Wages and Health Worker Retention: Evidence from Public Sector Wage Reforms in Ghana

James Antwi
Greenwich School of Management
University of Wales

David Phillips
Department of Economics, Management, and Accounting
Hope College

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Abstract

Can governments in developing countries retain skilled health workers by raising public sector wages? We investigate this question using sudden, policy-induced wage variation in which the Government of Ghana restructured the pay scale for health workers employed by the government. We find that a ten percent increase in wages decreases annual attrition from the public payroll by 1.0 percentage point (from a mean of 8 percentage points) among 20-35 year-old workers from professions that tend to migrate. As a result, the ten-year survival probability for these health workers increases from 0.43 to 0.49. The effects are concentrated among these young workers, and we do not detect effects for older workers or among categories of workers that do not tend to migrate. Given that Ghana was a major source of skilled health professional migrants during this period and that our attrition measure correlates strongly with aggregate migration, we interpret these results as evidence that wage increases in Ghana improved retention mainly through reducing international migration.[1] JEL Codes: O15, F22, J45, J61, and H51.

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1 Introduction

High attrition of skilled employees may generate under-staffing in the public health care systems of developing countries. Wage differentials between domestic public employment and other options are one factor that could be driving doctors, nurses, and other skilled health workers to leave the public health sector, often for jobs in high-income countries. This trend has generated concern that migration will weaken public health systems and lead to poor health outcomes (Chen and Boufford, 2005).[2] More generally, migration of highly skilled individuals generates concern that "brain drain" will lead to lower levels of human capital and economic growth in developing countries.[3]

The recent literature on the economics of high-skilled migration has debated whether such migration really leads to lower average levels of human capital. Neo-classical trade-theoretic frameworks emphasize the benefits of migration (e.g., Grubel and Scott, 1966), but skilled migration can lead to a net negative "brain drain" in the presence of fiscal externalities, human capital productivity spillovers, or non-neoclassical frictions (Bhagwati and Hamada, 1974; Miyagiwa, 1991). The most recent literature has changed directions, focusing on how the

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[2] There is an empirical literature on the health effects of medical brain drain, though it is mixed (Clemens, 2007; Bhargava and Docquier, 2008; Chauvet, Gubert, and Mesplé-Somps, 2008).

[3] For two recent reviews of the literature, see Docquier and Rapoport (2012) and Gibson and McKenzie (2011b)

possibility of migration can induce greater skill acquisition. If this effect is large enough, the opportunity to migrate can actually increase average human capital levels, leading to a "brain gain" (Stark, et. al. 1997; Stark, et. al. 1998; Mountford, 1997). Recent theoretical works have extended this framework and debated its merits (Mountford and Rapoport, 2011; Schiff, 2005). A large empirical literature has tested whether this "brain gain" effect appears in cross-country macro data (Beine, Docquier, and Rapoport, 2001; Beine, Docquier, and Rapoport, 2010; Docquier, Faye, and Pestieau, 2008; Easterly and Nyarko, 2009; Beine, Docquier, and Oden-Defoort, 2011), and a few recent contributions test this hypothesis in micro data using natural experiments or instrumental variables (Batista, et. al. 2012; Chand and Clemens, 2008; Shrestha, 2011). In general, the literature finds evidence that migration opportunities do provide an incentive to acquire more education.

Thus, high-skill migration may be a "drain" or a "gain" for human capital in the sending country, depending on whether the incentive to acquire skills outweighs the direct effect of losing high-skilled migrants. The context, including the particular country and migrant group in question, may determine the desirability of high-skill migration. Beine, Docquier and Rapoport (2008) simulate the net effect of skilled migration on human capital across various countries. They find that more countries lose than gain and that net brain gain is most likely in countries with low migration rates and low levels of human capital. Bhargava, Docquier, and Moullan (2011) focus on physicians and find evidence that migration does generate an education incentive. However, this effect is too small to outweigh the direct drain effect for most countries. Similar to the results of Beine, Docquier, and Rapoport (2008) with all high-skill migrants, they find that high physician migration rates are more likely to lead to "brain drain" while lower rates may sustain a "brain gain." These results from the literature provide a useful background for the present study. We focus on the migration of skilled health workers from Ghana from 2003-2009. According to Bhargava, Docquier, and Moullan (2011), Ghana's physician migration rate of 38 percent in 2004 was the 12^{th}-highest in the world and the 2^{nd} highest (behind Zimbabwe) among countries with more than 4 million people. Theory and empirical work indicate that positive migration rates can lead to higher levels of average human capital; however, Ghana's extremely high physician migration rate during our sample period indicates that brain drain is more likely to be a valid concern. In such situations, public policy to discourage migration may have a productive role.

However, the literature has provided less guidance on what effects should be expected when public policy levers are applied to the migration of skilled health workers. Health workers from developing countries state that wage levels play an important role in migration decisions (Kangasniemi, Winters and Commander, 2007; Awases, et. al. 2003). However, only a few studies have attempted to measure how much actual health worker migration decisions respond to wages. As a result, we know little about whether wage increases can be a cost-effective way of reducing migration of skilled health workers. In the present study, we attempt to fill this gap by measuring how elastically the retention of Ghanaian health workers responds to wage changes. Our approach has two main strengths. First, we use detailed administrative payroll data that reports wages and retention for all publicly employed health workers in Ghana from 2003 to 2009. These data allow us to track several thousand health workers over time and measure effects that are representative of a national public health system in which migration rates had reached very high levels. Second, we observe large, plausibly exogenous changes in wages generated by the adoption of a new wage structure. While not randomly assigned, the variation in wages across time, profession (e.g., doctors, nurses, etc.), and seniority generated by this natural experiment allows us to measure the causal effect of wages on migration credibly.

To identify the impact of wages we employ a fixed effects strategy, including group effects for workers in a given grade-seniority group as well as common time effects. [4] This approach tests whether the groups of health workers who received the largest raises had their attrition rates fall the most. We relax the common time trends assumption that fixed effects requires in three main ways. First, we allow for time fixed effects that differ across three groups: doctors, nurses, and other health workers. Second, we control for observed individual demographics and concurrent policies affecting migration of health workers both out of Ghana and into the UK. In our preferred specification, we find that wages have a strong negative effect on attrition with a 10 percent wage increase leading to a 1.03 percentage point decrease in annual attrition. This implies an increase of the 10-year survival rate from 43 percent to 49 percent. Third, we check whether wage increases are targeted at particular groups of health workers in a manner that would bias our estimates. We demonstrate that, if anything, large wage increases are targeted toward groups of workers with higher than average attrition trends. As a result our (negative) point estimates will be biased toward zero, if anything. Controlling for linear time trends that are specific to each grade-seniority group generates similar, though noisy, results.

[4] Throughout, “grade” refers to the wage grade of a worker. These generally indicate both occupation as well as large differences in seniority. For example, doctors and nurses are in different grades, but there are also 7 different grades of nurses: Staff Nurse, Senior Staff Nurse, Nursing Officer, Senior Nursing Officer, Principal Nursing Officer, Dep. Dir. of Nursing Services, and Chief Nursing Officer. Within each grade, there are also several “steps” of seniority. Our fixed effects are defined at this finest level.

We find evidence that the effect of wages on attrition is concentrated among early-career workers with no effects on older health workers. We also find evidence that doctors respond more strongly to wage increases than do other health workers. There is some evidence that men also respond to wage increases more elastically than do women, though this result is not particularly robust. Finally, we demonstrate that the effect we measure is concentrated among workers in occupations that tend to migrate and is not apparent for other workers. We take this as further evidence that wages affect attrition mainly through reducing migration.

Our results most directly relate to two strands of the existing literature. First, Bhargava and Docquier (2008) investigate the determinants of physician migration with cross-country panel data and find that migration rates are negatively associated with physician wages. Also, Okeke (2009) finds that physician migration rates respond to changes in GDP brought about by rainfall shocks. The present study is best interpreted as complementary to this existing work. Cross-country empirical studies confirm that wages and growth are correlated with physician migration across a large span of countries and time, though credibly measuring causal effects can be difficult. By focusing on one particular instance in which detailed micro data and plausibly exogenous variation in wages are available, we are able to confirm that the cross-country correlation between physician migration and wages has causal content in this instance. As noted above, we do so in a context where high migration rates make measuring the effectiveness of such a policy particularly useful. Our estimates indicate that raising wages can lead to a large reduction in health worker attrition during times of heavy migration.

Second, our results relate to the much broader literature on the role of wages in determining migration decisions for all individuals, not just doctors. Classic theory indicates that low home wages “push” migrants abroad (Borjas, 1987). However, higher income may also relax credit constraints, leading to higher migration rates (Lopez and Schiff, 1998), and increased migration has been observed in response to rainfall-induced income shocks (Yang and Choi, 2007) and randomized Progresa transfers (Angelucci, 2004). The empirical literature is large, making a full review impossible,[5] but the present study is most similar to a pair of studies that use micro data to more credibly measure the effect of compensation on migration decisions. Yang (2006) uses variation in the real wage differential between home and destination generated by exchange rate volatility to measure the effect of real wages on return migration of temporary workers from the Philippines. He finds evidence that migrants respond to the classic "push" and "pull" effects of wages, rather than aiming for investment targets. Gibson and McKenzie (2011a) narrowly focus on the "best and brightest" from three Pacific nations to ease concerns about bias from positive selection. They argue that other factors (e.g., risk aversion, family considerations) matter more than income for the migration decisions of these individuals. We add to this literature by examining a new and interesting population: highly skilled health workers from Ghana. In our sample, low home wages do appear to generate a strong "push" effect. These results run counter to those of Gibson and McKenzie (2011a), demonstrating that wage considerations can be important not just for the return migration of low-skilled individuals (e.g., Yang, 2006) but also for highly-skilled first-time migrants.

The remainder of the paper is as follows: section II describes Ghana's health sector and the 2006 wage reforms; section III provides a short discussion of the theory; section IV describes our identification strategy; sections V and VI describe the data and the results. Section VII tests

[5] A large cross-country literature finds mixed results about whether the "push" effect or the credit effect dominates (Clark, et. al. 2007; Pedersen, et. al. 2008; Mayda, 2010; Docquier, Lohest and Marfouk, 2007; Grogger and Hanson, 2011; Belot and Hatton, 2008).

the robustness of our empirical strategy to group-specific time trends and errors in linking wages across the pre-reform and post-reform periods. Section VIII concludes.

2 Background

2.1 Migration of Health Workers from Ghana

Ghana has long been a major source of migrants in the health sector. Likely due to their high quality training, low wages, and English proficiency, many Ghanaian health workers have left for jobs abroad. Bhargava and Docquier (2007) provide cross country data on physician migration into OECD countries. As shown in Figure 1, in an average year from 1991-2004 three to four percent of Ghana's physicians migrated annually, easily outpacing the African average. Prior to this time period, migration rates were even higher, with Dovlo and Nyonator (1999) reporting annual migration rates of 10 to 20 percent for graduates in the 1985-1994 classes of the University of Ghana Medical School. As shown in Table 1, these migrants mainly leave for English-speaking, high-income countries. Data from the Ghana Nurses and Midwives Council indicate that 71 percent of nurses leaving during 2002-2005 went to the UK, with most of the remainder leaving for the US. Data from Dovlo and Nyonator (2003) indicate a similar pattern for physicians.

After multiple decades of extensive migration by Ghanaian health workers, flows of health workers out of Ghana have slowed in recent years. Figure 2 demonstrates this fact for nurses using Nurses and Midwives Council data and administrative payroll data. Ghana's Nurses and Midwives Council keeps statistics on the number of requests by domestically trained nurses to have their credentials verified for international employment. As the figure indicates, migration of nurses from Ghana plateaued in the early 2000's, dropped precipitously in 2006, and then leveled off at a reduced rate. Attrition of nurses under age 35 from the public payroll shows a similar pattern. In the same figure, attrition rates show a large drop in 2006 and subsequently stabilize, closely following the NMC migration data. Recent decreases in migration are also apparent for physicians, as depicted in Figure 3. Attrition from the public sector and data on new Ghanaian registrants to the UK's General Medical Council correlate strongly with each other and show a similar drop in 2006. The close correspondence between migration data and attrition from the public payroll will be important later for the interpretation of our results. Because individual-level migration data is unavailable for our sample, we will use attrition from the public payroll as our dependent variable. The time-series correlation of our dependent variable with migration measures indicates that attrition of young employees in our data is best interpreted as migration.

The recent, sudden decline in migration of health workers from Ghana begs the question as to its causes. As Figure 4 shows, health workers migrating to the UK can roughly triple their earnings, even after adjusting for purchasing power differences. For example, doctors in Ghana earned about 1,000 Ghana Cedis per month but could earn about 3,000 Ghana Cedis per month (PPP) in the UK. Many point to such wage gaps as the main cause of migration of skilled health workers to high-income countries. In 2006, at precisely the same time as the fall in migration, the government of Ghana introduced a new wage structure for health workers that increased earnings significantly for many health workers. While many other factors and policies in Ghana and abroad likely influenced the decline in migration, we will focus on isolating the role that wages played.

2.2 Public Health Sector Wage Changes in Ghana

In 1998, the Ministry of Health introduced the Additional Duty Hours Allowance (ADHA) for health workers. As its name implies, the ADHA's explicit purpose was to compensate doctors, nurses, and other core clinical workers for working unusually long hours. However, shortly after its creation in 1998, the ADHA became a simple salary supplement and was extended to other cadres of health workers. The Ministry of Health (MOH) assigned a fixed number of notional hours to each cadre (doctor, professional nurse, etc.) of employee, and all employees in the same cadre received the same number of hours. Since these hours were paid at the worker's usual hourly rate, the ADHA amounted to a percentage bonus of a health worker's basic salary. Within a cadre all employees received the same percentage bonus from ADHA, while different cadres received different bonuses due to differences in notional hours assigned. This system, supplemented by common percentage pay raises among all employees, ensured that the relative pay of all health workers was stable from 2000-2006.

In 2006 due to budgetary pressure, the Government of Ghana desired to fold the ADHA into regular pay. Health workers also pushed for ADHA to be converted into basic salary because the ADHA payments were often delayed and were not taken into account when determining pensions. Since ADHA had grown to be a very large proportion of many health workers' pay, the government decided to adopt an entirely new salary structure, the Health Salary Structure (HSS). Pay rates under the new schedule were defined based on a job evaluation that arranged different grades in the new salary structure according to the skills and tasks of the job performed by that grade. As a result, the new salary structure gave nominal wage increases of varying degrees to all health workers, but due to inflation and the loss of ADHA, some workers saw their real total earnings rise slowly or even drop. Importantly, due to differences in the raises assigned to various groups of workers and due to the fact that some cadres benefitted more from ADHA than did others, the new salary structure completely rearranged the relative pay of many workers. Finally, as part of the arrangement made in adopting the HSS, workers' nominal wages were frozen from 2006-2009.

Figures 5 and 6 display these wage changes. Following a division that will be useful later in our discussion, we split our data into 'potential migrants'[6] and 'non-potential migrants' for Figures 5 and 6, respectively. In the wage schedule, a health workers' pay is determined by 'grade' and 'step.' Grades differentiate large promotions (principal nursing officer, medical

[6] We define 'potential migrants' more precisely below. Essentially, the definition includes doctors, nurses, and a few other high-skilled professions while the "non-potential migrants" consist mainly of orderlies, drivers, security guards, etc.

officer, senior medical officer, specialist, etc.) based on performance and length of service while steps embody smaller promotions within a grade. In the figure, each line represents real log wages (inclusive of ADHA) for each possible grade-step combination, normalized to zero in 2003. Thus, following an individual line over time traces the wages of a worker that is never promoted from 2003 to 2009. From 2003 to 2005 the lines generally move together, demonstrating that all groups of workers received common percentage wage increases. But from 2005 to 2006, the wages of different groups of workers diverge. Some workers received real wage increases of more than 50 percent while others even saw their real wages decrease by more than 10 percent. Figure 6 duplicates the same image for non-potential migrants, demonstrating that the policy change led to dramatic wage changes for these workers as well.

Table 2 summarizes this variation in wages quantitatively. Panel A describes actual earnings, providing the mean and standard deviation of log earnings both for workers in professions likely to migrate and those in professions that do not tend to migrate for each year of our sample period. When looking simply at individuals' earnings, the introduction of the new salary schedule in 2006 is difficult to detect. For both groups of workers, it generated wage increases of 20-25 percent, but this change is roughly in line with previous years. Additionally, the new salary schedule neither increased nor decreased dispersion of wages, with the variance of log earnings staying on trend. In the analysis that follows, it will be useful to consider wages adjusted to remove promotions and use this as an instrument for actual wages. Panel B tells a similar story with this variable, showing that earnings adjusted for promotions likewise stay on trend.

While the new salary structure did not significantly alter average wages or wage dispersion, Figures 5 and 6 indicate that it did massively re-allocate workers' wages. Panel C of Table 2 confirms this fact by summarizing wages normalized relative to the wages that a worker in the same grade-step group would have earned in 2003. The mean of normalized wages follows the same trend as before, but the dispersion of normalized wages shows the effect of the salary structure adopted in 2006. By definition, the standard deviation of normalized log wages is zero in 2003, and the common percentage wage increases given to all workers in 2004 and 2005 generate only minor changes in this value. However, in 2006 the new salary structure rearranges the wages of all workers, leading to a spike in the standard deviation of normalized wages to 0.17, and this dispersion persists after 2006. While the overall distribution of wages remained roughly constant, the locations of individual workers in that distribution were shuffled. This reorganization provides the necessary variation in wages across time and grade-step groups of workers to identify a model with time and grade-step group fixed effects. As is evident in Table 2 this policy change affects both potential migrants and non-potential migrants, allowing us to measure the effect of wages in both groups. In what follows, we will focus on potential migrants, exploiting the variation in wages across professions, seniority, and time generated by this policy change to measure the impact of wages on migration. The similar policy-induced variation in wages for non-potential migrants will then provide us with an opportunity to see whether any effect of the wage changes is isolated to those health workers who are likely to migrate.

3 A Simple Theoretical Framework

3.1 A Simple Model of Migration

Consider an individual choosing between continuing to work in the public health system and leaving for another job. We will interpret this other option as migrating for a job outside the country, but in principle the outside job could be in the private health sector or outside the health profession. Assuming a linear indirect utility function, an individual i in job j will attrite at time t iff:

$$\alpha_0 + \beta_1 w^*_{ijt} + \delta_0 x_{ijt} \geq \alpha_1 + \beta_2 w_{ijt} + \delta_1 x_{ijt} + c_{ijt}$$

$$\Leftrightarrow c_{ijt} \leq \beta_0 + \beta_1 w^*_{ijt} - \beta_2 w_{ijt} + \delta x_{ijt} \quad (1)$$

where c_{ijt} is the cost of migration, w^*_{ijt} is the log wage abroad, w_{ijt} is the log wage at home, and x_{ijt} is a vector of individual characteristics that are valued differently at home and abroad (where $\delta = \delta_0 - \delta_1$ is the marginal value of an attribute abroad relative to home and $\beta_0 = \alpha_0 - \alpha_1$ is the relative value, other things equal, of living abroad rather than at home). If *F* is the distribution of c_{ijt} then the probability of attrition A_{ijt} is:

$$A_{ijt} = \Pr[Attrition] = F(\beta_0 + \beta_1 w^*_{ijt} - \beta_2 w_{ijt} + \delta x_{ijt})$$

In this simple model, the impact of home wages on the probability of attrition is unambiguously non-positive. Assuming *F* is differentiable with density $f(\cdot)$:

$$\frac{\partial A_{ijt}}{\partial w_{ijt}} = -f\left(\beta_0 + \beta_1 w^*_{ijt} - \beta_2 w_{ijt} + \delta x_{ijt}\right) * \beta_2 \leq 0$$

However, even in this model the magnitude of the impact of wages depends greatly on the functional form and support of *F*. In particular, if the income gains from migrating result in a very large utility gain ($\beta_1 w^*_{ijt} - \beta_2 w_{ijt}$) then the impact of home wages will likely be small. Intuitively, large income-based utility gains move us into the 'tail' of the distribution of migration costs, leading to few individuals who are on the margin of migrating.[7] This result depends on the existence of large wage gaps as well as marginal utilities of income (β_1, β_2) that do not differ too greatly between sending and destination countries. In the case of health workers migrating from Ghana to their main destination in the UK, large wage gaps clearly exist. Because of the perceived ineffectiveness of wage supplements in the presence of large wage gaps, some policy-focused research discourages attempting to retain health workers via salary increases (Vujicic, et. al., 2004). However, if a preference for consumption in the home country

[7] Formally, as long as $\lim_{w^* \to \infty} f(\cdot)$ exists, then it must be zero. As a result, the limit of $\frac{\partial A_{ijt}}{\partial w_{ijt}}$ must be zero as well.

($\beta_1 < \beta_2$) or other factors (x_{ijt}) compensate for wage gaps, the effect of a home wage increase could be large and negative.

3.2 Credit Constraints

The unambiguous negative impact of home wages on attrition disappears if a simple credit constraint is added to the model. In an extreme case, suppose that a worker receives the public sector wage at time *t*. Then, the individual can choose whether or not to leave, expecting that future wages will be the same as today. Finally, suppose that the cost of migration must be financed out of current wages. Then, for an individual to migrate, they must be able to finance migration:

$$c_{ijt} \leq w_{ijt} \qquad (2)$$

Thus, an individual attrites iff (1) and (2) both hold, i.e., the probability of attrition is

$$A_{ijt} = \Pr[Attrition] = F\left(\min\left\{w_{ijt}, \beta_0 + \beta_1 w_{ijt}^* - \beta_2 w_{ijt} + \delta x_{ijt}\right\}\right)$$

For individuals with low wealth, wage increases may actually lead to higher migration rates:

$$\frac{\partial A_{ijt}}{\partial w_{ijt}} = f\left(w_{ijt}\right) \geq 0 \; if \; w_{ijt} < \beta_0 + \beta_1 w_{ijt}^* - \beta_2 w_{ijt} + \delta x_{ijt}$$

Thus, if a change in home wages reflects both an increase in current wages and a similar increase in expected future wages, the sign of the marginal effect of home wages on migration is an empirical question as well.

4 Identification Strategy

4.1 Main Identification

Finding exogenous variation in wages is important for a study of migration and home wages because the correlation between wages and migration can rarely be interpreted as the causal impact of wages. Individuals with high ability generally receive higher wages and migrate more frequently (Hanson, 2010). As a result, the correlation across individuals between home wages and migration will not reflect the causal impact of wages on migration. Meanwhile, the correlation between migration and wages across different locations will also not generally reflect the causal impact of wages because causality also runs the other direction: migration is a supply shock potentially affecting wages.

The wage reform described above helps alleviate these difficulties. The scene depicted in Figure 5 closely mimics the variation in wages that would result from an experiment with variable intensity of treatment. Of course, the Government of Ghana did not set wages randomly, which makes this an imperfect natural experiment, but we will argue that the nature of this policy change combined with a sufficiently flexible fixed effects approach will produce a credible causal estimate. Since salaries are uniform for workers in the same step (i.e., seniority) of the same grade, we condition on fixed effects for each grade-step group and common time fixed effects to exploit variation in wages resulting from policy-induced wage changes from 2005 to 2006. In this basic setup, we take the variation in these wage changes across different grade-step combinations as exogenous. As such, we estimate the impact of wages on attrition from the public payroll using a difference-in-differences estimator. Given the dummy dependent variable, the model is a linear probability model, which can be considered a discrete time hazard model since the dependent variable is attrition:

$$A_{ijt} = \alpha + \beta w_{jt} + \phi_j + \eta_t + \epsilon_{ijt} \quad (3)$$

In this equation, j denotes the grade-step group in the public sector wage schedule, i denotes an individual and t denotes the year; A_{ijt} is an indicator of attrition from the payroll; w_{jt} represents wages paid to grade-step group j during year t according to the public sector wage schedule in Ghana; η_t is a common time fixed-effect; ϕ_j is a grade-step group fixed effect; and ϵ_{ijt} is an error term.

Equation (3) needs to be improved somewhat, however, because it utilizes not only policy-induced wage variation but also variation in wages resulting from promotions, i.e., changes in j for a given worker. To avoid this situation, define j_0 as the grade-step group in which worker i is observed when first entering the data. To exclude wage variation resulting from promotions, we modify equation (3) to use fixed effects for these initial grade-step groupings, j_0, rather than the actual group in that period, j.

$$A_{ijt} = \alpha + \beta w_{jt} + \phi_{j_0} + \eta_t + \epsilon_{ijt} \quad (4)$$

Then, we estimate the new equation by instrumental variables, using wages that an individual would have received if never promoted as an instrument for actual wages. Formally, if log wages are defined as:

$$w_{jt} = f(j, t)$$

where $f(\cdot)$ is the public sector wage schedule that maps grade-step group j into wages in a manner that changes from year to year, t, as a result of policy. We define an instrument $\widehat{w}_{ijt}$ as:

$$\widehat{w}_{ijt} = f(j_0, t)$$

where j_0 denotes the grade-step of individual i when we first observe them on the public payroll. So, the instrument represents the wages that worker i would have received at time t had they never been promoted out of their initial grade-step j_0. Importantly, this instrument eliminates variation in wages that comes from promotions because this variation may reflect ability and thus be endogenous. When combined with time fixed effects and group effects, the variation remaining is that caused by enactment of the new wage schedule.

4.2 Controlling for Potential Confounding Factors

The sudden reforms of 2006 and otherwise stable wage environment create a reasonable natural experiment in which to measure the impact of wages. Of course, we do not observe a perfect experiment with wages randomly assigned to each group of health workers. As a result, our identification strategy relies on the assumption that wage changes from 2005 to 2006 for different groups of workers can be taken as exogenous. We control for time and group effects, which remove the influence of time variant factors that affect all groups of workers similarly and time-invariant differences across different groups. However, our identification could fail if the government of Ghana directed the largest wage increases to groups of workers based on observed characteristics correlated with attrition. To address these concerns, we take two steps. First, we control for specific confounding variables to rule out plausible alternative explanations of our results. This will be discussed in the present section. Second, in section 4.3 we make a positive case for why these wage changes are plausibly exogenous and unrelated to other confounding variables.

We can classify many concerns with our basic identification strategy in a general sense as unobserved time-varying shocks that affect the various professions in our data differently. To address these issues, we estimate the following equation using a similar IV strategy:

$$A_{ijt} = \alpha + \beta w_{jt} + \delta x_{ijt} + \phi_{j_0} + \eta_{pt} + \epsilon_{ijt} \quad (5)$$

where x_{ijt} is a vector of controls for individual demographics, labor market conditions abroad, and other domestic policies, and the time fixed effects are now allowed to vary by professional groupings, p, which are a function of the grade-step group j_0. To estimate the more general structure of time fixed effects, we group grades of workers into three broad professional classifications: professional nurses, doctors, and other health workers. We then allow for time effects that vary across these three groups. Workers in these groups may differ widely in education, ability to migrate, and political bargaining power, which could cause them to receive widely different time-varying shocks and influence the size of their pay increases in 2006. Equation (5) avoids these problems by using only variation in policy-induced wage changes within these occupational groups and absorbing variation in wages across these groups. Education, labor union, and migration options are generally homogeneous within these professions, making variation in the 2006 wage increases more likely to be exogenous.

While more general than the common time-trend assumption, these occupation-specific time effects do not control for all possible violations of exogeneity. In particular, workers within the same broad occupational category differ on several observable dimensions. For example, more senior workers may receive differing wage increases from younger workers while simultaneously being unlikely to migrate regardless of wage levels. As a result, controlling for worker age is important. We control for the demographic and job characteristics available in our data including a polynomial in age, gender, region of job placement, and department of job placement.

We also control for several concurrent policies. In Ghana, several measures were taken with the goal of reducing migration of health workers. The Ghana College of Physicians and Surgeons opened in 2004, becoming the first medical specialist training school in Ghana. It is thought to have decreased migration of doctors who would have otherwise migrated for training purposes. Also during this time period, the Ministry of Health and the Nurses and Midwives Council collaborated with the service delivery agencies to enforce a bonding scheme for nurses. Under this program, publicly-trained nurses were required to complete a term of public service or pay a bond before they could be given verification by NMC to practice abroad. Other policies to reduce migration included a subsidized car loan scheme as well as increased availability of fellowships for continuing professional education. Outside of Ghana, major policy changes also occurred, particularly in the UK. In 1999, the UK National Health Service adopted a Code of Practice limiting recruitment from developing countries. This policy strengthened considerably in subsequent years as the UK moved to limit not just the NHS, but also recruitment agencies working on behalf of the NHS. Meanwhile, wages and domestic supply of health workers in the UK were changing and could also coincide with the wage reforms that we are studying in Ghana.

For both foreign and domestic policies, our identification will still be valid if they affect all health workers within an occupational group equally. However, if any policy disproportionally affects particular groups of health workers, then this could bias our results. For example, the opening of the Ghana College of Physicians and Surgeons likely affected migration of physicians. Our main specification includes time effects specific to physicians, controlling for many potential sources of bias from this concurrent event. However, our results could be biased if the Ghana College affects migration decisions of some doctors (e.g., non-specialist doctors) and not others (specialists) and wage changes are correlated with this difference. To control for this source of bias, we include a regressor for contemporaneous enrollment in the Ghana College interacted with a dummy indicating whether the individual in question is a non-specialist doctor. Controlling for contemporaneous enrollment will reduce this bias, though it is possible that expectations of future increases in enrollment could also affect current migration. This would be particularly problematic for our identification if enrollment started at low levels and expanded rapidly from 2006 onward. However, as shown in Figure 7, enrollment in the Ghana College increased initially but due to capacity constraints actually dropped considerably in 2008 and subsequently leveled off near its 2006 level. While enrollment certainly varied over time, potential enrollees had no obvious reason to expect a long term increasing trend in enrollment. Thus, controlling for contemporaneous enrollment should be sufficient.

Figure 8 demonstrates a similar fact for an important foreign policy concern: changing demand for health workers in the UK resulting from new NHS recruiting rules. Again, this concurrent policy should not present a major challenge to our identification. Overall inflows of health workers from the world into the UK have decreased dramatically, but the change has affected doctors and nurses similarly. Even the stricter assumption of common time trends of attrition across professions can be supported here. In any case, we will demonstrate that our identification strategy is not affected by controlling for the impacts of these foreign and domestic policy changes.

While time effects specific to the three broad professional groups and extensive controls eliminate many threats to the exogeneity of these policy induced wage changes, we cannot control for all possibilities. While in principle our data contain the variation in wages needed to include group-specific time effects at a finer level (e.g., splitting doctors into residents, medical officers, and specialists), in practice insufficient wage variation in our data prevents us from allowing for separate time fixed effects for more groups than the broad ones we use in our analysis. While we are able to identify plausibly exogenous variation for health workers not currently available in the literature, this remains a drawback of our approach. Given that we allow for differing time shocks to the two largest occupations in our sample, doctors and nurses, we are able to address the most likely cause of bias from this source.

4.3 Sources of Variation in Wages

While controlling for identifiable confounding variables strengthens the validity of our estimates, we cannot control for all factors. Thus, it is important that the wage changes we exploit in this study, though not randomly assigned, were nonetheless set according to a policy process that renders the variation in wages plausibly exogenous. Consider the reduced form version of equation (5) in which we substitute the instrument for actual wages:

$$A_{ijt} = \alpha + \beta\widehat{w}_{j_0 t} + \delta x_{ijt} + \phi_{j_0} + \eta_{pt} + \epsilon_{ijt} \quad (6)$$

Then, averaging the equation across all individuals in each j_0 group and time period, we get:

$$\bar{A}_{j_0 t} = \alpha + \beta\bar{\widehat{w}}_{j_0 t} + \delta\bar{x}_{j_0 t} + \phi_{j_0} + \eta_{pt} + \bar{\epsilon}_{j_0 t} \quad (7)$$

Since our identification uses variation before and after 2006, consider the first difference of (7) between 2005 and 2006:

$$\Delta\bar{A}_{j_0 2006} = \beta * \Delta\bar{\widehat{w}}_{j_0 2006} + \delta * \Delta\bar{x}_{j_0 2006} + \eta_p + u_{j_0} \quad (8)$$

where u_{j_0} is a new composite error term; η_p is a fixed effect for the three broad professional groups; and the other variables are first differences of group averages between 2006 and 2005. Put in this form, our identification strategy relies on the assumption that the first term, $\Delta\bar{\widehat{w}}_{j_0 2006}$, is exogenous. In particular, consider the determinants of wage changes:

$$\Delta\bar{\widehat{w}}_{j_0 2006} = \gamma z_{j_0} + \delta * \Delta\bar{x}_{j_0 2006} + \eta_p + u_{j_0} \quad (9)$$

where z_{j_0} is a vector of excluded determinants of the wage changes. In an ideal setting, wage changes would be randomly assigned to grade-step groups in 2006. Lacking that situation, we require that the excluded determinants of the wage increases, z_{j_0}, be uncorrelated with attrition changes ($\Delta\bar{A}_{j_0 2006}$) outside of their effect on wages.

As discussed above, the main determinant of wages under the 2006 wage schedule was a "job scoring" exercise which assigned a value to each job depending on the tasks and education required for the job. The first column of Table 3 demonstrates this fact through a simple regression of 2006 wage levels for each grade-step group on the job score for each position. The relationship is positive and statistically strong with a 1 standard deviation increase in the job score associated with 10 percent higher wages. More importantly, the R^2 of the regression is 0.96, indicating post-2006 wages were computed as an approximately linear function of the job score. Estimating equation (9) using job scores as z_{j_0} confirms that job scores are a main determinant of wage changes as well. Results are shown in the second column of Table 3. While various considerations may affect the wage-setting process, the bureaucratic job scoring procedure, driven by the characteristics of the job itself, largely determined the new wage schedule in this case.

Importantly, "job scores," and thus wages, were determined using a methodology external to the situation in Ghana. In particular, job responsibilities were listed for each job. Then, scores were assigned to each job according to a methodology borrowed from the UK National Health Service that maps job responsibilities into job scores. Finally, wages were assigned according to job scores. Thus, wages under the new salary schedule were determined by a mechanistic procedure based on the responsibilities of the job in question and labor market considerations of the UK NHS. The third column of Table 3 demonstrates this fact, showing that even a relatively noisy measure of wages in the UK (see data section) explains 39 percent of the variation in job scores. These results provide good reason to believe that the 2005-2006 wage changes in Ghana are exogenous. In a typical situation, public sector wages may respond endogenously to political considerations or the bargaining power of particular groups in a manner that is be correlated with employee attrition. In the present situation, though, wages were set largely in reference to the UK health system. This alleviates most concerns about the endogeneity of the policy change.

While this external reference point supports taking the 2005-2006 wage changes as exogenous, some concerns may remain. The UK National Health System does not set wages by random assignment either. In particular, it sets higher wage levels for positions requiring additional skill or education, and these higher skill levels may be correlated with attrition patterns in Ghana. In the likely event that this is true, it would affect our results; however, if wage increases were set in a manner related to the pre-reform *level* of attrition for any grade-step group, this is not problematic for our identification. Given that we control for group-specific fixed effects, this selection bias will be eliminated. Instead, our assumption is that pre-reform *trends* in attrition are not systematically related to wage increases received between 2005 and 2006. To check this assumption we consider a version of equation (9), which tests if pre-2006 trends in attrition are a determinant of wage increases:

$$\Delta\bar{\bar{w}}_{j_0 2006} = \gamma(\bar{A}_{j_0 2005} - \bar{A}_{j_0 2003}) + \delta * \Delta\bar{x}_{j_0 2006} + \eta_p + u_{j_0} \quad (10)$$

The fourth column of Table 3 shows the results of this analysis, first without any of the covariates. As is apparent, the 2005-2006 wage changes are in fact correlated with pre-existing attrition trends, and the correlation is intuitive. The new wage structure assigns large wage increases to groups of workers with rising pre-2006 attrition rates. While not ideal, this correlation does not pose a major obstacle to our identification for two reasons. First, the positive correlation indicates that our results, if anything, are biased toward zero. The groups selected for large wage increases would, in the absence of any policy change, have had *higher* attrition rates than comparable groups receiving small wage increases. This will induce some spurious positive correlation which will bias our (negative) estimates toward zero. Second, most of this bias disappears when controlling for our available covariates. As shown in the fifth column of Table 3, controlling for changing demographic and job covariates cuts the coefficient by more than half from 0.025 to 0.011 and makes it statistically insignificant. Thus, any bias from selective targeting of the wage increases is likely small and if anything biases our estimates toward zero.

Of course, without random assignment of wages we cannot address every issue. While controlling for group effects at a fine level and removing promotions from our instrument should reduce bias generated by ability and positive selection, unobserved ability could still generate endogeneity. For example, our specification focuses on the contemporaneous effect of wages on attrition, but if individuals make migration decisions based on lifetime expected wages, then our instrument will systematically underestimate home wages for high ability individuals who expect to be promoted. Since migration likely selects on ability, this would induce correlation between our instrument and the error term. We expect that the magnitude of bias created by this type of endogeneity will be small because of how finely our groups are defined; however, we cannot rule out such a possibility.

Finally, aside from assessing the exogeneity of the policy change we examine, equation (9) can also be used to consider how the new salary structure affected the overall dispersion of wages. For instance, if wage increases were targeted at groups of health workers with the highest ex-ante wages, wages would become more dispersed. This can be couched in a regression framework by correlating 2005-2006 wage increases with wage levels in 2005. The final column of Table 3 shows these results. Confirming our analysis of overall payroll dispersion in Table 2, there is no relationship between initial wage levels and wage increases induced by the policy change. A positive point estimate indicates that an individual with 10 percent higher wages ex-ante would receive a wage increase that is 0.15 percent larger, a difference which is both statistically and economically insignificant.

5 Data

5.1 Administrative Wage Data

The main data source used in this study is individual-level payroll data obtained from the Controller and Accountant General's Directorate of the Government of Ghana. This data contains payroll records from 2003 to 2009 for each health worker classified under MOH paid by the central government including employees of the Ministry of Health, Ghana Health Service, Christian Health Association of Ghana (CHAG), the teaching hospitals, and MOH training institutions. This panel data provides individual-level observations over several years, and yields a rich picture of the health labor market in Ghana. Additionally, for each individual this data provides detailed information on employee grade (i.e., Senior Medical Officer, Chief Lab Technologist, etc.) and salary step for each individual. Information on age, gender (equals 1 if male), department (CHAG, GHS, Headquarters, etc.), and region of posting are also available.

We use health sector public wage schedules to map grade and step into a basic salary for each worker (and as a source of values assigned in the job scoring exercise). As described above, the 2005-2006 salary changes hinged on the Additional Duty Hours Allowance. Thus, it is important to consider not just the basic salary but also the Additional Duty Hours Allowance for each worker. ADHA was allocated according to a fixed formula depending on a worker's category and basic pay. Thus, we can combine payroll data with data on ADHA hours allotments to estimate their ADHA earnings. From 2003-2005 the formula for total wages is:

$$w_{jt} = \log(E_{jt} + \frac{E_{jt}}{160} * 1.75 * h_j)$$

where E_{jt} is the basic salary of an individual in grade-step j at time t and h_j is the number of ADHA hours allotted to a worker in grade-step j. From 2006-2009, we simply use the log of basic salary. Table 4 provides summary statistics. The first column describes potential migrants (defined below), which is our main sample. Real (measured at 2004) monthly wages for this group average 376 Ghana Cedis.[8]

As described above, our instrument for log wages will be log wages that would be earned by worker *i* if he or she were never promoted. In particular, the instrument for a worker *i* at time *t* takes the value from the time *t* wage schedule for a worker with grade-step j_{i0} where j_{i0} is the grade-step of worker *i* when he or she first enters the data. One complication with this definition is that from 2005 to 2006, the entire wage schedule changed from the Ghana Universal Salary

[8] About 410 USD.

Structure (GUSS) to the Health Salary Structure (HSS). Recall that 'step' refers to small differences in seniority within a grade. As a result of the change in salary structures, the number of steps within a given grade changed in some instances. In these cases, a step from before 2006 cannot be trivially mapped to a step from after 2006. For concreteness, consider an observation in 2007 for an individual who first enters the data in 2003. From the data, we can measure the grade and step of the individual in 2003, and these data are from the GUSS system. Call the grade and step $grade_{i0}$ and $step_{i0}^{GUSS}$. Our instrument should indicate the wages a person in $grade_{i0}$ and $step_{i0}^{GUSS}$ would receive in 2007. However, because of the change from GUSS to HSS, the actual wage schedule in 2007 for $grade_{i0}$ may have fewer steps within it in 2007 than it did in 2003. So, we approximate the initial GUSS step by an HSS step reflecting the same percentage progress up the grade. Formally, consider an individual at a time after 2006 who first entered the data before 2006. For observations after 2006, we define the initial step in the HSS system, $step_{i0}^{HSS}$, as:

$$step_{i0}^{HSS} = step_{lowest}^{HSS} + \left(step_{i0}^{GUSS} - step_{lowest}^{GUSS}\right) * \frac{totalsteps_i^{HSS}}{totalsteps_i^{GUSS}}$$

where $step_{i0}^{GUSS}$ is an individual's 'first-observed' step under the GUSS system; $step_{lowest}^{GUSS}$ is the entry-level step for individual i's grade and $totalsteps$ refers to the total number of steps in i's grade under a particular salary schedule. In this way, we can map the initial grade-step of a worker j_{i0} from the pre-reform payroll schedule to the post-reform payroll schedule.

The payroll data is monthly but due to technical challenges does not cover all months prior to 2006. As a result, it is not possible to study attrition over monthly intervals. Thus, we analyze the data at intervals approximating one year. To this end, we only use data from selected months: November 2003, July 2004, December 2005, December 2006, December 2007, December 2008, and July 2009. Since we use time fixed effects, the varying lengths of time between observations should not be an important issue.

5.2 Measuring Attrition

Individual records can be matched from year to year based on identifiers in the data. In particular we match records on first name, last name, gender, and date of birth.[9] We use these matched records over time to measure attrition of health workers from the payroll. In particular, if an individual is in the sample at time *t* but never after time *t*, we say the individual attrited at time *t*. In this study, we usually interpret the impact of wages on attrition from the payroll as the impact of wages on migration. The two are not, of course, generally equivalent. Workers could potentially leave the public payroll for employers outside the dataset (i.e., the private sector or military hospitals), or they could retire from working in the health field. We emphasize migration, but we cannot explicitly separate migration from other forms of attrition in the data.

5.3 Choosing the Sample

Interpretation of the results depends heavily on what part of the sample we use because the data covers workers of all ages and occupations with widely varying skill sets, education requirements, and responsibilities. For older workers, retirement is a major consideration. In our data, the probability of remaining after 20-40 years of experience is still positive and decreasing. This indicates that a significant minority of health workers still remains and attrites from the public sector after long careers. Retirement is an obvious explanation. To focus on migration rather than retirement, we truncate our main sample to those 35 years of age and younger, though we will expand this scope when we investigate the impact of wages on workers of different ages.

We also split our sample based on whether workers' occupations allow them to be a 'potential migrant.' Classification was determined based on pre-reform attrition rates. In

[9] Employee numbers are available in the data and in most circumstances would be ideal. However, the treatment of some cadres' employee numbers changed from 2005 to 2006. Given that this re-definition of employee numbers comes at the same time as the natural experiment, we choose to use a consistent method of matching over all time periods. Since these demographic identifiers are nearly always unique, this method is preferred.

particular, those categories of workers with a year 2003 attrition rate greater than the attrition rate for the whole population in 2003 are considered to be 'potential migrants.' The first column of Table 5 provides a list of all worker categories classified as potential migrants along with their prevalence in the 2003-2008 sample. As expected, nurses and physicians compose most of the 'potential migrant' sample, though there are also many skilled allied health workers, such as pharmacists and non-clinical workers, such as accountants. The second column indicates the largest categories of those excluded from this group, mostly low-skilled workers (orderlies, watchmen, drivers, etc.), as well as clinical workers whose skills are in low demand in developed countries (community health nurses, etc.). Nurses in training are available in the database but excluded from both groups because they are in school and receive only small stipends. The second column of Table 4 shows that, as expected, the non-potential migrants have an attrition rate about half that of the potential migrants, and they are paid less than half as much. However, mean age (conditional on being younger than 35) is similar to our main sample at around 30. While just over half of individuals are female in the main sample, the non-potential migrants are more likely to be female.

We have chosen the division between 'potential migrants' and 'non-potential migrants' based on attrition rates in 2003. While necessarily somewhat arbitrary, this measurement has the benefit of being objective and based on pre-2006 information that could not be endogenously affected by the 2006 salary changes. However, it does have the drawback of being based on attrition data rather than migration data. As a result, some categories of health workers who are reported as not tending to migrate (e.g., midwives and pharmacists) will be in our 'potential migrants' sample along with Ministry of Health employees not in health professions (e.g., accountants); however, these concerns are minimal because the vast majority of potential migrants by any reasonable definition will be doctors and nurses, and we have found similar results under an alternate definition.[10]

Splitting the sample in this way provides two services. As noted before, it focuses analysis on categories of workers that were known to have high rates of migration during the sample period. This helps narrow the scope of our study to a group where there are external reasons for believing that migration is a main cause of attrition. Second, it also provides the opportunity to test whether wages affect these two groups in similar or different ways. Retirement and the private sector are open to both the potential migrants in our main sample and to those excluded from our main sample. If we observe similar effects of the wage changes on both groups, then this would indicate that we are observing the effect of wages on some other form of attrition rather than migration. However, if the wage reforms show no effect on attrition of non-migrants, then we are likely measuring the impact of wages on migration.

Aside from limiting the sample in reasonable ways, circumstantial evidence also indicates that the large scale attrition seen in the data can most plausibly be explained by migration. As Table 4 shows, in our data roughly 8 percent of all potential migrant health workers leave the public payroll each period. As we have already seen, this coincides with well-known large-scale migration of health workers from Ghana. So, migration is at least consistent with the attrition rates in our data. Additionally, other forms of exit seem implausible. Large-scale retirement for young workers seems unlikely. Due to central payment of not only GHS but also CHAG and others, our data cover the vast majority of all health workers in Ghana. Ghana MOH estimates that 81.9 percent of all health workers work in the institutions covered by our sample, with most

[10] In a previous version of the paper, we determined potential migrant status based on the subjective determination of officials in the Ghana Health Service in 2009. This definition is arguably more precise in identifying who might migrate but also subjective and potentially endogenously related to post-2006 information. In any case, our results are similar with both definitions.

of the remainder in the private for-profit sector or prison and military hospitals. Also, for many categories of potential migrant health workers, coverage of our data frequently surpasses 90 percent (Ministry of Health, 2007). Given the small proportion of health workers in for-profit and military medicine, these sectors' human resource usage would have to increase by about 40 percent per year to absorb all of the health workers leaving the public payroll. What data exists on the private sector is not consistent with this story. For example, the World Health Organization's National Health Accounts indicate that the private sector's share in health sector spending actually fell from 58.6 percent to 48.4 percent from 2000 to 2007 (World Health Organization, 2010). Thus, external evidence seems to indicate that attrition from the public payroll in our sample is more plausibly attributed to migration than to other causes.

5.4 Additional Data Sources

The payroll data is supplemented by data from other sources. The job scoring data come from public sector salary schedules. For inflation we use the GDP deflator from the World Bank's World Development Indicators. All values are reported in real 2004 Ghana Cedis. In 2004, the average exchange rate was USD 1.12 per Ghana Cedi. Foreign wages are drawn from the UK Annual Survey of Hours and Earnings. Individuals are matched to UK wages based on their cadre (doctor, professional nurse, etc.) at the SIC 4-digit level, when possible. Others are matched to SIC 3-digit and 2-digit codes when necessary. Necessarily, these data are not nearly as precisely measured as home wages because they are not individual specific. UK wages are changed into Ghana Cedis using PPP exchange rates from the Penn World Tables. As Table 4 shows, wages in the UK average 1550 Ghana Cedis per month at PPP rates. This is more than 4 times the purchasing power of the average domestic salary.

In addition to wages, other labor market factors in the UK likely affected migration during this time period, particularly adoption and strengthening of the NHS Code of Practice. We control for this using a measure of the openness of the UK to migrants from different professions: the log of the total number of new migrants to the UK for a particular profession in a given year from all source countries. We have this variable available from registration data in the UK with physicians from the UK General Medical Council, nurses from the UK Nurses and Midwives Council, and others (Art Therapists, Biomedical Scientists, Clinical Scientists, Dieticians, Occupational Therapists, Orthopists, Physiotherapists, Radiographers, and Audiologists) from the UK Health Professions Council. In our data, we also match Ghanaian dentists as physicians in the UK; medical assistants and anesthetist assistants as nurses; lab assistants and lab technical officers as clinical scientists; nutrition officers as dieticians; and x-ray officers as radiographers. For other categories, we code the variable as zero.

Two concurrent domestic policies affecting health worker migration are included in some specifications. The Ghana College of Physicians and Surgeons opened in 2004, becoming the first specialist training school in Ghana. It is thought to have decreased migration of doctors who would have otherwise migrated for training purposes. We measure this event using enrollment in the Ghana College of Physicians and Surgeons, obtained from the school's official records. We include enrollment in the Ghana College interacted with a dummy for non-specialist doctors as a control. Also, during the sample period the Nurses and Midwives Council, in cooperation with GHS and the Ministry of Health, began enforcing a public-sector service requirement for nurses. They began withholding certification from nurses who wished to migrate until they served their bond period. We model this as a dummy that is one for nurses starting in 2006 and zero otherwise.

6 Results

6.1 Main Effects

We estimate the instrumental variables regression of equation (5) with $\hat{w}_{ijt}$ as an instrument for w_{jt}. Table 6 shows the results for this regression. Coefficients on wages are normalized so that they can be interpreted as the percentage point change in migration resulting from a 10 percent wage increase. Each column represents a different specification. First stage F-statistics are reported at the bottom of each column and indicate that a weak first stage should not be a problem. Column (1) of Table 6 shows the results of the simple difference-in-difference approach for the ‘potential migrants’ sample. There are no covariates other than the time effects and grade-step effects. The coefficient is negative and statistically significant at the 5 percent level, indicating that the ‘push’ effect of wages outweighs any credit constraint effect. The coefficient of -1.83 indicates that a 10 percent wage increase would lead to a 1.83 percentage point decrease in attrition. This is fairly substantial relative to the average attrition rate of about 8 percent. This first specification relies on a common time shock assumption for different groups of health workers. Column (2) relaxes this assumption by allowing for doctors, nurses, and other health workers to have different time effects. The coefficient declines to -1.02 and remains significant at the 5 percent level. Column (3) introduces a full set of controls for UK wages, total migration to the UK by profession, the two concurrent domestic policies, gender, a quartic polynomial in age, a set of dummies for department of posting, and a set of dummies for region of posting. These controls have only a small effect increasing the estimated coefficient and decreasing standard error, though it is enough to make the coefficient statistically significant at the 1 percent level. This combination of occupation-specific time effects and a full set of control variables represents our preferred specification. Thus our preferred estimate is that a ten percent wage increase reduces annual attrition by 1.03 percentage points, improving the ten-year survival probability from 0.43 to 0.49.

6.2 Heterogeneous Effects

Recall that our main sample includes only workers under age 35 from occupations we classify as potential migrants. Further investigation indicates that the effects we detect are limited to this group of health workers. Table 7 replicates Table 6 but with the sample of workers from non-potential migrant occupations. The effects for this sample are if anything positive, much smaller in magnitude, precisely estimated, yet for the most part only marginally statistically significant. For example, our preferred specification yields a coefficient on log wages of 0.44. Thus, we have evidence that higher wages decrease the probability of attrition for professions that do migrate but no evidence that such an effect exists for professions that do not tend to migrate. Since other interpretations of attrition such as retirement and moving to the private sector are available to both groups, it seems unlikely that these drive the results. Migration appears to be more consistent with the evidence.

We also explore heterogeneous effects along the dimensions of age, gender, location of posting, and professional grouping. Of these, age is perhaps the most important because we have focused our sample on workers under the age of 35. The first columns of Table 8 explore the importance of this restriction. The first column duplicates our preferred specification for the main sample of workers under age 35. The second column then applies this same specification to the entire sample of workers under the age of 65. We do not detect an impact of wages on attrition in the broader sample, with a positive coefficient of 0.49 that is not distinguishable from zero. From the results in these two samples, we infer that wages appear to have no average effect across the entire population of health workers but a large negative effect among younger workers. Column (3) formalizes this result, where a positive coefficient on the interaction of wages and age, significant at the 1 percent level, suggests that the impact of wages on attrition is less negative among older workers.

The effect among early-career workers is consistent with the simplest model of migration in which increasing home wages reduces a "push effect." It is perhaps not surprising that these effects diminish for older cohorts. In a life cycle model of migration, a fixed cost of migration finances the opportunity to receive higher annual wages. With fewer years remaining, older workers face a similar cost but lower benefits to migrating. Additionally, if individuals differ idiosyncratically in their preference for migration, the health workers that have chosen to remain in Ghana for several years may be a selected group that has such a low probability of migrating that marginal wage changes have no impact. Finally, ageing itself may be correlated with other factors (marriage, having children, building a home, etc.) that may make individuals very unlikely migrants, again causing wages to have no measurable impact on this very small probability. These explanations are all observationally equivalent in our data, but they provide ample explanation for the fact that the effect diminishes in older cohorts. In any case, it appears that these factors outweigh the impact of credit constraints, for in a model of credit constraints we would expect the youngest individuals to have low wealth and thus be credit constrained. Then, it would be these individuals for whom the "push" effect would be most offset by a more relaxed credit constraint. Clearly, we do not observe this effect as dominant in this data.

We also explore other forms of heterogeneous effects. Column (4) demonstrates that the impact of wages is of larger magnitude for men. This gives some suggestive evidence that men respond more elastically to wage increases than do women; however, this result is not robust to different specifications or samples. We also explore how a rural posting may moderate the impact of wage increases on attrition. To this end we match the district of posting to data from the Core Welfare Indicators Questionnaire (CWIQ) on the percent of population who must travel over an hour to arrive at a health facility. When we interact this measure with wages, we obtain a positive but statistically insignificant coefficient. In column (6) we test whether the impact of wages matters more for physicians than for other health workers. From a policy perspective, doctors may have more potential for international mobility, making the impact of wages on them particularly interesting. In our sample we do find doctors to be significantly more responsive to wage increases than the other 'potential migrants' (mainly nurses). Finally, column (7) includes all of the interactions, demonstrating that the impact of wages in this context was strongest for young, male doctors.

7 Robustness

7.1 Allowing for Grade-Step Specific Time Trends

Our main analysis controls for a large class of violations of the common time trends assumption. However, as discussed in Section 4, our preferred specification still requires that different grade-step groups of workers have parallel attrition trends, at least within a broad occupational group and controlling for observable policies and demographics. This assumption will be violated if large wage increases were targeted toward groups of health workers with attrition rates that were already trending up or down. As was demonstrated in column 4 of Table 3, large wage increases were targeted at groups of workers with rising attrition trends. So, if anything, we would expect non-randomly selected wages to bias our estimates toward zero, and as column 5 of Table 3 demonstrates even this bias should dissipate when controlling for observable demographics.

We extend this line of reasoning in the final column of Table 6. While variation in our wage data makes the analysis imprecise, we can estimate a more general specification. We allow for linear time trends that can differ for each grade-step group, which is the finest occupational classification in our data. This allows for differing time trends in attrition for all but the most similar workers, workers who are not only in the same grade (e.g., Senior Medical Officers) but who also have the same seniority within their grade. This estimation leads to a somewhat larger point estimate of -1.52 but also much larger standard errors. While these results clearly include a large amount of uncertainty, they suggest that the negative impact of wages on attrition is robust to many violations of the common trends assumption. If anything, our original estimates should be biased toward zero.

7.2 Using Only Grade-Level Wage Variation

In the main analysis, we instrument for actual wages with wages that an individual would have received if they were never promoted. To this end we identify the grade and step of the salary schedule for each individual when they first enter the data and then assign wages in each year based on that initial grade-step group. As detailed in the data section, translating steps from the pre-2006 GUSS system to the post-2006 HSS system can be non-trivial. Grades always directly translate across systems but the number of steps within a grade can change. In the main analysis, we approximate the step that an individual moving from GUSS to HSS (without a promotion) would receive by assigning individuals to a step with the closest percent progress up the grade.

While this process represents a simple and logical means of approximating post-2006 steps when assigning values for our instrument, it almost certainly does so with error. Potentially, this measurement error could generate bias in our estimates either due to attenuation or if these errors are correlated with attrition. To check our results for robustness to this possibility, we replicate the main analysis using only grade-level variation in wages. As before, wages for a person i in grade-step group j at time t are defined as

$$w_{ijt} = f(j, t)$$

and we assign the instrument to be

$$\widehat{w}_{ijt} = f(j_0, t)$$

Differing from above, we now assign an individual's initial grade-step group, j_0, as the lowest step for their initial grade (i.e., the "entry-level" step that someone would be in when first working in that grade). This necessarily reduces some of the available variation in the instrument, but it is measured without error since grades translate directly across the two pay schedule systems. As a result, it does not face the problem of approximation error in calculating post-2006 steps.

Table 9 shows the results of estimating equation (5) with the new, more restrictive instrument. This replicates the main results from the first three columns of Table 6. In the most basic setup, the instrument is weak (with a first stage F less than 1), leading to a large negative estimate with a wide confidence interval. Introducing more controls in columns (2) and (3) generates in a stronger instrument and results that resemble our main results from Table 6. Together, they indicate that a 10 percent increase in wages leads to a 1.9 percentage point decrease in the attrition rate. These results indicate that, if anything, errors in mapping steps across years result in attenuation bias toward zero.

8 Conclusion

This paper measures the impact of home wages on attrition of skilled health professionals from the public sector in Ghana by exploiting variation in wages caused by a policy-induced natural experiment. We find that a 10 percent wage increase reduces the annual attrition rate by about 1.02 percentage points. This corresponds to a six percentage point increase in the 10 year survival probability of a typical worker. The effect is concentrated solely among young workers age 20-35 who come from professions that tend to migrate. We take this as evidence that the effect of wages on attrition from the public sector mainly runs through migration. While we do not have truly random variation in wages available, our use of sudden, policy-generated variation in wages allows us to plausibly estimate a causal effect of wages on health worker attrition using micro-data. Additionally, the relationship between the wage changes and pre-existing trends in attrition indicate that any bias resulting from endogenous choice of wages by policymakers is likely toward zero. To our knowledge, estimating the causal effect of wages on health worker migration using detailed micro data and a sudden policy change has not been possible before. These results support the most basic economic models of migration in which individuals choose to migrate based on wage differentials between home and foreign countries. These results run counter to expectations that the impact of marginal wage changes may be small when wage gaps are very large or that higher home wages might relax credit constraints causing more migration.

Context is important for interpreting our results. The literature studying whether migration levels respond to wages (or GDP) at the macro level has been mixed (e.g., Mayda, 2010; Docquier, Lohest and Marfouk, 2007). Likewise, micro-level studies that pay close attention to measuring causal effects find different results for different populations. Relatively low-skilled, temporary migrants from the Philippines respond elastically to real relative wage changes in a classic "push-pull" manner (Yang, 2006) while the "best and the brightest" from other Pacific island nations may place a greater weight on other factors (Gibson and McKenzie, 2011a). Our unique data and the policy change we observe allow us to measure the effect of home wages for the entire staff of a national public health system. In this sample of individuals who tend to migrate permanently and who are highly-skilled, we find confirmation of the classic "push-pull" effects of wages.

The population in which we measure this push effect of home wages is of particular interest. Migration of skilled health professionals away from developing countries has been widely debated. To many, it is an unfortunate "brain drain" of needed health workers from places where skilled health professionals are already scarce (e.g., Chen and Boufford, 2005). As a result, many steps have been taken toward reducing such migration. For example, the UK National Health Service has voluntarily imposed restrictions on foreign recruitment via its Code of Conduct, and this idea has been taken up recently by the World Health Assembly. Others question whether medical migration leads to a "brain drain" or a "brain gain" in the first place (Clemens, 2007) and whether restrictions on migration violate human rights of migrants, ignore more important problems of health worker performance and urban-rural distribution, or are driven by recouping misguided education subsidies (Clemens, 2009). Of course, settling this debate is beyond the scope of this article. The existing literature (Bhargava, Docquier and Moullan, 2011; Beine, Docquier and Rapoport, 2008) does indicate, though, that unusually high health worker migration rates are more likely than most instances of high-skilled migration to lead to "brain drain." That makes the situation facing the public health system of Ghana in the early 2000's particularly useful for study.

In this context, our results can provide useful policy guidance. If policymakers operating public health systems in developing countries face unusually high migration rates, then they may wish to reduce this trend. We demonstrate that health workers can be retained, not just by restrictions on leaving but also by rewards for staying; salary supplements are one effective option. More generally, our results indicate that migration of health workers should be an important consideration as policymakers in developing countries contemplate public sector wage reforms. Finally, if policymakers in developed countries desire to redistribute health workers, subsidizing health worker salaries in sending countries is one means to this end that does not involve restrictions on the movement of individuals.

Of course, some caveats are necessary in interpreting the results. We trade external validity for internal validity by narrowing our focus. Our use of attrition from public payroll rather than an explicit measure of migration creates uncertainty about whether we are measuring other forms of attrition. We cannot account for all factors of the necessary cost-benefit calculus, including the reality that raising wages for health workers can sometimes lead to calls for wage increases in other sectors of the public payroll. Nonetheless, we make progress toward evaluating the effectiveness of one particular means toward limiting the migration of skilled health workers. We find that wage increases can result in large reductions in the attrition of skilled health workers. If policymakers judge that an instance of medical migration is harmful, wage increases may be an effective policy tool.

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Table 1. Destinations of Migrant Health Workers from Ghana

Destination	Nurses	Physicians
UK	71%	56%
US	22%	35%
South Africa	--	6%
Canada	3%	1%
Australia	2%	--
Other	2%	2%
Source	Ghana Nurses and Midwives Council	Dovlo and Nyonator (1999)

Table 2. Variation in Wages

A. Log Earnings

	Potential Migrants		Others	
	Mean	S.D.	Mean	S.D.
2003	5.60	0.46	4.86	0.45
2004	5.71	0.47	4.97	0.45
2005	5.96	0.48	5.23	0.45
2006	6.21	0.50	5.44	0.42
2007	6.24	0.50	5.46	0.39
2008	6.27	0.52	5.54	0.40

B. Log Earnings if Never Promoted (Instrument)

	Potential Migrants		Others	
	Mean	S.D.	Mean	S.D.
2003	5.60	0.46	4.87	0.47
2004	5.65	0.47	4.96	0.47
2005	5.86	0.46	5.18	0.47
2006	6.18	0.49	5.45	0.38
2007	6.17	0.47	5.43	0.36
2008	6.20	0.48	5.45	0.38

C. Normalized Log Earnings if Never Promoted (Normalized Instrument)

	Potential Migrants		Others	
	Mean	S.D.	Mean	S.D.
2003	0.00	0.00	0.00	0.00
2004	0.10	0.02	0.09	0.03
2005	0.36	0.01	0.35	0.01
2006	0.66	0.17	0.67	0.18
2007	0.66	0.19	0.67	0.17
2008	0.68	0.20	0.67	0.18

All panels display earnings for all individuals under age 35. Panel C is normalized relative to earnings in 2003.

Table 3. Sources of Wage Variation

	(1)	(2)	(3)	(4)	(5)	(6)
Sample	Potential Migrants	Potential Migrants	Potential Migrants	Potential Migrants	Potential Migrants	Potential Migrants
Dependent Variable	Log Wage (Instrument)	Change in Log Wages (Instrument)	Job Score	Change in Log Wages (Instrument)	Change in Log Wages (Instrument)	Change in Log Wages (Instrument)
Job Score	0.051***	0.006***	--	--	--	--
	(0.001)	(0.001)				
Log UK Wage	--	--	1.07***	--	--	--
			(0.11)			
Pre-2006 Attrition Trend	--	--	--	0.025**	0.011	--
				(0.012)	(0.011)	
Lagged Log Wage	--	--	--	--	--	0.015
						(0.028)
Occupational Group Dummies	NO	NO	NO	NO	YES	NO
Controls for Changes in Average Demographics	NO	NO	NO	NO	YES	NO
R^2	0.96	0.11	0.39	0.03	0.35	0.00
Obs	166	147	160	142	142	151

Statistical significance at the 1, 5, and 10 percent levels is denoted by ***, **, and * respectively. Observations are at the grade-step group level. Regressions are weighted by the number of individuals in each group.

Table 4. Summary Statistics

	Potential Migrants	Others
Attrition	0.08	0.04
	(0.27)	(0.19)
Real Ghana Wage	376	173
	(208)	(83)
Real UK Wage	1550	702
	(915)	(229)
Age	30	29
	(2.9)	(3.4)
Male	0.47	0.37
	(0.50)	(0.48)
Nursebonding	0.26	0.00
	(0.44)	(0.02)
COPS	17.4	0.10
	(37.4)	(3.17)
Log UK Migrants	6.3	0.29
	(4.0)	(1.19)
N	17,401	33,222

Source: Administrative payroll data. Standard deviations are in parentheses. The sample includes only individuals under age 35.

Table 5. Defining Potential Migrants

Potential Migrants Worker Category	Obs (2003-2008)	Others Worker Category	Obs (2003-2008)
PROFESSIONAL NURSE	8,530	HEALTH/WARD ASSISTANT	7,735
MEDICAL OFFICER - HOUSE OFFICER	2,408	COMMUNITY HEALTH NURSE	6,417
ACCOUNTS OFFICERS	1,727	ORDERLIES	4,195
MEDICAL OFFICER	1,439	PHARMACY TECHNICIANS	1,650
ACCOUNTANTS	733	TYPISTS	1,188
PHARMACISTS	628	DRIVERS	795
EXECUTIVE OFFICERS	530	TECHNICAL OFFICER (LAB)	760
STOREKEEPERS	467	ARTISANS	753
TECHNICAL OFFICER	281	MEDICAL RECORD ASSISTANT	714
DISPENSING ASSISTANTS	211	STENOGRAPHERS	614
OTHER	191	TECHNICAL OFFICER (CDC)	611
MIDWIVES	122	LABOURERS	590
ESTATE OFFICERS	99	KITCHEN ASSISTANTS	505
HEALTH EDUCATION OFFICER	19	FIELD TECHNICIANS	477
MEDICAL ASSISTANTS	15	BIOSTATISTICS ASSISTANT	473
CARETAKERS	1	STAFF COOKS	436
		WATCHMEN	434
		LABORATORY ASSISTANTS	404
		BIOMEDICAL SCIENTIST	398
		TECHNICAL OFFICER (XRAY)	286
		WASHMEN/IRONERS	262
		TECHNICAL OFFICER (BIOSTAT)	257
		HEALTH SERVICE ADMINISTRATOR	230
		BOATMEN (COXWAINS)	227
		CATERING OFFICERS	174
		CONSERVANCY LABOURERS	165
		RECEPTIONIST	161
		SCAVENGERS	153
		RECORDS SUPERVISOR	134
		SECURITY GUARDS	122
		BLOOD BLEEDER	108
		SUPPLY OFFICERS	101

Potential migrants include all categories of workers with attrition rates in 2003 greater than the attrition rate for the whole population. Non-potential migrants only shown for categories with at least 100 observations.

Table 6. Main Effects

Sample Dependent Variable	(1) Potential Migrants Attrition	(2) Potential Migrants Attrition	(3) Potential Migrants Attrition	(4) Potential Migrants Attrition
Log Ghana Wage	-1.83**	-1.02**	-1.03***	-1.52
	(0.74)	(0.40)	(0.39)	(1.11)
Log UK Wage	--	--	0.06	-0.30*
			(0.08)	(0.17)
Log UK Migrants	--	--	0.00	-0.05**
			(0.01)	(0.03)
Nursebonding	--	--	-0.12***	0.10***
			(0.02)	(0.03)
COPS	--	--	0.0004***	0.0010***
			(0.0001)	(0.0002)
Gender	--	--	-0.02***	-0.02***
			(0.01)	(0.01)
Age Quartic	NO	NO	YES	YES
Year Fixed Effects	YES	NO	NO	NO
Profession-Year Fixed Effects	NO	YES	YES	YES
Grade-Step Fixed Effects	YES	YES	YES	YES
Department Dummies	NO	NO	YES	YES
Region Dummies	NO	NO	YES	YES
Grade-Step Specific Time Trends	NO	NO	NO	YES
Obs	17,154	17,154	17,141	17,141
Number of Clusters	202	202	202	202
First Stage F	198	279	291	57

Statistical significance at the 1, 5, and 10 percent levels is denoted by ***, **, and * respectively. Standard errors are clustered at the grade-step level.

Table 7. Non-Potential Migrants

	(1)	(2)	(3)	(4)
Sample	Non-Potential Migrants	Non-Potential Migrants	Non-Potential Migrants	Non-Potential Migrants
Dependent Variable	Attrition	Attrition	Attrition	Attrition
Log Ghana Wage	0.39*	0.37	0.44*	1.23*
	(0.23)	(0.23)	(0.23)	(0.63)
Log UK Wage	--	--	0.02	-0.08
			(0.04)	(0.07)
Log UK Migrants	--	--	0.02	0.01
			(0.02)	(0.03)
Nursebonding	--	--	-0.06	0.14
			(0.05)	(0.17)
COPS	--	--	-0.12***	0.002
			(0.01)	(0.002)
Gender	--	--	0.01***	0.01***
			(0.00)	(0.00)
Age Quartic	NO	NO	YES	YES
Year Fixed Effects	YES	NO	NO	NO
Profession-Year Fixed Effects	NO	YES	YES	YES
Grade-Step Fixed Effects	YES	YES	YES	YES
Department Dummies	NO	NO	YES	YES
Region Dummies	NO	NO	YES	YES
Grade-Step Specific Time Trends	NO	NO	NO	YES
Obs	32,972	32,972	32,840	32,840
Number of Clusters	637	637	632	632
First Stage F	199	197	173	27

Statistical significance at the 1, 5, and 10 percent levels is denoted by ***, **, and * respectively. Standard errors are clustered at the grade-step level.

Table 8. Heterogeneous Effects

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Sample	Under 35	Under 65	Under 65	Under 35	Under 35	Under 35	Under 35
Dependent Variable	Attrition	Attrition	Attrition	Attrition	Attrition	Attrition	Attrition
Log Ghana Wage	-1.03***	0.49	-0.50	-0.65	-1.03***	-0.40	0.10
	(0.39)	(0.40)	(0.47)	(0.43)	(0.39)	(0.51)	(0.38)
WageXAge	--	--	0.019***	--	--	--	0.016***
			(0.005)				(0.005)
WageXGender	--	--	--	-0.22**	--	--	-0.11**
				(0.10)			(0.04)
WageXRural	--	--	--	--	0.0002	--	0.0005***
					(0.0003)		(0.0001)
WageXDoctor	--	--	--	--	--	-1.80***	-2.70**
						(0.62)	(1.15)
Controls	YES	YES	YES	YES	YES	YES	YES
Profession-Year Fixed Effects	YES	YES	YES	YES	YES	YES	YES
Grade-Step Fixed Effects	YES	YES	YES	YES	YES	YES	YES
Obs	17,141	74,090	74,090	17,141	17,139	17,141	74,088
Number of Clusters	202	425	425	202	202	202	425

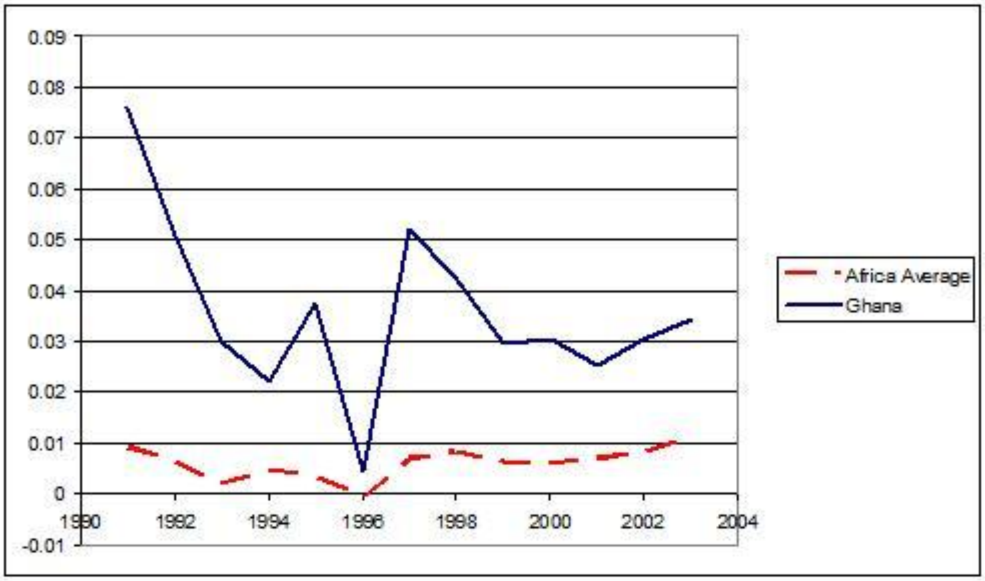
Statistical significance at the 1, 5, and 10 percent levels is denoted by ***, **, and * respectively. Standard errors are clustered at the grade-step level.

Table 9. Robustness: Excluding Step-Level Variation

	(1)	(2)	(3)
Sample	Potential Migrants	Potential Migrants	Potential Migrants
Dependent Variable	Attrition	Attrition	Attrition
Log Ghana Wage	-4.80	-1.84***	-1.87***
	(3.30)	(0.56)	(0.53)
Log UK Wage	--	--	0.07
			(0.07)
Log UK Migrants	--	--	-0.01
			(0.01)
Nursebonding	--	--	-0.12***
			(0.01)
COPS	--	--	0.0005***
			(0.0001)
Gender	--	--	-0.02***
			(0.01)
Age Quartic	NO	NO	YES
Year Fixed Effects	YES	NO	NO
Profession-Year Fixed Effects	NO	YES	YES
Grade-Step Fixed Effects	YES	YES	YES
Department Dummies	NO	NO	YES
Region Dummies	NO	NO	YES
Grade-Step Specific Time Trends	NO	NO	NO
Obs	16068	16068	16055
Number of Clusters	36	36	36
First Stage F	0.47	14.89	12.82

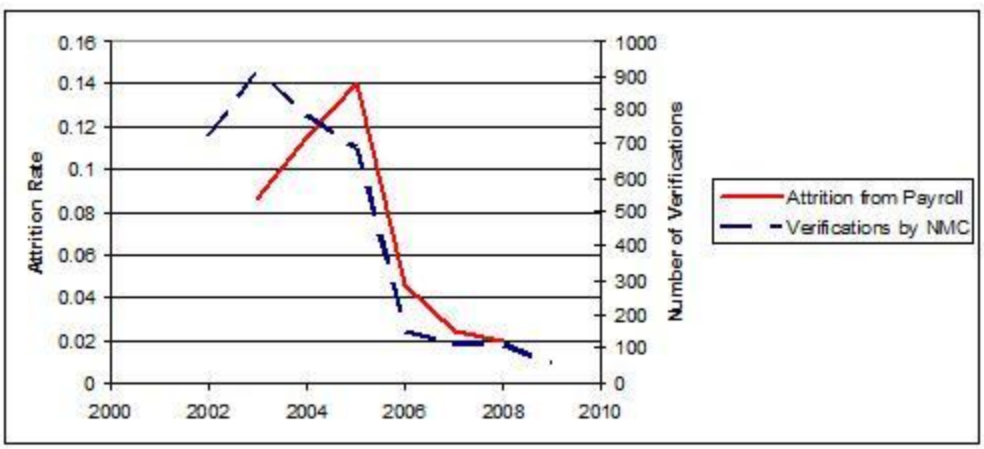
Statistical significance at the 1, 5, and 10 percent levels is denoted by ***, **, and * respectively. Standard errors are clustered at the grade level. The instrument is restricted to use only grade-level variation and assign all individuals to the lowest step within the grade.

Figure 1. Historical Migration of Physicians from Ghana



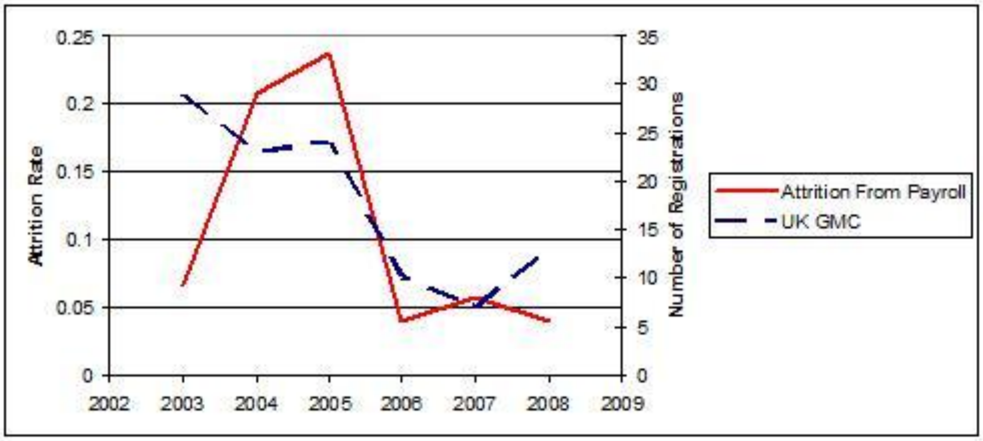
Source: Bhargava and Docquier (2007); the data have been converted into flows

Figure 2. Migration and Attrition of Nurses from Ghana



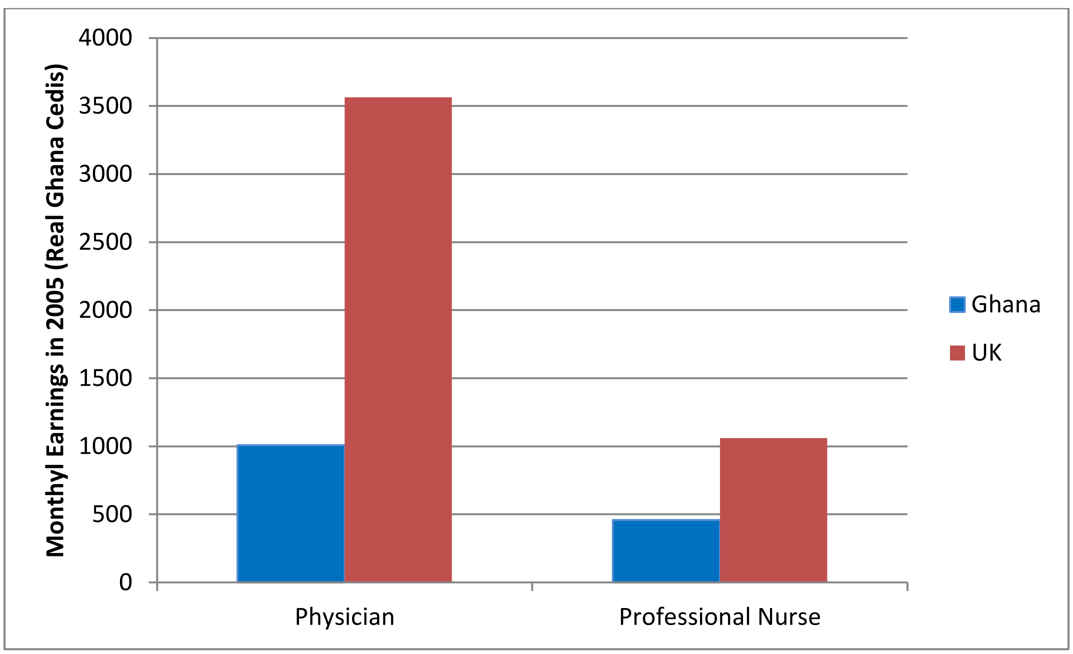
Source: Nurses and Midwives Council; IPPD Database

Figure 3. Migration and Attrition of Physicians from Ghana



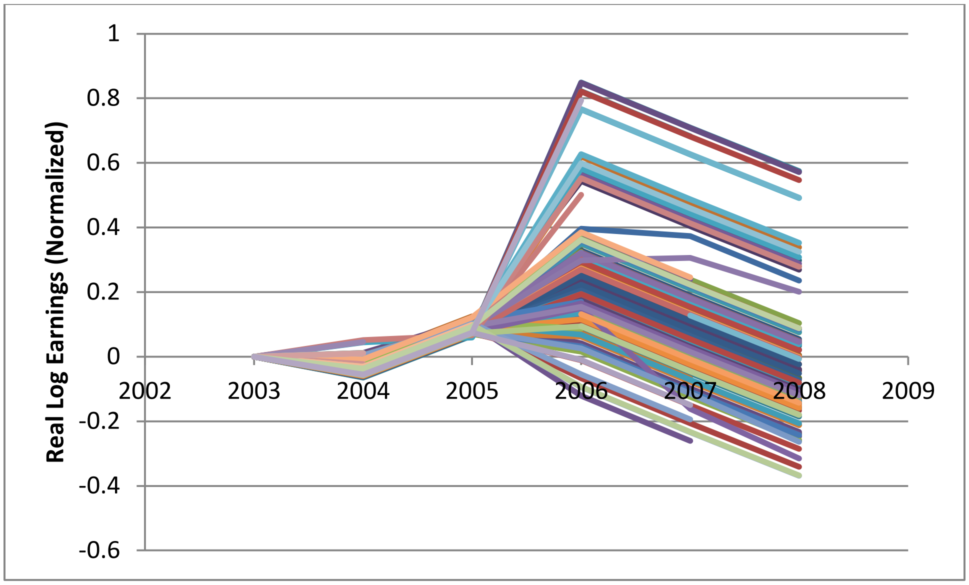
Source: UK General Medical Council and IPPD Database

Figure 4. Salaries of Health Workers in Ghana and the UK



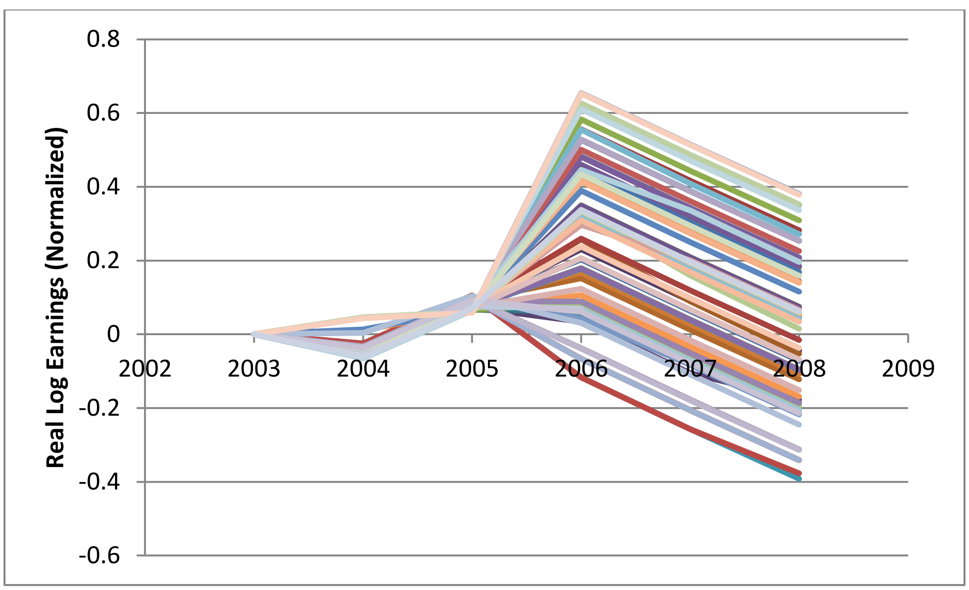
Source: IPPD Database and UK Annual Survey of Hours and Earnings; UK figures are converted to real Cedis using PPP exchange rates

Figure 5. Wages for Health Workers in Ghana, Potential Migrants, 2003-2008



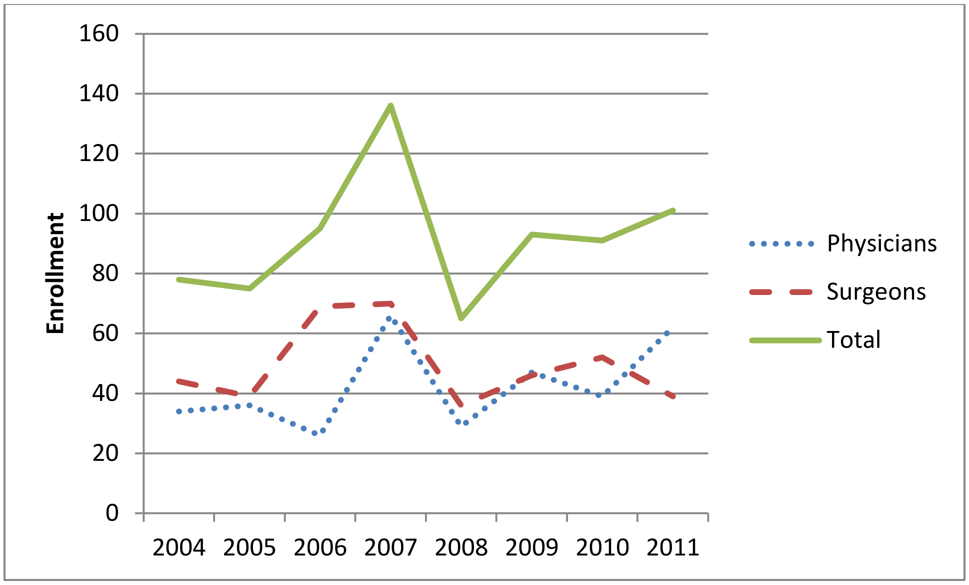
Each line indicates the real log wages of a particular grade-step group (e.g., senior medical officers on step 5). Each group's wages are normalized to zero in 2003. Source: IPPD Database

Figure 6. Wages for Health Workers in Ghana, Non-Potential Migrants, 2003-2008



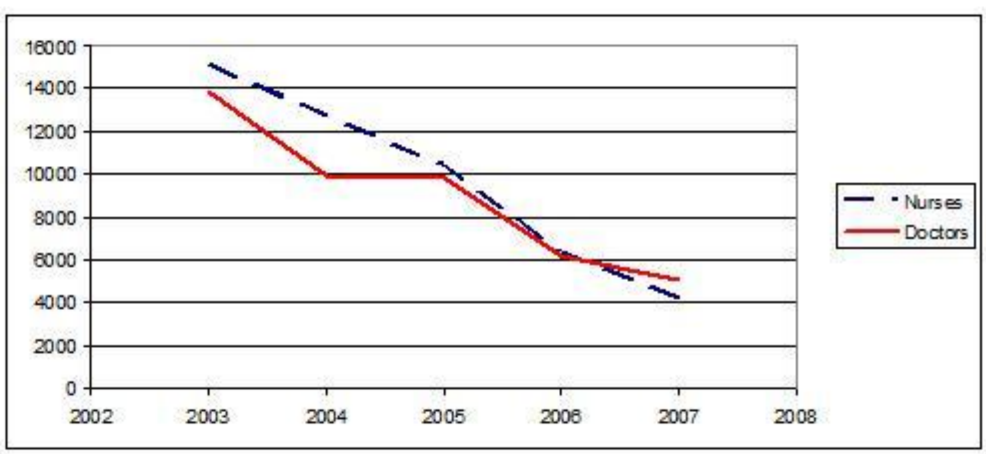
Each line indicates the real log wages of a particular grade-step group (e.g., senior medical officers on step 5). Each group's wages are normalized to zero in 2003. Source: IPPD Database

Figure 7. Enrollment in the Ghana College of Physicians and Surgeons



Source: Ghana College of Physicians and Surgeons

Figure 8. Migration of Health Workers to UK from All Source Countries



Source: UK General Medical Council; UK Nurses and Midwives Council