Adverse Selection and Career Outcomes in the Ethiopian Physician Labor Market[‡]

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February 20, 2008

Abstract

This paper uses a newly collected dataset on Ethiopian physicians to shed light on the allocative efficiency of the physician labor market. We use a lottery mechanism employed to assign medical school graduates to the region of their first jobs to identify the long-term impact of initial postings to rural areas versus the capital Addis Ababa. We find that physicians being assigned to Addis are more satisfied with their initial and their current posting. However, high ability physicians opt out of the lottery and find Addis assignments through the market where they successfully seem to compete for specialization training with physicians assigned to Addis through the lottery. In fact, in the long run, lottery physicians with a first assignment in the rural area are just as likely to find work in Addis. We also find evidence of adverse selection in the market for physician labor that was initially allocated under the lottery system, compared with the market for physicians who did not participate in the lottery. We rationalize these findings by suggesting that the lottery, by explicitly randomly assigning new graduates, obfuscates information about them that future employers would otherwise find valuable. High ability workers from the lottery do relatively worse later in their careers than their counterparts who did not take part in the lottery, and are more likely to exit the physician labor market in Ethiopia.

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[†]The survey for this study was financed by a grant from the Gates Foundation and Norad, administered through the World Bank. The opinions expressed in the paper are those of the authors and do not reflect the position of the Government of Ethiopia or the World Bank Group.

1 Introduction

Ethiopia faces acute challenges in reaching all of the Millenium Development Goals, including the three goals relating to health - to reduce child mortality, improve maternal health, and combat HIV/AIDS, malaria, and other diseases. This paper assesses one factor that will be important in moving towards these goals – the performance of the physician labor market.

With a population of around 70 million people, 85% of whom live in rural areas, and per capita income of about $150, the country is one of the poorest in the world, The Ministry of Health (2005) reports that in 2005 there were 2,543 physicians in Ethiopia, representing a population-physician ratio of approximately 28,000. This is the fifth lowest population-to-physician ratio among African countries, and compares pitifully with the ratio of 1 per 10,000 as recommended by the WHO. If anything near this ratio is to be attained, there will clearly need to be a sustained long term increase in the net supply of physicians to the Ethiopian market.

Rural and remote areas of Ethiopia are particularly underserved by health workers. Indeed, by some estimates, up to half of the physicians in Ethiopia serve the residents of the capital, Addis Ababa, home to about 5 percent of the population. Increasing labor supply in rural areas can be effected either by fiat or with financial and other incentives. The Ethiopian government has traditionally relied on the first approach, through the operation of a lottery-based clearing house for the assignment of new medical school graduates to their first postings.

In this paper we use recently collected data from a survey of physicians to address two basic questions about the physician labor market: first, what are the long term effects on a health worker's career prospects of rural assignment; and second, how does the lottery system affect the efficiency of the market for health workers. In addressing each of these questions, we use data both on physicians who participated in the lottery system, and on those who chose to enter the market directly.

To examine the efficiency effects of the lottery system, we explore the selection into the lottery and compare outcomes of those who participated in the lottery and those who did not. We propose a model in which random assignment under the lottery early in his career may obscure information about a physician's quality that would be otherwise useful to future employers. For this group of workers, the labor market might suffer from adverse selection, with relatively high quality workers opting out of the profession. On the other hand, if information about health workers who do not enter the lottery, and are therefore not randomly assigned to their first jobs, is more durable, then the market in which these workers participate later should not be subject to adverse selection.

We develop empirically testable implications of this theory on the functioning of the Ethiopian physician labor market, and test them against a newly collected dataset. The short-run implications of the model, pertaining to the allocation of new graduates, are broadly supported by the data: we find that first, the market allocates new graduates to jobs in different regions based at least in part

on physician's ability and locational preferences. In contrast, these variables do not predict the initial assignment across regions for lottery participants. In light of this, higher ability graduates tend to opt out of the lottery. The data also indicate that recent growth of demand for private sector physicians is associated with falling lottery participation. And finally, the pattern of job satisfaction expressed amongst lottery participants across ability levels reflects the random nature of the lottery assignment: good doctors are on average disappointed with their first assignments, while low-quality physicians report being more satisfied.

The long-term predictions of our model relate to the efficiency of the physician labor market. In support of the model, we observe wage compression in the market for physicians who participated in the lottery: high-ability physicians who participated in the lottery earn significantly less than those who did not, while lottery participation does not significantly affect the future wages of lower ability doctors. Similarly, access to future training opportunities appears to

be attenuated for high ability lottery participants relative to similar physicians who opted out of the lottery, while there is little such difference for lower ability graduates. Finally, in light of these dynamics, we find evidence of higher rates of attrition among high-ability physicians who took part in the lottery than for those who did not.

2 Human resources for health in Ethiopia

This section provides background information on human resources in the health sector, and a description of the institutional mechanism by which first job assignments have historically been made – that is, through a lottery mechanism.

2.1 Human resources

The number of health workers working in Ethiopia is difficult to estimate. The Ministry of Health (2005) reports that in 2005 there were a total of 2,543 physicians, of which 444 (17%) operated in the private sector, 578 (23%) in the NGO sector, and 354 (14%) in other government organizations (such as the military). Of the 1,077 physicians classified as working for the public sector, 20 percent were located in Addis Ababa. Since most physicians in other regions are also located in urban centers, the share of public sector doctors in rural areas is far less than 80%.

In addition, retaining health workers in Ethiopia is proving increasingly difficult, partly due to active recruitment efforts by other countries. Clemens and Pettersson (2007) find that the number of Ethiopian physicians that are working as physicians abroad constitute 30% of all practicing Ethiopian physicians. Since undoubtedly some Ethiopian physicians will change careers following international migration, this suggests that the total number of physicians leaving Ethiopia is in fact higher than 30%.

In recent years, there has been a rapid growth in the private health care sector, but the vast majority of this growth has occurred in Addis Ababa. In fact,

according to survey data we collected in 2006 on physicians in Ethiopia, 380 out of an estimated 597 physicians working in Addis (or 64%) currently work as physicians outside the public sector, the vast majority in the private sector, earning salaries that are double those in the public sector in Addis and triple those in the public sector outside Addis. In one of the two other regions covered by the survey, Southern Nations Nationalities Peoples Republic (SNNPR), about 10% of physicians are estimated to be working outside the public sector (including NGOs). In the second region, Tigray, virtually all doctors are estimated to work in the public sector.

As suggested by these statistics and confirmed through discussions with health workers themselves, attracting health workers to remote areas is a particular challenge if the WHO-recommended ratios are to be met in a meaningful way.

2.2 The lottery system

Until recently, the primary vehicle through which the Ethiopian health system has ensured a supply of health workers to the rural regions has been a national clearing house. Each year a national lottery is announced through the media in September. Health workers who graduated in the previous June and July, as well as doctors who have completed their internships, are invited to go to the Ministry of Health, starting in October, to participate in the lottery.

Under the lottery, which is officially mandatory although in practice physicians can opt out, a participant is randomly assigned to one of the twelve regions of the country, and the regional health bureau is informed of this assignment. Job assignments at the regional level are administrated by the relevant regional bureau (World Bank, 2006). Assigned workers are required to serve a fixed number of years before being "released" and permitted to apply for other positions.[1]

National clearing houses for entry level physicians are also common in other countries. For example, in the United States, the market for almost all entry level positions (called residencies) for new doctors is mediated by a clearinghouse called the National Resident Matching Program (NRMP). Applicants and employers submit rank order lists representing their preferences, which are then used by the clearinghouse to centrally determine a match between applicants and employers (Niederle and Roth, 2007). Roth (2008) describes how this system was instituted in 1952, after the market for health workers had progressively unraveled.[2]

[1] The maximum number of health workers assigned to each region is decided before October by a 3-person committee at the Ministry of Health, on the basis of the official requests of health workers sent by each region. An exception in the lottery system has been recently introduced with respect to the assignment to posts in the newest regions of Benishangul, Hafar, Somali and Gambella. Before the lottery takes place, each health worker is asked whether he/she would be willing to work in any of these new regions. If the answer is negative, as in the majority of cases, the corresponding posts are added to the lottery.

[2] Employers had been making offers earlier and earlier in the hiring season so as to get a shot at the best candidates, and then began insisting that candidates accept or reject an

Against this background, the Ethiopian clearing house has until recently ensured a steady supply of physicians to jobs outside Addis Ababa, having attracted a large proportion of potential participants (at least 60% of graduates). However, unlike the NRMP in the United States, the lottery system does not seek to match employer preferences with physician preferences, at least not with respect to regional job assignments.

While the lottery is still officially in place, during the past five years Ethiopia has embarked on a radical decentralization program across all areas of the public sector, with much of the responsibility for service delivery being devolved to lower levels of government and allowing private health facilities to operate alongside public ones. According to discussions with senior health officials, legal questions have also been raised about the government's ability to enforce the requirement that doctors whose training was federally funded can be required to work for a fixed period in an employment assigned through the lottery.

In what follows, we use the lottery system to estimate the long-term impacts of rural assignment, and compare this rural versus Addis labor market outcomes among non-lottery participants. We then examine whether participation in the lottery itself can compromise the efficiency of future allocations in the physician labor market.

3 A model of the physician labor market

3.1 Motivation of the model

In our pre-survey discussions with health workers, a number of potential benefits associated with working in Addis were identified, including higher wages and superior work and non-work amenities. Reflecting these observations, we assume that wage differentials in the entry-level physician labor market do not exactly offset the different costs of working in different parts of the country. The resulting geographic imbalance of demand and supply in the physician labor market means jobs must be rationed by non-price mechanisms. The lottery and the market employ potentially different rationing systems, with different allocative properties.

This raises the question of whether a lottery is a good way to assign graduating physicians to jobs. On the one hand, random allocation is sometimes defended on the basis that it is fair, although this is only true in an ex ante sense. (It would seem fairer to require all health workers to spend a given amount of time in undesirable jobs, rather than to randomly assign such tasks to an unlucky share.) On the other hand, economic theory suggests at least two reasons that a lottery might impact negatively on the workings of the labor market. First, in the short run, if there are important efficiency gains from

offer in a very short period of time to ensure they had a shot at the next best candidate on their list. Niederle and Roth (2007) and Roth (2008) provide further economic analysis of the efficiency properties of the NRMP.

matching individuals to jobs, then a truly random allocation will be inefficient, compared with an allocation mechanism that explicitly reflects preferences and costs, such as an idealized market.

Second, in the long run, using a lottery to allocate labor could obfuscate important information about health workers that is relevant to future employment decisions. For example, suppose there are important matching efficiencies in the market for graduating physicians. Amongst lottery participants, who are matched randomly to jobs, realized productivity in the first job (as revealed for example through letters of recommendation) may be a poor indicator of underlying potential productivity in a second assignment. Under a market mechanism, on the other hand, we might expect "good" graduates (those who were highly ranked in medical school) to be more likely to be matched to "good" jobs. Even if underlying ability is unobservable later in a physician's career, employers can use information about his first job as an indicator of quality in making their recruitment decisions. In particular, because jobs in Addis are rationed, we can use location as such an indicator.

Assuming lottery participation itself is observable, the physician labor market will bifurcate into two sub-markets. In the lottery market, employers lack verifiable information on physician quality, which may lead to adverse selection. The effects could include wage compression and the departure of high quality physicians from the market (either to other careers, or to migration). The non-lottery market, on the other hand, in which employers have an informative signal of physician quality, might be expected to operate more efficiently.

These observations suggest that the labor market outcomes of lottery participants and non-participants may differ in systematic ways across different types of physicians. In pre-survey interviews, health officials linked recent expansion of the private sector with a downward trend in lottery participation. In light of this, we model lottery participation incentives as a function of expected search costs in the market, under the assumption that the growth of the private sector has reduced these costs.

We formalize the intuition above in the model below, and then test the implications on our dataset. Because we have detailed information on both lottery and non-lottery physicians[3], including details of their medical school performance, and their first and current assignments, we are able to investigate both the allocation mechanisms themselves and whether there is evidence of adverse selection among lottery physicians.

3.2 Adverse selection in the physician labor market

We propose a model in which there are two types of physicians - type L with low ability, and type H with high ability. The share of L-type physicians in the population is σ. There are also two types of "first" job - a first job in Addis, and a first job outside Addis. physicians first choose whether to entry

[3] While participation in the lottery system has officially been obligatory, only about 60 percent of our sample report having done so.

the lottery or not. If a physician stays out of the lottery, he suffers a random utility cost ε, which has distribution $G(\varepsilon)$. This disutility cost can be thought of as a search cost the individual expects to incurr in the labor market outside the lottery, or as an unknown cost imposed by the government, since lottery participation is officially mandatory.[4]

If a physician enters the lottery, he is randomly assigned to a first job by the government. WIth probability ρ he gets a job in a good facility, and with probability $1-\rho$ his first job is in a poor facility. If he does not enter the lottery, he is assigned to a job by the market. We make the extreme assumption that the market assigns type H physicians to Addis and type L physicians outside Addis - effectively the market observes and rewards ability. We assume all type L physicians enter the lottery, along with a fraction η of type H physicians. The assumption about type L physicians will be shown below to be correct in equilibrium, and the value of η will be calculated . Thus the share of the population of all physicians who participate in the lottery is

$$n^{Lott} = \underbrace{\sigma}_{L\text{-types}} + \underbrace{(1-\sigma)\eta}_{H\text{-types}}$$

There are $n^M \equiv (1-\sigma)(1-\eta)$ type H physicians who don't participate in the lottery and enter the market directly. The evolution of the labor market is shown in Figure 1.

In the second stage, all physicians search for jobs, either in the profession or not. By now, a physician's ability is known only by him, but the location of his first job is public information. For physicians who did not participate in the lottery, the market can use the location of the first as a perfect signal of ability, and reward it accordingly. physicians who were not in the lottery receive a wage equal to their productivity: π_H for type H physicians, and $\pi_L < \pi_H$ for type L physicians. (In equilibrium there are no type L physicians not in the lottery.) For physicians who were in the lottery, the market must offer a constant wage. We assume that this is equal to the average productivity *of physicians who accept a job at that wage.*

Without loss of generality, assume that all type L physicians have the same outside option, which is strictly less than their productivity in the profession, π_L. On the other hand, type H physicians have an outside option equal to $\widetilde{\pi}_H + \mu$, where $\widetilde{\pi}_H < \pi_H$ and μ is randomly distributed according to cdf F, with mean zero (so on average the outside option is less than a type H physician's productivity in the job), and infinite support (so $0 < F(\mu) < 1$ for all μ). Indeed, let us assume that $\max_\mu(\widetilde{\pi}_H + \mu) < \pi_H$, so it is Pareto optimal for all type H physicians to continue in the profession. Thus a type H physician from the lottery will leave the market and take his outside option as long as

$$\widetilde{\pi}_H + \mu > \overline{\pi},$$

[4] We show below that federally funded doctors are more likely to enter the lottery than those with private funding, suggesting the threat of government sanctions is operative.

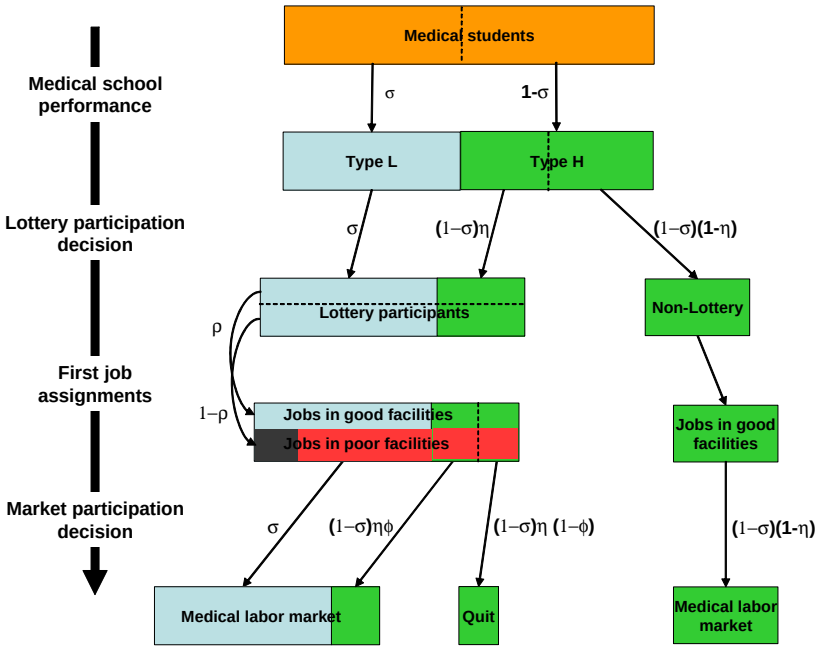


Figure 1: Evolution of the physician labor market. Performance at medical school determines doctor quality. The pool of type L and H doctors sorts itself into the lottery and non-lottery systems. First jobs are assigned randomly under the lottery to good and poor facilities. All non-lottery participants get first jobs in good facilities. Of those who participate in the lottery, further sorting occurs after the initial job assignment: some continue in the health sector, and others quit the profession, due to adverse selection.

which occurs with probability $1 - F(\overline{\pi} - \widetilde{\pi}_H) \equiv 1 - \phi$. The number of H-type physicians from the lottery who stay in the market is then $(1-\sigma)\eta\phi$. Since $\pi_H > \pi_L$, the average productivity of type L lottery participants who stay in the market is at least as high as the outside option they face, so the total number of lottery participants who stay in the market is

$$n_{in}^{Lott} = \underbrace{\sigma}_{L\text{-types}} + \underbrace{(1-\sigma)\eta\phi}_{H\text{-types}}.$$

The average productivity of all physicians (both type L and type H) who were in the lottery and who remain in the market is

$$\overline{\pi} = \frac{1}{n_{in}^{Lott}} \left[\sigma\pi_L + (1-\sigma)\eta\phi\pi_H\right], \tag{1}$$

where $\phi(\overline{\pi}) = F(\overline{\pi} - \widetilde{\pi}_H)$. This equation can be rearranged to yield

$$\overline{\pi} - \pi_L = \left(\frac{1-\sigma}{\sigma}\right)\eta\phi(\overline{\pi})[\pi_H - \overline{\pi}]$$

At $\overline{\pi} = \pi_L$, the right hand side of this expression is strictly positive, while the left hand side is zero. At $\overline{\pi} = \pi_H$, the left hand side is positive and the right hand side is zero. A sufficient condition for a unique solution to exist is that the right hand side be strictly decreasing in $\overline{\pi}$ between π_L and π_H This in turn can be guaranteed if

$$\frac{\phi'(\overline{\pi})}{\phi(\overline{\pi})} = \frac{f(\overline{\pi} - \widetilde{\pi}_H)}{F(\overline{\pi} - \widetilde{\pi}_H)} < \frac{1}{\pi_H - \overline{\pi}}$$

in this range. The right hand side of this expression attains its smallest value (in the range $[\pi_L, \pi_H]$) at $\overline{\pi} = \pi_L$. So for given properties of the distribution function F, as long as π_H is not too much larger than π_L there will be a unique solution to (1), which depends on π_L, π_H and $\widetilde{\pi}_H$, as well as σ and η.

Note that for a fixed value of η, as outside opportunities improve for type H physicians, i.e., as $\widetilde{\pi}_H$ increases, the equilibrium value of $\overline{\pi}$ falls as a greater share of type H physicians from the lottery pool quit the market. In addition however, the share of type H physicians who enter the lottery to begin with will fall. Taking π_L, π_H $\widetilde{\pi}_H$ and σ as parametric, η is the only endogenous variable, so let us write the equilibrium average productivity of lottery participants who enter the medical market in stage 2 as $\overline{\pi}(\eta)$.

To determine the share of type H physicians who initially enter the lottery, η, note that when type H physicians from the lottery are deciding whether to stay in the market, they compare the wage $\overline{\pi}$ with their outside option $\widetilde{\pi}_H + \mu$. If $\mu > \overline{\pi} - \widetilde{\pi}_H$ then they quit the market and earn $\widetilde{\pi}_H + \mu$; if $\mu < \overline{\pi} - \widetilde{\pi}_H$ then they stay in the market and earn $\overline{\pi}$. Thus the expected wage earned at stage 2 for a type H physician who chooses to enter the lottery is

$$\overline{w}_H(\eta) = \frac{1}{n^{Lott}}\left(n_{in}^{Lott} \times \overline{\pi} + \left[n_{out}^{Lott} \times \widetilde{\pi}_H + \int_{\overline{\pi}-\widetilde{\pi}_H}^{\infty} \mu dF(\mu)\right]\right) \tag{2}$$

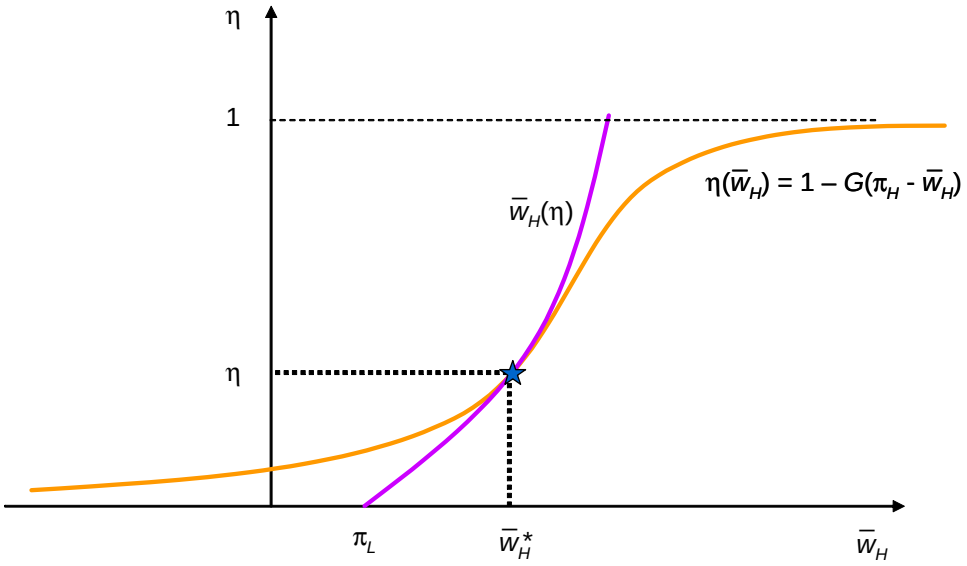


Figure 2: Equilibrium lottery participation by type H doctors, η^*.

where $n_{out}^{Lott} = n^{Lott} - n_{in}^{Lott}$. Note that we assume a type H physician does not know what μ is going to be when he decides whether to enter the lottery. The expected wage of a type H physician not in the lottery is simply π_H.

Because $\overline{\pi} \geq \pi_L$, all type L physicians enter the lottery. Type H physicians enter the lottery as long as

$$\overline{w}_H > \pi_H - \varepsilon$$

where ε is the cost of not participating in the lottery. That is, H types participate in the lottery as long as $\varepsilon > \pi_H - \overline{w}_H$. Thus the share of type H physicians who enter the lottery is

$$\eta(\overline{w}_H) = 1 - G(\pi_H - \overline{w}_H). \tag{3}$$

Solving (2) and (3) gives the equilibrium share of type H physicians who participate in the lottery, η^*, and their expected wage at stage 2, $\overline{w}_H^*$, as illustrated in Figure 2.

3.3 Empirical implications of the model

The model above includes a number of empirically testable assumptions and predictions. The assumptions and some of the predictions relate to short-term effects, immediately following completion of physician training. Other predictions reflect the longer-term evolution of physicians' career paths.

3.3.1 Main assumptions:

1. There are regional differences in monetary and/or non-monetary returns that favor working in Addis.

2. When the market allocates new graduates to jobs in different regions, this allocation is based at least in part on a worker's ability and locational preferences. Under the lottery, these variables do not predict the initial assignment across regions.

3.3.2 Short-term predictions:

1. High ability physicians are more likely to select out of the lottery than low ability physicians.

2. Growth of demand for private sector services should be associated with falling lottery participation.

3. If the lottery assigns graduates randomly, then some good doctors get bad jobs and some bad doctors get good jobs. Thus amongst lottery participants, we expect high ranked doctors to be less satisfied than low-ranked doctors.

3.3.3 Long-term predictions:

1. Among high-ability physicians, current wages should be lower for lottery participants than for those who did not participate in the lottery.

2. In light of this, rates of attrition among high-ability physicians should be higher for lottery participants than for those who did not participate in the lottery.

4 Empirics

4.1 Sampling methodology

Our sampling strategy aimed at obtaining representative samples of doctors and nurses from three of Ethiopia's eleven regions – the capital city of Addis Ababa, Tigray, and Southern Nations and Nationalities Peoples Republic (SNNPR). Addis is a city of about 3 million people and is located in the central highlands. Tigray has a population of about 4 million people and lies in the extreme north of the country, bordering Eritrea, while SNNPR, with a population of 14 million borders Kenya to the south. The regional capital of Tigray is Mekele, and that of SNNPR is Awassa. Our sample is representative within these geographic areas.[5] The design over-sampled physicians in SNNPR and Tigray due to the small number of physicians outside Addis Ababa: all physicians in these rural regions were sampled, while only about one third of physicians in Addis

[5] Other regions, such as Oromia (which surrounds Addis Ababa) and Amhara (which is immediately north of Oromia) are larger (with 26 and 19 million residents respectively) and less remote, at least in terms of direct distance measures, but we have no reason to expect this to have introduced systematic biases in our estimates.

	Addis Ababa	SNNPR	Tigray	Total
Total Facilities	40	39	18	97
Hospitals	6	12	11	29
Health centers and clinics	34	27	7	68
physicians	91	72	56	219

Table 1: Numbers of facilities and physicians surveyed

were. Our final sample included 219 physicians working in health centers and hospitals.

A random sample of 1/3 of doctors was achieved in Addis Ababa by (a) randomly sampling facilities of the various types with sampling weights corresponding to the estimated proportion of doctors working across the different facilities; and (b) interviewing all doctors at the sampled facilities. In SNNPR and Tigray, all doctors were included in the sample. This was achieved by sampling all public hospitals in SNNPR and Tigray (there are generally no doctors in non-hospital health facilities in these regions and there were no private hospitals). In addition to interviewing health workers, we administered a facility level survey with the facility administrator or other senior official at each facility we visited. A summary of our physician sample is provided in 1.

Amongst doctors, the interview response rate varied across regions: 86% in Tigray, while in SNNPR and Addis Ababa it was lower – 58% and 66% respectively. In Addis, the response rates were similar among public and private facilities (70% versus 64% respectively), but the reasons differed. At public facilities, all doctors present agreed to be interviewed, although 21% of sampled doctors were absent on the day of the interview for unexplained reasons, and 9% for planned leave). In contrast to public facilities, the share of sampled doctors who were present but refused to be interviewed was 22% at private facilities. Further, no unexplained absences were recorded, while 15% of doctors were absent on planned leave. In Tigray, non-response arose because one sampled facility no longer existed, and one was inaccessible for security reasons. In SNNPR, nine out of ten of the physicians listed as being employed but not interviewed were absent at the time of the facility visit for training purposes. We will highlight below the possible implications for our findings of this pattern of non-response.

4.2 Description of Data

In this section we report summary statistics from both the facility and individual questionnaires, with a view to presenting a picture of working conditions and the physician labor force in the three regions covered by the survey. The first table below provides summary statistics from the facility survey, weighted by the estimated share of physicians working in each type of facility. Doctors in SNNPR and Tigray work in remote locations: they are 6 hours and 5.1 hours from their regional capitals respectively, which are themselves remote

from Addis. However, the table shows that at least along several measurable inputs, facilities in the outlying regions are no worse than public facilities in Addis. In fact, SNNPR and Tigray facilities are better equipped to test for HIV and are more likely to have sufficient water supply. There are in turn differences between the two regions: for example, only half the doctors in Tigray work in facilities with sufficient medicine, compared with 73% and 88% of those in Addis and SNNPR respectively. Similarly, Tigray has more inpatient beds per doctor and more outpatients than both SNNPR and public facilities in Addis.

Private facilities in Addis are on the other hand much smaller, with about half the number of inpatients and outpatients per doctor compared with public facilities in the capital. Some quality indicators, such as water availability, are reported as significantly better in Addis' private facilities, but on other dimensions private facilities report being either no better (equipment), or somewhat worse (medicine).

Demographic and economic data from the individual-level questionnaires are reported in the table below.

Panel I reveals that doctors in Addis Ababa, especially those working in the private sector, are more experienced than those in the regions. In Addis, men are somewhat over-represented in the private sector, while in SNNPR there are virtually no female doctors whatsoever. We find evidence that doctors are more likely to have moved away from their home region to Addis than to either of the regions. This is reflected in the fact that three quarters of those in Tigray reported having lived there at age 10, compared with one half in SNNPR, and about 41% in Addis.

In economic terms, doctors in Addis do better than those in the regions. As reported in panel II of Table Y, asset ownership is higher in Addis, with one half and one quarter the doctors working in private and public facilities respectively reporting ownership of a car, compared with less than two and five percent, respectively, in SNNPR and Tigray. House ownership is higher among private sector physicians in Addis (35%), but the rates among other doctors are similar (10-16%).

Physician salaries in Addis, especially amongst those working in the private sector, are considerably higher than those earned in SNNPR and Tigray. Doctors working in the public sector in Addis earn salaries about 50% more than the average doctor in the regions, while salaries of private sector doctors are three times as much. The gap between private sector salaries in Addis and those of other doctors is partly offset by additional sources of income: public sector doctors in Addis earn additional income equal to 21% of their salaries, while the figures in SNNPR and Tigray are 17% and 33% respectively, and between a third and a half of doctors in the regions outside Addis report receiving housing allowances (although we do not have data on the monetary value of these allowances). Indeed, significant shares of doctors working outside the Addis private sector report holding more than one job – from 23% in the Addis public sector, to 12% in Tigray. On the other hand, private sector doctors in Addis supplement their (much higher) salaries by only 3 percent. Although

Facility Level Information				
	Addis Public	**Addis Private**	**SNNPR**	**Tigray**
Facilities in sample	9	30	21	17
Avg number of doctors per facility	6.9	2.6	5.2	2.6
	(10.6)	(2.4)	(4.8)	(2.2)
Estimated number of doctors in total	140	236	109	42
Reliable Electricity/Phone	100.0%	100.0%	97.3%	97.6%
Functioning x-ray machine	75.7%	82.2%	85.3%	81.0%
Functioning laboratory	100.0%	100.0%	100.0%	100.0%
Functioning operating theatre	62.1%	42.4%	92.7%	97.6%
Equipment to test for HIV	66.4%	87.3%	92.7%	100.0%
Sufficient water supply	23.6%	96.2%	87.2%	85.7%
Sufficient medicine	88.6%	73.3%	88.1%	50.0%
Sufficient basic care equipment	83.6%	84.8%	100.0%	69.1%
Number of inpatient beds	139.8	22.1	114.8	120.0
	(112.2)	(40.7)	(63.5)	(106.7)
Number of inpatient beds per doctor				
(no. of inpatient beds / avg no. of doctors per facility)	20.3	8.5	22.1	46.2
Number of outpatients	180.4	37.9	139.8	142.3
	(88.6)	(42.7)	(77.3)	(107.1)
Number of outpatients per doctor				
(no. of outpatients / avg no. of doctors per facility)	26.1	14.6	26.9	54.7
Hours travel to regional capital	0	0	6.0	5.1
			(5.5)	(4.9)

*Private includes NGO and missionary

Statistics are calculated using frequency weights corresponding to total no. of doctors by region working in (1) public hospitals, (2) private hospital, (3) government health center, (4) private clinic, NGO, or missionary

Demographics Doctors				
	Addis Public	**Addis Private**	**SNNPR**	**Tigray**
Male	70.0%	85.7%	97.2%	73.5%
Single	38.7%	24.5%	65.7%	55.4%
Age	39.2	41.5	29.8	31.7
	(1.64)	(1.73)	(1.21)	(1.65)
Birth order	2.81	3.55	2.7	3.1
	(0.12)	(0.33)	(0.35)	(0.22)
Number of siblings	6.1	6.4	6.4	6.6
	(0.31)	(0.38)	(0.34)	(0.64)
Number of children	0.9	1.71	0.47	0.73
	(0.14)	(0.22)	(0.22)	(0.20)
Parents healthworkers	5.2%	0.0%	0.92%	2.4%
Siblings healthworker(s)	14.8%	18.4%	22.2%	20.5%
Other family healthworker(s)	19.9%	26.5%	13.9%	7.2%
Live in home region when age 10	44.1%	40.8%	50.9%	74.7%
Own a car	26.9%	51.0%	1.9%	4.8%
Own land	14.8%	4.1%	13.9%	2.4%
Own house	15.2%	34.7%	10.2%	15.7%

Labor Market Doctors				
	Addis Public	**Addis Private**	**SNNPR**	**Tigray**
Proportion working private sector			10.20%	0.00%
Salary (US$)	244.6	484.9	154.5	178.2
	(10.9)	(40.3)	(11.9)	(14.2)
Income (US$)	296.9	501.5	181.5	236.7
	(24.8)	(41.2)	(30.1)	(39.5)
Other compensation with job	29.3%	46.9%	90.7%	53.0%
Housing allowance	0%	0%	53.7%	32.5%
Participated in lottery	62.0%	57.1%	57.4%	57.8%
Training sponsored by federal govt	67.7%	79.6%	73.1%	59.0%
Specialist training	40.4%	38.8%	6.5%	20.5%
Holds more than 1 job	23.5%	20.4%	16.7%	12.0%
Applied for official release certificate public sector	38.7%	86.0%	19.7%	4.7%
Of these, % application was granted	73.9%	95.3%	47.8%	25.0%

20% report holding more than one job, we expect that these multiple jobs are in some sense considered together to make up the worker's primary occupation, which accounts for the small amount of supplemental income. Finally, physician household incomes are higher in Addis than elsewhere.

Part of the salary premium observed in Addis reflects higher rates of specialization amongst doctors there - about 40% compared with 20% in Tigray and just 6 percent in SNNPR. However, we find that the rates of specialization in the public and private sectors in Addis are virtually identical, suggesting that training is not the sole driver of observed income differentials.

Finally, a similar proportion across the four employment categories, about 60 percent reports having participated in the lottery, and between 59 and 80 percent of doctors had their medical training sponsored by the federal government (as opposed to a regional or foreign government, or a private sponsor). Lastly, the table shows the proportion of physicians who applied to receive an official release formally authorizing them to work in the private sector. Of those currently working in the private sector, most (86%) report having applied for this release with the vast majority having been successful (95%). The corresponding application numbers are much lower among physicians working in the public sector; 39, 20, and 5 percent, respectively, for Addis, SNNPR, and Tigray, and consequent success rates being lower too - 74, 48, and 25 percent, respectively.

4.3 Testing the model's assumptions

We begin by testing the main assumptions of the model regarding (i) the attractiveness of working in Addis relative to the regions, and (ii) the observable determinants of the location of physicians' first jobs, and how they differ between lottery participants and non-participants.

4.3.1 Job Satisfaction from working in Addis

Pre-survey discussions with healthworkers suggest that the average physician perceives significant net benefits, in terms of salary and urban amenities, from working in Addis. This suggests that wages are not flexible enough to reduce these benefits to zero, or that physician jobs in Addis are qualitatively different to those in rural regions. The simple unconditional mean comparisons in Table X above, particularly with regard to wage differentials, support this notion. It is also consistent with separate work on the same sample of physicians by Hanson and Jack (2008), who find that relatively large financial incentives are necessary to induce sizeable shifts in physician labor to rural areas. In addition, we estimate the effect of having a job in Addis on wages, incomes, and job satisfaction, controlling for observable physician characteristics such as ability (as measured by academic class rank) and experience, and several other individual characteristics :

$$y_i = \beta_0 + \beta_1(Addis)_i + x_i'\gamma + \epsilon_i$$

x_i is a vector of physician characteristics, $Addis_i$ is a dummy variable indicating whether physician i works in Addis, and y_i represents an employment characteristics such as wages, or a measure of job satisfaction. Conditional on x_i and assuming no omitted variable bias, the coefficient β_1 should be 0 or even negative if y_i is a measure of wages and the compensating wage differential framework holds. A positive value of $\beta_1$indicates there are net benefits to having a job in Addis.

Indeed, the table above confirms that differences in labor market outcomes between Addis and the regions remain, even conditional on a vector of observables. We find that physicians currently working in Addis earn salaries that are between 79 and 82% higher, and are considerably more content with various aspects of their work, especially those who are currently working in Addis and who initially participated in the lottery. Note that non-lottery physicians currently working in Addis are significantly more content with their jobs overall than their non-lottery counterparts working in the rural regions despite not being more content about their much higher salaries, their workload, and their training opportunities, thus suggesting that Addis Ababa is also likely to have favorable non-employment characteristics. In sum, these tables support a main assumption of the model that on average, a job in Addis Ababa is more attractive than one outside the capital.

4.3.2 First job assignments: lottery versus market

We estimate that about 57% of physicians participated in the lottery, of whom about 13% were assigned to a first job in Addis Ababa. Among non-lottery physicians, 20% found their first job in Addis. If the lottery is random, we should find no significant predictors of first job assignment. On the other hand, if jobs in Addis are rationed, then market allocation might be correlated with certain individual characteristics. We test this by seeing if the individuals characteristics that predict assignment to Addis differ between the lottery participants and non participants Results are shown in the table below[6] :

The results confirm that the determinants of first job assignments differ systematically between lottery and non-lottery participants. Indeed, in line with the model, assignment appears to follow a market principle among non-lottery physicians, but not among lottery physicians, under the assumption that employment in Addis is favorable. Among physicians who opted out of the lottery, those who report ranking in the 2nd and 3rd quintiles are respectively 20.9 and 24.8 percentage points less likely to find a first job in Addis Ababa

[6]Linear probability estimation is done instead of probit maximum likelihood since there are a few instances where probit estimations are forced to drop several observations. For example, in the lottery sample, there are 3 healthworkers whose parents were also healthworkers. Because all three work outside Addis, these are dropped in probit estimations.

		Lottery	Market
1	Current salary (log)	0.815***	0.789***
		(0.144)	(0.167)
2	Current income (log)	0.728***	0.781***
		(0.177)	(0.156)
3	Satisfaction with wage current job	0.925**	0.793
		(0.457)	(0.581)
4	Satisfaction with training current job	-0.047	-0.465
		(0.313)	(0.421)
5	Satisfaction with workload current job	0.769**	0.576
		(0.302)	(0.396)
6	Satisfaction overall with current job	0.653*	0.827**
		(0.389)	(0.373)

Notes: Each cell represents a separate OLS estimation (rows 1-2) or ordered probit estimation (rows 3-6) and reports the coefficient on a dummy variable indicating whether the current assignment is in Addis or one of the two rural regions. The dependent variables are listed in column 2. Other controls are: separate dummies for class rank, dummies whether parents or other relatives have been healthworkers, dummies for the medical school sponsor, gender, and experience (yrs and yrs squared), number of siblings, and birth order. Job satisfaction variables reflect one of five (self-reported) values from 'not at all satisfied' to 'very much satisfied'. All estimations exclude physicians who were less than 2 years out of medical school. P-value: *** 1%; ** 5%, * 10%. Number of observations: 120 for lottery sample; 85 for market sample. Standard errors corrected for clustering on facility level.

	Lottery		Market	
	Addis assignment	Addis assignment	Addis assignment	Addis assignment
2nd ranked medical student	0.078		-0.173~	-0.209~
	(0.078)		(0.114)	(0.131)
3rd ranked medical student	0.029		-0.297*	-0.248**
	(0.100)		(0.148)	(0.122)
Parents healthworkers	-0.031		-0.341*	-0.258**
	(0.083)		(0.194)	(0.118)
Other relatives (uncles etc) healthworkers	0.046		0.259**	0.300***
	(0.102)		(0.127)	(0.105)
Sponsor: regional authorities	-0.190***	-0.146***	0.022	
	(0.055)	(0.053)	(0.098)	
Sponsor: private/foreign govt	0.090	0.105	0.022	
	(0.107)	(0.103)	(0.161)	
Male (=1)	-0.232**	-0.228**	-0.127	
	(0.097)	(0.087)	(0.176)	
Years experience	0.011		-0.006	
	(0.016)		(0.019)	
Years experience (sq)	-0.001		0.000	
	(0.001)		(0.001)	
Order of birth	-0.011		0.034	
	(0.017)		(0.028)	
No. siblings	0.022		-0.024	
	(0.017)		(0.031)	
Observations	122	122	85	85
R-squared	0.1451	0.0971	0.2249	0.1915

Notes: Linear probability models predicting whether the first assignment following medical school was in Addis or one of the rural regions. Student ranks are self-reported rankings on the medical school exam relative to class mates.
Leftout category is rank 1. Sponsor refers to main sponsor of medical school. Leftout category is federal government.
P-value: *** 1%; ** 5%, * 10%, ~ 15%. All estimations exclude physicians who were less than 2 years out of medical school.
Standard errors corrected for clustering on facility level.

compared to those who ranked in the top quintile[7]. Social connection to the medical profession, as proxied by having a relative working in the sector also improves a non-lottery participant's chance of securing employment in Addis. Somewhat surprisingly, having a parent or parents in the sector reduces the likelihood of getting a job in Addis, which might reflect locational preferences

On the other hand, as expected, class rank is not a significant determinant of job assignment among lottery participants, and neither does connection to the profession influence the chance of such individuals being posted to Addis or the regions. Nevertheless, the 1st and 2nd columns of the table do show that assignment within the lottery is not entirely random: physicians whose medical studies were sponsored by regional authorities are 14.6% less likely to have a first job assignment in Addis than lottery physicians whose studies were sponsored by the federal government. We interpret this as reflecting the discretion of officials in charge of the national lottery to give regions priority in recruiting those graduates whose medical training they funded. The only other variable correlated with the job assignment of lottery participants is sex: men are 22.9 percentage points less likely to be assigned to Addis than women. This difference could reflect preferences on both the demand and supply sides: first, Hanson and Jack (2008) find that the value of a job in Addis Ababa is significantly higher for women than for men; and second (and perhaps related) we do not rule out the possibility that the regional authorities in Addis submit physician openings specifically targeting female graduates.

4.4 Short-run impacts of the lottery system on the physician labor market

4.4.1 Who participates in the lottery?

While lottery participation has officially been mandatory, as we observed above many physicians in our sample did not get their first job through this mechanism. The model predicts that high ability physicians should be more likely to select out of the lottery than low ability physicians. This is tested in the table below.

The first and second column predicting lottery participation show that this is indeed the case: third ranked students are almost 24 percentage points more likely to participate in the lottery than 2nd and 1st ranked students.

The lottery is operated by the federal government, which also sponsored the training of 71 percent of the physicians in our sample. We find that these physicians are more likely to participate in the lottery, perhaps because they face a higher cost of opting out, given the Federal government's sponsorship role. Specifically, physicians whose medical training was sponsored by regional authorities (who make up 12% of all physicians) were 26 percentage points less likely, and those sponsored privately or by foreign governments (who combined

[7] 39% of physicians reports being in the 1st quintile, 41% in the 2nd, and 20% in the 3rd, while 0% in the 4th and 5th quintiles.

	Lottery participation	Lottery participation	Lottery participation	Currently in private sector	Currently in private sector	Physician is specialized	Physician is specialized	Salary (log)
2nd ranked medical student	0.025	0.026	-0.081	-0.171*		-0.245***	-0.227***	-0.167~
	(0.093)	(0.093)	(0.098)	(0.093)		(0.092)	(0.081)	(0.112)
3rd ranked medical student	0.237**	0.237**	0.234**	-0.172~		-0.277***	-0.294***	-0.128
	(0.093)	(0.093)	(0.093)	(0.111)		(0.086)	(0.078)	(0.125)
Parents healthworkers	-0.023	-0.016	0.115	-0.229*	-0.191**	-0.197***	-0.198***	-0.227
	(0.232)	(0.232)	(0.145)	(0.125)	(0.091)	(0.075)	(0.075)	(0.176)
Other relatives (uncles etc) healthworkers	-0.046	-0.044	-0.122	0.117	0.125	-0.169***	-0.179***	0.181
	(0.110)	(0.108)	(0.107)	(0.097)	(0.101)	(0.056)	(0.056)	(0.117)
Sponsor: regional authorities	-0.258*	-0.260**	-0.227	-0.203**	-0.203**	-0.207***	-0.207***	-0.142
	(0.133)	(0.131)	(0.138)	(0.097)	(0.098)	(0.052)	(0.049)	(0.102)
Sponsor: private/foreign govt	-0.418***	-0.416***	-0.447***	-0.217**	-0.238**	0.130	0.159	-0.205**
	(0.110)	(0.111)	(0.109)	(0.105)	(0.107)	(0.151)	(0.160)	(0.100)
Male (=1)	0.014	0.012	-0.004	0.101	0.090	0.121*	0.116	-0.033
	(0.119)	(0.119)	(0.122)	(0.093)	(0.093)	(0.070)	(0.072)	(0.097)
Years experience	0.062***	0.061***	0.071***	0.028~	0.029	0.016	0.001	0.052***
	(0.015)	(0.015)	(0.015)	(0.018)	(0.018)	(0.016)	(0.004)	(0.015)
Years experience (sq)	-0.002***	-0.002***	-0.002***	-0.000	-0.000	-0.001		-0.001***
	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.001)		(0.000)
Order of birth	-0.068***	-0.067***	-0.062**	0.029	0.017	0.067***	0.072***	0.029
	(0.025)	(0.025)	(0.027)	(0.021)	(0.020)	(0.021)	(0.020)	(0.021)
No. siblings	0.042**	0.041**	0.037*	-0.005	0.005	-0.058***	-0.059***	0.007
	(0.019)	(0.019)	(0.019)	(0.017)	(0.015)	(0.021)	(0.021)	(0.015)
Private clinics were comon when starting medical school		-0.031	-0.512***					
		(0.149)	(0.151)					
2nd rank x Private clinics were comon when starting medical school			0.466***					
			(0.053)					
3rd rank x Private clinics were comon when starting medical school			0.196					
			(0.313)					
Specialist training					0.125			0.702***
					(0.114)			(0.120)
Participated in federal lottery						-0.396***	-0.508***	
						(0.137)	(0.187)	
Participated in federal lottery x class rank (linearly)							0.134*	
							(0.085)	
Participated in federal lottery x 2nd class rank						0.182		
						(0.173)		
Participated in federal lottery x 3 class rank						0.263		
						(0.228)		
Observations	216	216	216	207	207	207	207	203
(Pseudo) R-squared	0.1588	0.1590	0.2130	0.2025	0.1860	0.2705	0.2644	0.4806

Notes: Probit models (dprobit coefficients reported) predicting whether physicians entered the lottery or not. Linear probability for private sector participation (probit omits 5 observations whose parents were heathworkers (=1) since none of these work currently in the private sector (=0). Leftout rank category is rank 1. Sponsor refers to main sponsor of medical school. Leftout sponsor category is federal government. Lottery participation based on entire sample. Private sector and specialization limited to physicians at least 2 years out of (general) medical school. P-value: *** 1%; ** 5%, * 10%, ~15%.
Standard errors corrected for clustering on facility level.

make up 16% of all physicians) were 42 percentage points less likely, to participate in the lottery than federally sponsored physicians.

Other determinants of lottery participation include family size (those from large families are more likely to participate), and birth order (those born later are less likely), which may reflect differential costs (ϵ) of opting out of the lottery. The coefficients on years of experience (the number of years since graduation) reflect the general decline in lottery participation.

4.4.2 Impact of private sector growth on lottery participation

The growth of demand for private sector services can similarly be interpreted as a reduction in the search or other utility costs, (ϵ), associated with opting out of the lottery, and should therefore lead to a reduction in lottery participation. We take the demand for physician labor by the private sector as exogenous to any graduate's lottery participation decision. The incentive to opt out of the lottery will depend of course on the opportunities a graduate expects to face in the market, so we begin by examining which kinds of physicians get jobs in the private sector. Columns 2-4 in the table above present our findings.

Although we lack comprehensive data on the rise of the private sector, surveyed physicians were asked if private clinics were already fairly common at the time they started their medical training. We use their responses as a proxy for the size, and growth, of the private sector. The second column in the table above shows that the coefficient estimate on this variable is not significantly different from zero. However, after introducing the interaction with class rank, both the coefficient on the variable itself, and on its interaction with 2nd rank becomes very significant and large in size. In particular, it suggest that consistent with the model above, before the expansion of the private sector, lottery participation was no different between 1st and 2nd ranked students, but 23 percentage points higher among 3rd ranked students – the lottery increases the chances that a third-ranked doctor gets a job in Addis. After the expansion of the private sector, 3rd ranked students are still 23 percentage points more likely to participate than 1st rank students, although both groups experience a large drop in participation of 51 percentage points. 2nd ranked students, on the other hand, do not experience a decrease in lottery participation. This latter effect seems puzzling.

We can speculate on the forces behind this pattern of effects. One possibility is that physicians in general aim to enter the private sector at some point in their careers. First ranked physicians expect to command a high salary immediately in the private sector, so they are willing to incur costs of quitting the lottery. The fourth estimation in the table shows what factors determine whether a physician currently has his primary job in the private sector. Indeed, the private sector attracts the best ability physicians, as measured by their medical school ranking and their years of experience. Physicians in both the 2nd and 3rd quintile are about 16 percentage points less likely than physicians in the 1st quintile to work in the private sector.

However, as shown in the next column, it is not the case that doctors who undergo further training and specialize are more likely to be working in the private sector (both are choice variables so this is merely presented as a correlation conditional on other variables). Still, as shown in the last column, physicians who specialize earn considerably higher wages (70% higher), even controlling for experience, rank and other background variables. The second to last column seeks to reconcile these facts. In particular, it shows that while lower ranked physicians and physicians participating in the lottery are less likely to specialize, the gap in specialization rates between lottery and non-lottery physicians declines with class rank: first rank physicians cannot only seek to enter the private sector directly following graduation, they are also much more likely to undergo specialization training outside the lottery. For second and third ranked physicians, the probability of receiving specialization training is very similar inside and outside the lottery, and similar to those of first ranked physicians inside the lottery (no significant difference – consistent with the adverse selection story)[8].

In sum, the rise of the private sector provides a clear incentive for 1st ranked physicians to leave the lottery; leaving the lottery does not only provide private sector opportunities, they also have a much higher probability of receiving specialization training outside the lottery which raises their public sector wage opportunities. Based on this, the incentives to leave should similarly increase for 2nd and 3rd ranked physicians, although less pronounced since leaving the lottery is not associated with the additional benefit of large increases in the likelihood of specialization training. That the growth of the private sector has not increased lottery exit among 2nd rank physicians is therefore unclear.

4.4.3 Comparing initial job satisfaction between lottery and non-lottery participants

Finally, because the lottery assigns some physicians *randomly* to high valued jobs such as those in Addis while assigning others to the rural regions, we expect satisfaction of the first assignment to be higher among the former than the latter. This is explored in the table below, which provides OLS/ordered probit estimates and nearest neighbor matching (NNM) estimates to generate sample average treatment effects (Abadie and Imbens, 2002), on an indicator variable whether the first assignment was in Addis (=1) or one of the rural regions in Ethiopia (=0), controlling for background variables such as class rank, sponsor of training etc. The main result is shown in the bottom row: the ordered probit and NNM estimates are nearly identical and indicate higher overall first job satisfaction among lottery physicians assigned to Addis. Note that there is no

[8] Specialization rates relative to 1st ranked physicians outside the lottery: (1) 1st ranked physician inside lottery (-37%); (2) 2nd ranked physician outside lottery (-23%) and inside lottery (-0.47%); and (3) 3rd ranked physician outside lottery (-29%) and inside lottery (-40%)

		Lottery (OLS/OProbit)	Lottery (NNM)	Market (OLS/OProbit)	Market (NNM)
1	Duration (years) first job	1.030***	1.050***	1.947**	3.256***
		(0.319)	(0.276)	(0.799)	(0.978)
2	Wage satisfaction first job	-0.065	-0.201	0.547	-2.063***
		(0.410)	(0.148)	(0.493)	(0.382)
3	Training satisfaction first job	-0.579	-0.465***	0.012	0.906***
		(0.425)	(0.128)	(0.610)	(0.207)
4	Work load satisfaction first job	0.443	-0.101	0.090	-0.337
		(0.321)	(0.304)	(0.303)	(0.314)
5	Overall satisfaction first job	0.646*	0.464*	0.165	-1.808***
		(0.354)	(0.253)	(0.573)	(0.402)

Notes: Each cell represents a separate OLS (duration) / ordered probit (satisfaction) or Nearest Neighbor Matching with Robust Standard Errors and Bias Correction (Abadie and Imbens, 2002) estimation and reports the coefficient on a dummy variable indicating whether the first assignment out of medical school was in Addis or in any of the rural regions. The dependent variables are listed in column 2.
Controls are: separate dummies for class rank, dummies whether parents or other relatives have been healthworkers, dummies for the medical school sponsor, gender, and experience (yrs and yrs squared), number of siblings, and birth order. Job satisfaction variables reflect one of five (self-reported) values from 'not at all satisfied' to 'very much satisfied'.
All estimations exclude physicians who were less than 2 years out of medical school. P-value: *** 1%; ** 5%, * 10%.
Number of observations: 121 for lottery sample; 85 for market sample. Ordered probit standard errors corrected for clustering on facility level.

significant difference in wage satisfaction and work load satisfaction, and even some indication of dissatisfaction with training opportunities. Not surprisingly, the results among market physicians are ambiguous. None of the ordered probit satisfaction estimates are significant, while the NNM suggest lower wage and overall satisfaction, but higher training satisfaction. Lastly, the duration of the first assignment is significantly higher in Addis, both among lottery and market physicians.

4.5 Longer-term dynamics in the physician labor market

We now turn to an examination of the longer-term impacts of initial job assignments early in the careers of physicians. The two aspects of first job assignment we distinguish between are first *where* a physician is assigned, and second *by which mechanism* he is assigned – i.e., lottery or market. That is, we first esti-

mate the impact of getting a first job in Addis Ababa on future labor market outcomes, which will help shed light on the long-term private costs of assigning graduates to rural facilities.

Our model of physician labor market dynamics suggests two long-term implications of the lottery mechanism. First, among high-ability physicians, current wages should be lower for lottery participants than for those who did not participate in the lottery. There should not be such a wide difference for low-ability physicians, implying that the distributions of wages in the lottery and non-lottery groups should be discernibly different. Second, and in light of this, rates of attrition among high-ability physicians should be higher for lottery participants than for those who did not participate in the lottery.

4.5.1 Long term impact of initial assignment to Addis

Although jobs in Addis are more attractive because of the income and amenity values they provide, is getting such a posting early in one's career an important determinant of future labor market outcomes? In this sub-section we explore this issue, first using the lottery system as a quasi-randomized experiment to examine the impact on lottery participants, and then employing matching techniques to measure the impact on all physicians in our sample.

The table below examines how the impact of having had a first job in Addis differs between lottery participants and non participants.

We estimate the impact of initial job assignment for the two sub-samples (lottery and non-lottery participants) assuming any selection into Addis is on observables. This identifying assumption is clearly tenuous among non-lottery participants since there could be unobserved covariates that are correlated with the initial Addis assignment but independent of class rank and relatives in profession. Our main focus is therefore on the lottery sample.

Interestingly, for lottery participants, being assigned to Addis by the lottery is not a guarantee of long-term benefits. Those assigned to Addis rather than to one of the rural regions are no more likely to be working in Addis now, to have employment in the private sector, or to have significantly higher wages in their current employment[9]. Somewhat surprisingly, we find that lottery physicians assigned to Addis are significantly less likely to be specialized now (between 15% and 18%), so starting a career in the capital is not necessarily a ticket to specialization - if anything the opposite. In contrast, as shown in columns 3 and 4, both the OLS/ordered probit and NNM estimates indicate that market physicians with a first assignment in Addis are more likely to be specialized. One explanation for this difference is that Addis attracts high-ranking medical students through the market with whom average-ranked lottery students must compete for specialist training.

[9] Note that the small sample size (121 lottery observations) means that we are unlikely to detect relatively small differences in outcomes.

		Lottery (OLS/OProbit)	Lottery (NNM)	Market (OLS/OProbit)	Market (NNM)
1	Currently working in Addis	0.165	-0.109	0.046	0.421***
		(0.210)	(0.154)	(0.131)	(0.098)
2	Physician is specialized	-0.149**	-0.176***	0.195*	0.426***
		(0.065)	(0.040)	(0.097)	(0.143)
3	Currently works in private sector	0.164	-0.037	0.014	-0.627***
		(0.166)	(0.103)	(0.192)	(0.131)
4	Current salary (log)	0.161	-0.011	0.065	0.345**
		(0.170)	(0.091)	(0.186)	(0.155)
5	Overall satisfaction current job	0.757*	0.202	0.037	-3.132***
		(0.393)	(0.322)	(0.563)	(0.474)
6	Currently lives in same region as region at age 10	0.386***	0.433***	-0.123	-0.259***
		(0.097)	(0.048)	(0.186)	(0.073)

Notes: Each cell represents a separate OLS (ordered probit for satisfaction) or Nearest Neighbor Matching with Robust Standard Errors and Bias Correction (Abadie and Imbens, 2002) estimation and reports the coefficient on a dummy variable indicating whether the first assignment out of medical school was in Addis or in any of the rural regions. The dependent variables are listed in column 2.
Controls are: separate dummies for class rank, dummies whether parents or other relatives have been healthworkers, dummies for the medical school sponsor, gender, and experience (yrs and yrs squared), number of siblings, and birth order. Job satisfaction variables reflect one of five (self-reported) values from 'not at all satisfied' to 'very much satisfied'.
All estimations exclude physicians who were less than 2 years out of medical school. P-value: *** 1%; ** 5%, * 10%. Number of observations: 121 for lottery sample; 85 for market sample. OLS (and ordered probit) standard errors corrected for clustering on facility level.

The table shows that, except for the specialization estimate, the estimates for market physicians are unclear. None of the other coefficients on being first assigned to Addis in the OLS estimates are significant, while all NNM estimates are very significant yet unclear. They suggest that physicians landing a job in Addis after medical school are significantly more likely to still be working there, and earn higher incomes, but are less likely to work in the private sector and less satisfied with their current job. We are reluctant to interpret these non-lottery findings not only because of likely omitted variable bias, but these NNM non-lottery findings are very sensitive to the matching variables[10].

In sum, these estimates suggest that in the long run there is a fare amount of mobility following the initial lottery assignments. Still, physicians assigned to Addis through the lottery may fare slightly better than those assigned to the rural area as measured by their current job satisfaction. This is despite having lower levels of specialization than lottery physicians initially assigned to the rural regions. The bottom row in the table may be able to reconcile these findings. Physicians assigned to Addis are significantly more likely to be living now in the region they used to live in as adolescents, suggesting that despite lower specialization, they may benefit from non-employment-related compensating differences.

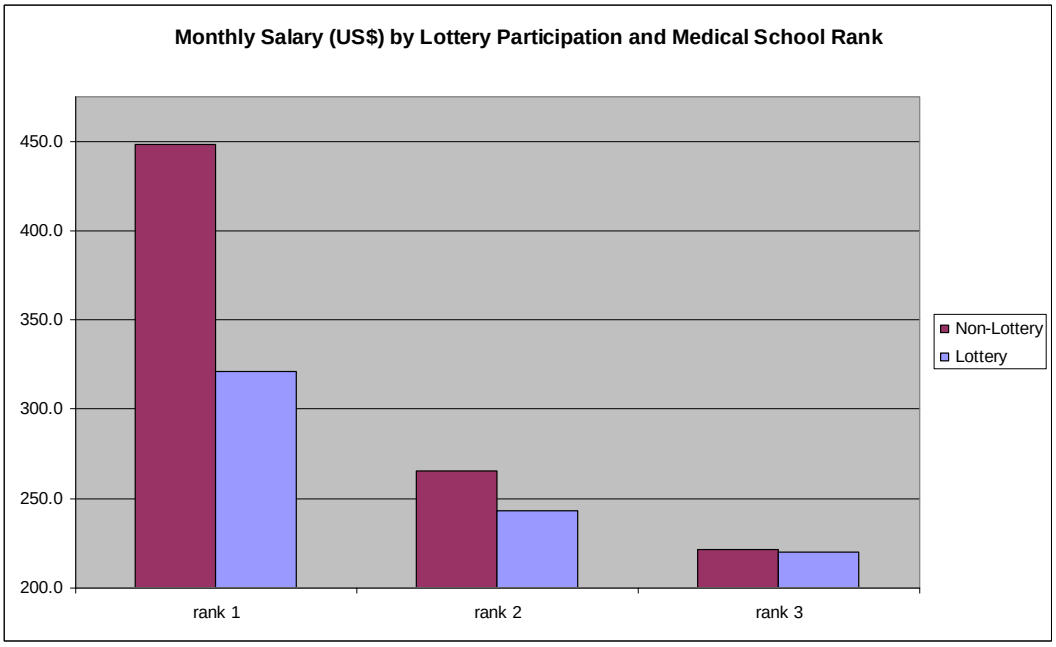
4.6 Evidence of adverse selection

Consistent with the notion that the lottery obscures important information, we found that differences in specialization rates between lottery participants and non participants was smaller among low ranked physicians than high ranked physicians. Next we investigate the extent to which the data further support the idea that the labor market in which lottery participants operate later in their careers suffers from adverse selection. We examine three issues: wage compression, georgraphical inertia, and labor market attrition.

4.6.1 Wages

If information on worker quality is publicly observable then a physician's first job does not provide a useful signal to future employers. In our empirical analysis we do allow for the possibility that working in Addis Ababa (either in a good facility, or in a place with access to other colleagues and a richer learning environment) has a real, positive effect on productivity. In this case, conditioning on class rank, future wages may be positively correlated with having a first job in Addis. However, the distribution of wages should be the same for both lottery participants and those who enter the market immediately after graduation. On the other hand, if the lottery obfuscates worker quality information, then we expect that the conditional wage distribution will be narrowed. The figure

[10] For example, including only rank and whether parents and relatives have been health workers (the only correlates with initial Addis assignment) as matching variables, all estimates are insignificant (smallest p-value = 0.29), except specialization which remains significantly positive.



below, which shows the unconditional wage distribution by rank separately for lottery and non-lottery physicians, provides suggestive evidence to this effect.

Consistent with the model, the graph shows that physicians who were 3rd ranked students earn virtually the same whether they were initially in the lottery or not. Among 2nd rank ones, non-lottery physicians earn slightly more but not much. However, there is a large difference among 1st ranked physicians, with non-lottery physicians earning 39% more on average. The below explores this in a regression context predicting log wages using interactions between class rank and lottery participation. Here, 3rd rank is the left out category to highlight the focus on 1st rank dynamics.

The table first shows that there is not enough power to including a dummy for lottery participation and its interaction with dummies for rank 1 and rank 2, not of which are significant (column 2). Forcing the effect of lottery participation to be zero for 3rd ranked physicians (consistent with the graph above), the coefficient estimates on the interaction terms both fall just outside the significance range (column 2). Combining 1st and 2nd rank in their interaction with lottery participation, column 3 shows that compared with 3rd ranked physicians, 2nd ranked physicians earn 17% more if they are outside the lottery (p-value is 0.166) but earn the same as 3rd ranked physicians inside the lottery (a combination of the direct effect and the interaction), and 1st ranked physicians 46% more outside the lottery, but only 22% more inside the lottery (a combination of the direct and interaction effect). This is consistent with the model's prediction

	Current salary (log)	Current salary (log)	Current salary (log)
1st ranked medical student	0.410**	0.497***	0.464***
	(0.175)	(0.155)	(0.137)
2nd ranked medical student	0.057	0.146	0.173~~
	(0.153)	(0.128)	(0.124)
1st ranked medical student x	-0.186	-0.300~	
lottery participation	(0.212)	(0.195)	
2nd ranked medical student x	-0.077	-0.196	
lottery participation	(0.204)	(0.139)	
1st and 2nd ranked medical student x			-0.243**
lottery participation			(0.122)
lottery participation	-0.121		
	(0.166)		
Parents healthworkers	-0.320	-0.333	-0.311
	(0.287)	(0.280)	(0.278)
Other relatives (uncles etc) healthworkers	0.056	0.059	0.062
	(0.132)	(0.130)	(0.128)
Years experience (yrs)	0.063***	0.060***	0.060***
	(0.020)	(0.019)	(0.019)
Years experience squared	-0.002***	-0.002***	-0.002***
	(0.001)	(0.001)	(0.001)
Sponsor: regional authorities	-0.306*	-0.299*	-0.307*
	(0.162)	(0.161)	(0.160)
Sponsor: private/foreign govt	-0.168	-0.159	-0.157
	(0.116)	(0.116)	(0.117)
Birthorder	0.065**	0.068**	0.070**
	(0.028)	(0.028)	(0.028)
No. of siblings	-0.020	-0.020	-0.022
	(0.019)	(0.019)	(0.019)
Observations	203	203	203
R-squared	0.2848	0.2834	0.2821

Notes: P-value: *** 1%; ** 5%, * 10%, ~ 15%. All estimations exclude physicians who were less than 2 years out of medical school. OLS estimations with standard errors corrected for clustering on facility level. ~~ p-value=0.166

Student ranks: self-reported medical school exam results relative to classmates
(Leftout category: 3rd ranked students)

Sponsor: medical school sponsor. Leftout category: federal government

that there is substantial wage pooling within the lottery. Omitted variable bias caused for example by an omitted effect that increased both wages and opting out of the lottery, is unlikely to be a culprit for two reasons. First, one would expect 3rd ranked physicians to also earn more outside the lottery. And second, if there is no wage pooling inside the lottery, one would expect 2nd ranked students inside the lottery to earn more than 3rd ranked students inside the lottery.

4.7 Labor market attrition

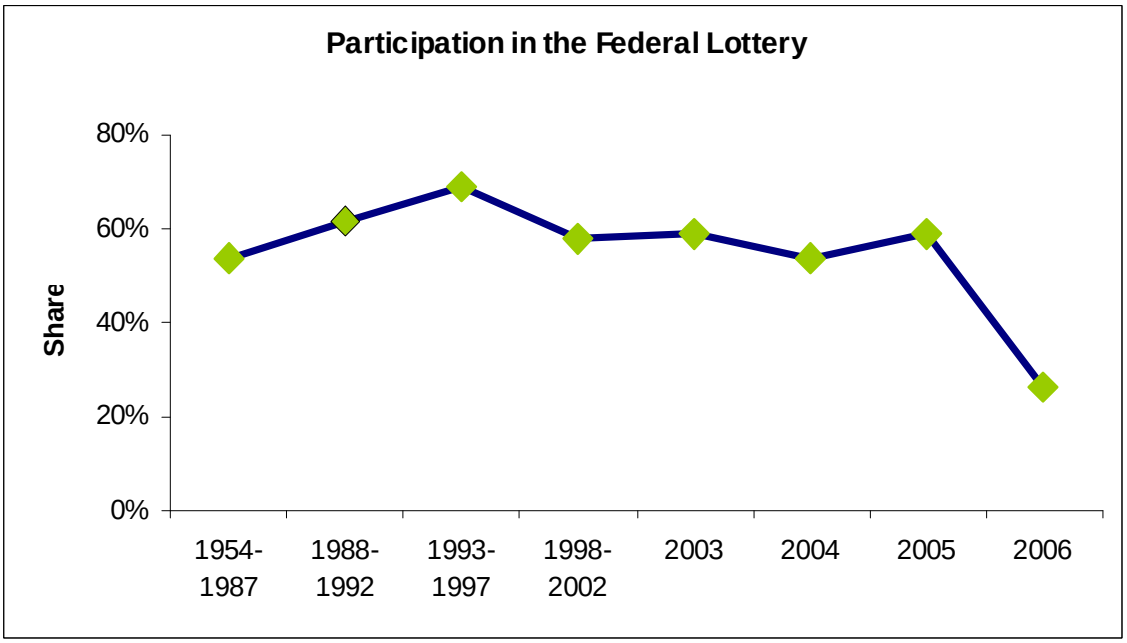
Recall that the model predicts that among the pool of high ability lottery physicians, those with high later life reservation wages are predicted to leave the profession, leading to adverse selection. Naturally, by the mere fact that we cannot observe physicians who left the population of physicians, finding evidence of attrition is nearly impossible. The Figure and the Table below provide two pieces of evidence that are at a minimum consistent.

First, the time series of lottery participation show a drop not just among the latest 2006 cohort which is consistent with anecdotal evidence that the lottery is unravelling (we are unable to identify whether this change reflects a real drop in lottery participation, delayed attrition from the health sector by non-participants, or a combination of both.), but also among the oldest cohorts before 1993. Since anecdotal evidence suggest that government enforcement of the lottery has been declining over time, one would expect that lottery participation was highest among the oldest cohorts. If this was the case, then differential attrition rates between lottery and non-lottery participants over time could have given rise to this pattern.

Second, the table below explores in a regression context the extent to which high-ranked lottery participants have left the profession more than similarl individuals who did not participate in the lottery.

The dependent variable is a dummy for being first ranked. The positive coefficient on experience (0.033) indicates that older cohorts are more likely to be first-ranked than younger cohorts, suggesting that over time first ranked individuals have chosen not to enter the profession (in Ethiopia)[11]. On the other hand, the negative coefficient on the interaction between experience and lottery participation indicates that within older cohorts, lottery participants in our sample are less likely to be first ranked than non-participants. This suggests that amongst high-ranked individuals, lottery participants have left the profession more than non-participants. This is consistent with the idea that the lottery has long-term impacts on the workings of the physician labor market. explores in a regression context whether there is an interaction between participation in the national lottery and the number of years since leaving medical school in

[11] Alternatively, it could be that physicians have become more humble over time in reporting their class rank. Because all the estimations control for experience, this would not affect our findings. Still, there is little reason to think that the younger generation is somehow more humble.



predicting whether someone is ranked 1st in class. If the attrition rate among 1st ranked physicians is higher inside the lottery than outside, we would expect that the proportion of 1st ranked physicians who participated in the lottery declines over time in our sample relative to the non-lottery physicians in our sample. The table shows that this is indeed the case.

5 Conclusion

Delivering health and other public services to remote areas of developing countries is perhaps one of the greatest challenges facing poor countries that aspire to reach the Millennium Development Goals. This paper has used a newly collected dataset on Ethiopian physicians to shed light on issues of rural physician labor supply, including the dynamics of career evolution, and the allocative efficiency of the physician labor market. We have used a lottery mechanism employed to assign medical school graduates to their first jobs to identify the long-term impact of initial postings to rural areas, and have examined the performance of the physician labor market born of that lottery mechanism.

We find the market for new physicians operates surprisingly efficiently, while the allocation of graduates under the lottery is close to random. Better graduates opt out of the lottery, especially following the rise of private health sector opportunities, and earn more in the short and long run than lower quality physicians. And although the lottery is ex ante fair, ex post we find that physicians

Predicting 1st rank in medical school	
Participation in national lottery	0.149
	(0.137)
Participation in national lottery x	-0.018*
time since medical school (yrs)	(0.010)
Time since medical school (yrs)	0.033*
	(0.017)
Time since medical school squared (x100)	-0.074~
	(0.047)
n	209
	OLS

P-values: ~15%, *10%, **5%, ***1%
Robust standard errors clustered on facility
Sample limited to physicians who are at least in their 3rd year out of medical school

assigned through the lottery to Addis were more satisfied with their first assignment and remain more satisfied with their current assignment. However, we find that being posted under the lottery to a rural area is not the end of a physician's chances of a successful career: indeed, they are more successful in getting specialized training than lottery participants initially assigned to Addis, and they are no less likely to be currently working in Addis. In fact, there is some indication that doctors initially assigned to Addis through the lottery compete unsuccessfully with higher ranked non-lottery doctors for specialization training, and opt to move to their home regions instead.

There is evidence that the lottery mechanism obfuscates information about worker quality, which can lead to adverse selection in the physician labor market later on. We find that amongst lottery participants, rates of specialization and wages are compressed. A high-ability physician participating in the lottery earns less, is less likely to be specialized, and is more likely to leave the profession, compared with similar physician who did not take part in the lottery. These observations support our hypothesis that the lottery has some mild negative long run effects on the workings of the labor market. Enforcing full participation in the lottery is unlikely to ameliorate these effects. Instead, policy should focus on explicit financial or in-kind incentives to attract physicians to rural positions, and to motivate them once there.