059 nursing students enrolled in the average province, or a 128% increase (Table 2).[1] Based on the 2007 Census, which was fielded during the peak of the expansion period, the average high nurse migration province had 1,001 postsecondary students in any field of study who moved from low nurse migration provinces. For our initial bounds, we make two extreme assumptions: 1) that prior to the visa expansion, no students migrating from low to high provinces to attend college were enrolled in nursing programs;

[1] We calculate this effect by adding up the effect of the policy change in each year from 2000 to 2006, and dividing by 7, as in Section 5.1.

and 2) that after the expansion, all students migrating from low to high provinces to attend college were enrolled in nursing programs. Under these assumptions, all 1,001 of the 3,059 additional nursing students were misclassified as from high provinces instead of low, leading to an overestimate of the treatment effect. A conservative lower bound estimate for our effects would remove these students from the high provinces and include them in the low provinces. This suggests the average high nurse migration province experienced a 1,057 (=3,059-2,002), or 45%, student increase in response to the policy expansion, compared to the 129% increase that we report in Table 2.

While this is still a sizeable effect, it relies on two extreme and unrealistic assumptions. To estimate a more realistic lower bound, we relax assumption 2 and instead assume that after the visa expansion, students migrating for postsecondary schooling enrolled in nursing programs at the same rate that all postsecondary students nationally enrolled in nursing programs. At the peak of nursing program enrollment (2006), 20.8% of postsecondary students were enrolled in nursing programs. If 20.8% of the 1,001 migrating students enrolled in nursing programs, this would represent 208 students on average moving from low to high nurse migration provinces. Reassigning these 208 students from high to low migration provinces would yield an increase of nurse enrollment in high relative to low provinces of 2,643 (=3,059-416) students, or 111%, compared to our estimate of 129% (Table 2). Thus, under conservative but reasonable assumptions, we show that it is unlikely that migration for education between low and high provinces significantly biases our results.

Appendix C: Risk Aversion and Major Choice

We find sizeable enrollment, graduation, and licensure responses to the increased opportunities for nurse migration in spite of the fact that the probability of migrating to the U.S. is still quite low. Given the low probability of nurse migration to the U.S., is it reasonable that students would change their education decisions and switch degree types in response? To provide some intuition on this choice, we conduct a simple back-of-the-envelope calibration of a standard utility function under different levels of risk aversion.

We assume constant relative risk aversion (CRRA) CES utility, such that:

$$U(c) = \frac{c^{1-\gamma}}{1-\gamma}$$

Individuals have no savings, such that income and consumption are identical, and models of expected utility of consumption and income are identical. Individuals make the decision whether to enroll in a nursing program or stay enrolled in their counterfactual field of study. If they enroll in a nursing program, they have probability $p_{N,US}$ of migrating to the U.S. as a nurse, probability $p_{N,PH}$ of working as a nurse in the Philippines, and probability $(1- p_{N,US}- p_{N,PH})$ of not getting a job as a nurse either in the U.S. or the Philippines. Individuals who work as nurses in the U.S. earn wage $w_{N,US}$, individuals who work as nurses in the Philippines earn $w_{N,PH}$, and individuals who have a nursing degree but do not get a job as a nurse earn $w_{NO,PH}$. If the individual does not enroll in a nursing degree, they earn wage $w_{O,PH}$.

Thus, the individual is indifferent between switching to a nursing degree if:

$$\mathrm{p_{N,US}}\frac{{w_{N,US}}^{1-\gamma}}{1-\gamma} + \mathrm{p_{N,PH}}\frac{{w_{N,PH}}^{1-\gamma}}{1-\gamma} + \left(1 - \mathrm{p_{N,US}} - \mathrm{p_{N,PH}}\right)\frac{{w_{NO,PH}}^{1-\gamma}}{1-\gamma} = \frac{{w_{O,PH}}^{1-\gamma}}{1-\gamma} \quad (3)$$

We calculate the probabilities and wages from our data, and calibrate the model under varying levels of risk aversion. We calculate $p_{N,US}$ by dividing the number of nurses migrating from the Philippines to the U.S. during the expansion years by the total stock of individuals with nursing degrees in the Philippines ($p_{N,US}$=0.06). To determine $p_{N,PH}$, we divide the number of individuals working as nurses in the Philippines by the total stock of individuals with nursing degrees ($p_{N,PH}$=0.44). We use wage data from the

U.S. Bureau of Labor Statistics to determine average annual wages for nurses in the U.S. ($w_{N,US}$=USD 56,940). Using the Philippine LFS, we calculate average annual wages of nursing in the Philippines ($w_{N,PH}$=USD 6,571.2).[2] The wages of those with a nursing degree working in an alternative field are $w_{NO,PH}$=USD 3,304. Finally, individuals who do not switch degree types earn the average wage for all college educated workers who are not working as nurses ($w_{O,PH}$=USD 4,344).[3]

We calculate the certainty equivalent wages, w_{CE}, under several reasonable levels of risk aversion. Following Morten (2019), who examines migration and risk sharing in India, we use values of γ = 0.5, 1.2 1.6, 2.0, and 2.5. Appendix Table 7 shows the certainty equivalent for each value of the coefficient of relative risk aversion. Individuals are more risk averse as γ increases. Under all levels of risk aversion used by Morten, individuals would choose to take the gamble and enroll in a nursing degree since $w_{CE}>w_{O,PH}$. For instance, even when γ=2.5, we calculate that individuals would be indifferent between the gamble of switching to a nursing degree and earning USD 4,374 with certainty, which is greater than the average wages for college educated workers not working as nurses ($w_{O,PH}$= USD 4,344).

This simple calibration suggests that individuals with reasonable levels of risk aversion would choose to enroll in a nursing degree program instead of an alternative degree program, even though the chance of migration to the U.S. is quite low. Note that this calculation ignores any non-pecuniary benefits to U.S. migration, such as potential citizenship for the migrant and their family, which has large benefits, and would increase the returns to migration.

[2] All Philippine wages are converted to U.S. dollars at PPP exchange rates.
[3] See Appendix A4 for additional details on the construction of wages and probabilities.