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For public service or money: understanding geographical imbalances in the health workforce

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Geographical imbalances in the health workforce have been a consistent feature of nearly all health systems, and especially in developing countries. In this paper we investigate the willingness to work in a rural area among final year nursing and medical students in Ethiopia. Analysing data obtained from contingent valuation questions for final year students from three medical schools and eight nursing schools, we find that there is substantial heterogeneity in the willingness to serve in rural areas. Using both ordinary least squares and maximum likelihood regression analysis, we find that household consumption and the student's motivation to help the poor are the main determinants of willingness to work in a rural area. We carry out a simulation on how much it would cost to get a target proportion of health workers to take up a rural post.

Keywords Health care delivery, health workers, labour supply, public service

KEY MESSAGES

- In investigating the willingness to work in a rural area among final year nursing and medical students in Ethiopia, we find that there is substantial heterogeneity in the willingness to serve in rural areas, and that the main determinants are household consumption and the student's motivation to help the poor.
- Preference for an urban job was found to be strongly related to access to education for children, and chances of promotion and access to training for the health worker him/herself.
- A simple budget simulation shows that it should be affordable to get graduating health workers to take up a rural post, even when increasing the health workforce substantially.

'There is an obvious difference between rural and urban postings. Working in rural areas involves helping the poor . . . in urban areas, one can learn, have more income, have a good school for one's children.'
(Health worker in Ethiopia)

Introduction

Health services depend critically on the size, skills and commitment of the health workforce. Human resources have been a long-standing policy concern in both developed and developing countries. Recent reports have stated that human resources comprise a fundamental constraint to improving health outcomes and achieving the Millennium Development Goals (WHO 2002; USAID 2003; Joint Learning Initiative 2004; World Bank 2004). While human resource challenges take many dimensions, this paper focuses on the specific issue of geographical imbalances, a persistent feature of nearly all health systems. Given the obvious relationship between the number of health workers and the capacity to deliver services, both in terms of volume and quality, the distribution of health professionals has implications for equity in access to health services. But it is also an efficiency issue: the under-provision of cost-effective interventions in some areas implies that health outcomes can be improved through a reallocation of resources.

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Ultimately, the difficulties in attracting and retaining staff in rural facilities are rooted in the preferences and choices of health professionals. Evidence from various countries suggests that, while financial rewards are important, they are not the only consideration. In choosing where to work, other factors come into play, including training opportunities, career development prospects, living conditions, colleagues and working conditions, and social, family and security considerations, etc. (Hays *et al*. 1997; Kamien 1998; Peters *et al*. 2002; Shields 2004). Hence, the general preference for work in urban and affluent areas is not surprising. Work in rural areas is often associated with reduced access to training, limited professional interaction with peers, reduced exposure to technical sophistication, heavy responsibilities and workload, social isolation, poor social services, and, in some cases, limited opportunities for income-generation through a second job or other economic activity.

Countries have enlisted a wide range of strategies to redress geographical imbalances in the health workforce. The most direct approach—often referred to as compulsory service or bonding—is to mandate service on specific facilities or locations. But this *dirigiste* approach has proven difficult to manage and enforce in practice. Many schemes have suffered from corruption and favouritism, and this has undermined their legitimacy (Wibulpolprasert and Pengpaibon 2003). But even if these management problems can be overcome, compulsory service may render the health professions less attractive, with potential long-term implications for the workforce. In Indonesia, Sepowski (2004) found that health professionals who *choose* to work in a rural or underserved area, rather than doing so as part of a contractual obligation, are more likely to stay long term.

A less direct but arguably more efficient approach is to rely on economic—financial or non-financial—incentives. These incentives may take many forms, ranging from rural allowances or bonuses, subsidized housing, access to promotion or specialist training, choice of jobs, etc. Although the use of economic incentives is commonplace, there is limited understanding of how effective they are because a proper evaluation of incentive schemes is virtually absent (Sempowski 2004). The scarce evidence suggests that although economic incentives can produce results in short-term recruitment, their success for long-term retention is far less obvious. Anderson and Rosenberg (1990) argue that incentive schemes have limited success if they focus only on financial incentives, while Nigenda (1997), studying the retention of doctors in rural Mexico over the last 60 years, suggests that a financial incentive approach may be expensive.

In recognition of these limitations, some countries have pursued strategies which recognize that health workers (or potential recruits to the health profession) are not homogeneous, and that there is substantial variation in preferences to work in a rural or urban area. They argue that due to differences in background, education, personality and other factors, health workers differ in their views on the relative desirability of urban and rural postings, and have different responses to incentives when choosing between an urban and a rural posting. For example, the US (Rabinowitz *et al*. 1999), Australia (Rolfe *et al*. 1995; Easterbrook *et al*. 1999), Thailand (Wibulpolprasert and Pengpaibon 2003) and Indonesia (Chomitz *et al*. 1998) make special efforts to recruit students with a strong commitment to rural service, and aim to expose students to work in rural areas through job rotation. Experience shows that students recruited from rural areas are more likely to return to rural areas, and that they are more responsive to incentives that encourage working in a rural area (Kristiansen and Forde 1992; Chomitz *et al*. 1998; Laven and Wilkinson 2003). This illustrates the need to take health worker preferences into account, as this may increase the prospect of having a health workforce that is motivated, remains in post and provides quality health care.[1]

Although of considerable interest, international experience with strategies to redress geographical workforce imbalances provides limited operational guidance. What level of financial incentives is needed to make health workers choose a rural posting? What is the relative importance of different job attributes when health workers consider a rural job? The existing literature has little to offer with respect to these questions. In trying to fill this gap, we have to address how information about monetary valuations can be elicited. In seeking to understand the labour market choice of health workers and their willingness to work in a rural area, it is natural to look at actual choices. This has been the approach of a number of studies (Hurley 1990; Kristiansen and Forde 1992; Bolduc *et al*. 1996). Yet, the approach has important limitations. In many cases the government plays an important role in the allocation of health workers, and actual salaries do not reflect personal valuations. In addition, there is usually limited variation in the actual compensation of health workers, especially when the public sector dominates health service provision. Finally, even when there is a market, or the possibility of creating one, market prices or wages will not reflect non-pecuniary benefits, like access to training etc.

Situations such as these have led researchers to rely on contingent valuation and other stated preference methods. The use of contingent valuation has a long tradition in economics, going back to Ciriacy-Wantrup (1947) and Schelling (1968). Its aim is to place a monetary value on a good for which there is no market and, therefore, demand is unobservable. Although contingent valuation methods have been used extensively in areas such as environmental policy (Lockwood 1998), their use in the field of human resources in health is rare. One important exception is the study by Chomitz *et al*. (1998), which uses a stated preference approach to elicit information about the preferences of medical students in Indonesia. They find that moderately remote areas can be staffed using modest cash incentives, but that financial incentives would be prohibitively expensive for staffing very remote facilities. They also find that doctors who were recruited to medical school from the Outer Islands of Indonesia are more willing to serve in remote areas than their counterparts from Java, and that they required a lower financial incentive to accept a remote posting.

The stated preference approach is especially valuable in a context where preferences are not observed, for example because health workers cannot choose their posting, or the wages of health workers are unaffected by their preferences. This is typically the case in a health sector where the

government plays a central role in the allocation of health workers, their employment and wage setting. The stated preference approach then provides data that cannot be obtained in any other way. It also allows us to go beyond financial incentives and analyse the role of issues like access to schools for children, access to training opportunities, etc.

The remainder of the paper is organized as follows. First we present the basic characteristics of the data, how we collected the contingent valuation data and details of the survey. We then discuss the econometric strategy, before presenting the results. The policy implications are then discussed and a simulation exercise carried out, before concluding.

The Ethiopian context and the cohort survey

The cohort survey was implemented in Ethiopia, a country with some of the worst health outcomes in the world. The health challenges are particularly severe in the rural areas; the majority of the population (83%) lives in rural areas and there are substantial urban–rural disparities in living standards—the Household Income and Expenditure Survey 2000 indicates that average annual household expenditure in urban areas is almost twice that in rural areas (CSA/ORC Macro 2001). Endeavours to meet these challenges are hampered by the limited nature of health resources. Public spending is very low: in a recent report per capita health expenditures are estimated at around US$4, or US$25 PPP, which is significantly lower than the sub-Saharan Africa average of US$42, or US$89 PPP.[2] Moreover, Ethiopia not only has a very low number of health workers per capita—on average 11 nurses and two physicians per 100 000 inhabitants, which is low even for African standards—but also a distribution of health workers that is biased towards urban areas.[3]

Health workers in Ethiopia face a labour market with specific characteristics. Most important is the central role of the government. Wages are set by policy makers and therefore may not reflect the market value of labour. The government also plays a direct role in the allocation of health workers. Students who have been funded by the government—which is the vast majority—have an obligation to serve time working for the funding government agency (regional or federal) and are randomly allocated to posts through a lottery, with those funded by a regional government allocated to a post in that region.[4] Although the allocated job cannot be changed in principle, we find evidence that students bend the rules (see Lindelow and Serneels 2006). Only after having served the obligatory term in a government facility can health workers receive a release certificate from the public sector. This certificate is legally required to work in the private health sector. Private facilities at the clinic level are now commonplace, but only in urban areas. In general, the Ethiopian health sector is dominated by the public sector, with the exception of pharmacies and drug stores.

We use data from a survey with 219 nursing students in the final year of their training and 90 medical students just before they enter their internship. The nursing students represent an estimated 16% of the 2003/4 cohort, while the medical students represent 49% of the 2003/4 cohort. They are sampled from eight clinical nursing schools and three medical faculties from around the country. The sampling strategy was different for medical and nursing students, but in both cases we followed two-stage stratified sampling: we first selected the school and then randomly selected students from a complete list in each school.

For the medical schools we have full information about the sampling frame. From the 192 students enrolled in 2003/4, we randomly select 30 students in each school, to capture different school effects and cover the different regions. For nursing students we focus on clinical nurses with 2 years of training, who represent an estimated 67% of the total number of nurses. We composed a complete list of 20 clinical nursing schools in four regions: Addis Ababa, Amhara, Oromiya and SNNPR. The sample was stratified by type of school, distinguishing four types: state schools funded by the central government, state schools funded by the regional government, NGO or not-for-profit schools, and private (for-profit) schools.[5] Three nursing schools were dropped from the sample.[6] We then selected all three nursing schools related to a university and funded by the central government, two out of three nursing schools funded by the regional government, both NGO schools and one private school. In each school, we selected as close as possible to 30 students.[7]

Apart from the self-administered (supervised) questionnaire, the students also took a medical knowledge test.[8] In the survey, we measure the willingness to work in a rural area and also try to measure individual motivation. In the remainder of this section, we discuss both in turn.

In the past there has been controversy over how to measure contingent valuations properly (see Diamond and Hausman 1994; Hanemann 1994). Following the Exxon Valdes incident, a committee of experts was appointed by the National Oceanic and Atmospheric Administration (NOAA) and was asked to produce a report on best practice for reliable contingent valuation (see Portney 1994). The conclusions of the NOAA Committee can be summarized as follows: (i) use probability sampling; (ii) avoid mail surveys; (iii) interview people in a place that is related to the question analysed in the contingent valuation survey; (iv) formulate the question in a specific and realistic context; and (v) use closed-end questions or a variant thereof.

In writing our instruments we follow NOAA recommendations as close as possible. First, we followed stratified sampling, at the first stage selecting all relevant schools (bar one) and at the second stage selecting the students in each school randomly. Secondly, the questionnaires were administered in the schools in the presence of members of the team. Thirdly, the contingent valuation question was specific and the context was realistic. The salary of reference is the actual salary of health workers when they start their career. In addition, since students are close to their graduation, it is very likely that they have already thought about the issue before participating in the survey. Finally, since the sample size is small we use a 'payment card' type of question.[9] The question is the following:

> Imagine that when you finish your studies you get two jobs as a health worker in the public sector, one in Addis Ababa

and one in a rural area 500 km from Addis Ababa. Both contracts are for at least 3 years. Your monthly salary for the job in Addis Ababa would be 700 Birr. Which job would you choose if your monthly salary for the rural job would be $ amount.[10]

This question is repeated for a range of salaries, with $ taking the value of 600, 700, 800, 900, 1000 and 1200 respectively, and is asked both for a rural (200 km from Addis Ababa) and a remote posting (500 km from Addis Ababa). For medical students the basic salaries are 1200, 1300, 1500, 1700, 1900 and 2100. Figure 1 plots the cumulative distribution (CDF) of the contingent valuation question at the different salary levels. As expected, the CDF for a rural post (200 km from Addis Ababa) dominates the distribution for a remote post (500 km away from Addis Ababa). The graph illustrates that at the current monthly wage of 700 Birr, about one-third of the new nurses are willing to work in a remote area. As the rural wage increases, the number of nurses willing to work in a remote area rises, but not in a linear way. Beyond 1000 Birr, marginal take up decreases.

Figure 2 plots the density function or distribution of the reservation wage to work in a rural area separately for nursing and medical students. The distribution for nurses is bimodal, indicating that there are two groups of nurses: those willing to work in a rural area for a relatively low wage, and those willing to work for a relatively high wage. The distribution for medical students is heavily skewed to the left, indicating that most of them only want to work in a rural area for a relatively high salary. As is usually the case with contingent valuation data, our data are censored, in our case from above. Seventeen per cent of nursing students and 34% of medical students have a reservation wage that is higher than the maximum salary we presented.[11]

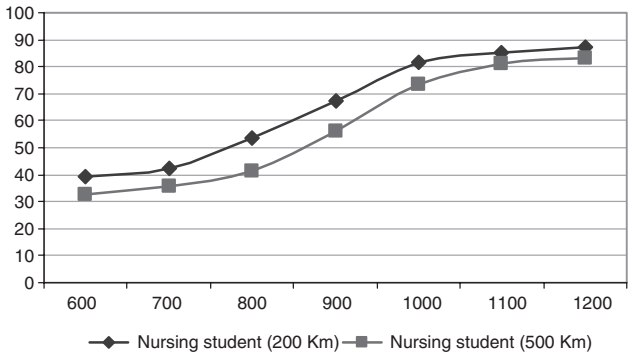

Figure 1 Cumulative distribution for the reservation wage for rural (200 km) and remote (500 km) posts

Figure 2 Density function of the reservation wage to work in a rural post (500 km)

Econometric method

The econometric analysis of contingent valuation data depends on the chosen formulation of the question.[12] In the case of an open-ended question, the contingent valuation is usually analysed by regressing it on a set of explanatory variables using ordinary least squares (OLS). We will use this approach as a benchmark. To analyse the answers from closed-ended questions, researchers initially used to run a simple logit or probit model where the explanatory variable was the offer, or the log of the offer. However, Cameron and James (1987) show that there is an important difference between the traditional logit/probit model and the dichotomous choice generated by a closed-ended questionnaire. In particular, while in the traditional logit (probit), the βs and the σ cannot be identified separately, this is possible in the statistical model generated by the closed-ended contingent valuation model.[13]

Below we develop a framework to analyse our particular case. For each row in the payment card—or each salary w_1—the individual can choose between accepting the offer to take up a rural post, $rp = 1$, or not accepting the offer, $rp = 0$. Assuming an indirect utility function $v(rp, w; x)$ where w is the salary on offer and x represents other variables that allow the function to shift, we can write the following for nurses:

$$\begin{aligned} \Pr(rp = 1|x) &= \Pr(v(1,w_1; x) - v(0,700; x) > \zeta_0 - \zeta_1) \\ &= F(-\Delta v) = F(\Delta w; \beta) \end{aligned} \quad (1)$$

where 700 is the reference salary and ζ_0 and ζ_1 are error terms. This indicates that—while controlling for the variables

x throughout, which include variables like age, education, income etc.—the probability of accepting a rural post with wage w_1 equals the probability that the utility v derived from accepting the rural post with wage w_1 exceeds the utility derived from not accepting the safe offer with base salary 700. For simplicity, we also assume that the function reflecting the difference in utility is log-linear in the difference of wages:

$$\Delta v = \delta \ln(\Delta w) + x'\beta \tag{2}$$

However, in the payment card type of question, an individual can choose the reservation salary from a *range* of options. We therefore need to compare for every wage offer the utility derived from that wage offer with the utility derived from the wage offer just below. The probability that the willingness to accept the offer lies in the interval (w_m, w_{m+1}) is then given by:

$$\begin{aligned}\Pr(rp_m = 1) &= \Pr(v(1,w_m;x) - v(0,700;x) > \zeta_0 - \zeta_1) \\ &\quad - \Pr(v(1,w_{m-1};x) - v(0,700;x) > \zeta_0 - \zeta_1) \\ &= F(w_m;\beta) - F(w_{m-1};\beta)\}\end{aligned} \tag{3}$$

Doing this for each row (salary), gives us a recursive probit model. The parameters of this model can be estimated using maximum likelihood, where the log-likelihood function is:

$$\begin{aligned}\ln L(\delta,\beta) = \sum_{i=1}^{N} \Bigg\{ & I_i^0[F(w_1;\delta,\beta)] + \sum_{m=2}^{M-1} I_i^m[F(w_{m+1};\beta) - F(w_m;\beta)] \\ & + I_i^M[1 - F(w_M;\delta,\beta)] \Bigg\}\end{aligned} \tag{4}$$

with the indicator variable I_i^m taking the value 1 if individual i accepts salary m but not salary $m-1$. The big advantage of this estimation method is that it uses all the information provided by the 'payment cards' and thus gives more robust results, and that robustness can be verified since σ is estimated individually. Using equation (4), we analyse the determinants of accepting a rural posting at a salary w.

Empirical results

Before considering the estimation of the above econometric specification we present the results of OLS estimation. The model takes as the dependent variable the reservation wage at which a post in a rural area is accepted and includes as independent variables those normally included in a wage regression, as well as individual characteristics that possibly affect the willingness to work in a rural area. We run the following regression:

$$\begin{aligned}\ln rw_i = x_i'\beta + u_i = {} & \beta_0 + \beta_1 AGE_i + \beta_2 FEMALE_i + \beta_3 EXP_i \\ & + \beta_4 TSCORE + \beta_5 ADDIS_i + \beta_6 DIST_i + \beta_7 HELPPOOR_i \\ & + \beta_8 TIGRAY_i + \beta_9 CATHOL_i + \beta_{10} PROTEST_i \\ & + \beta_{11} DOCTOR_i + u_i\}\end{aligned} \tag{5}$$

where *EXP* is the expenditure of the household, *TSCORE* is the score in the medical tests (in percentage points), *ADDIS* is a dummy variable that takes the value one if the student has a permanent address in the capital, *DIST* is the walking distance to primary school at age six, *HELPPOOR* is our control variable for motivation, and *TIGRAY, CATHOL* and *PROTEST* are dummy variables that characterize the ethnicity and religion of the student. The descriptive statistics for these variables are reported in Table 1.

Since our subjects are students, 90% of whom have never worked before, we use an estimate of expenditures of the parental household, *EXP*, as a proxy for other household income.[14] We use the method suggested by Grosh and Baker (1995) and Ahmed and Bouis (2001) to predict parental household expenditure. In our questionnaire we included questions on asset ownership drawn from the Household Income Expenditure and Welfare Monitoring Survey (HICE/WMS) 2000, a nationally representative survey, conducted by the Central Statistical Authority (CSA), which collects detailed data on household consumption and expenditures. We run the weighted regression $EXP_i = \sum_{a=1}^{p} \alpha^a D_i^a + u_i$ on the HICE/WMS 2000 data to obtain estimates of $\hat{\alpha}^a$, the coefficient for each asset, which we then use to predict EXP_i for our own sample.[15] The regression has an R^2 of 0.17 and correctly predicts almost all observations within a 95% confidence interval. The average student comes from a household with predicted annual expenditures of 6606 Birr (US$777), which corresponds to monthly expenditures of 550 Birr (US$65) or daily expenditures of 18 Birr (US$2). The mean estimated household expenditure for our sample is slightly higher than the mean for the entire population, which is 5403 Birr (US$635) per year.

To get an insight into whether poorer qualified health students are more likely to serve in a rural area, we conducted a medical knowledge test. The variable *TSCORE* is the score on this test, expressed as a percentage, and is our proxy for cognitive skills.

ADDIS and *DIST* capture the individual's familiarity with rural areas. Students who grew up or whose parents are still living in a rural area may be more likely to go back.

In our analysis, we also control for individual motivation. Past studies indicate that this may have an effect on career choice, especially in the health sector.[16] Since there is no clear agreement on how to measure motivation, we take a pragmatic approach focusing on the context of the medical profession and rural posting. In this context, we expect the motivation to help the poor to play an important role. *HELPPOOR* is our proxy for individual motivation and is an indicator variable that takes the value one when 'opportunity to help the poor' is ranked as the most important job characteristic. Using this definition, we find that 26% of the health workers have high intrinsic motivation (see Table 1).[17]

We also control for ethnicity (*TIGRAY* is the political group in power) and for religion (including *CATHOL* and *PROTEST*) since this may affect the willingness to work in a rural area. The majority religion is Ethiopian Orthodox and a large group is Muslim.

Table 2 shows the results of estimating equation (5) by OLS.[18] The first two columns show the results for nursing students only, while columns 3 and 4 report the results for nursing and medical students together. The results in the first two columns indicate that the reservation wage is lower the older the individual and the higher his intrinsic motivation. In contrast, coming from a wealthier family and having a permanent address in Addis Ababa imply a higher reservation wage, although the latter has low significance. In columns 2 and 4, being catholic tends to lower reservation wages, but the result is also unstable. Columns 3 and 4 show that the estimation results for the

Table 1 Descriptive statistics

Variable	Description	Mean (std dev)
Individual characteristics		
AGE	Age of the individual	23 (3)
FEMALE	Dummy variable indicating whether the individual is female	0.36 (0.48)
EXP	Predicted annual household consumption of parental household	6606 Birr* (1534)
ADDIS	Indicator variable for living in Addis Ababa	0.25 (0.45)
DIST	Distance walking to primary school at age 6 (in minutes)	31 (27)
TSCORE	Score on medical knowledge test	0.49** (0.11)
HELPPOOR	Indicator variable that 'opportunity to help the poor' is most important job characteristic	0.26 (0.44)
TIGRAY	Dummy variable indicating ethnicity is Tigray	0.06 (0.24)
CATHOL	Dummy variable indicating individual is of catholic religion	0.10 (0.30)
PROTEST	Dummy variable indicating individual is of protestant religion	0.21 (0.41)
DOCTOR	Dummy variable indicating individual is medical student	0.29 (0.45)
Job attributes		
PROMO	Dummy variable indicating promotion opportunities is the most important reason to prefer to work in rural or urban area	0.27 (0.44)
OTHINC	Dummy variable indicating that access to other income opportunities is the most important reason to prefer to work in rural or urban area	0.11 (0.32)
EDU	Dummy variable indicating that access to good education for children is the most important reason to prefer to work in rural or urban area	0.10 (0.30)
HEALTHC	Dummy variable indicating access to good health care is the most important reason to prefer to work in rural or urban area	0.12 (0.32)
WORKPL	Dummy variable indicating good physical conditions of workplace is the most important job characteristic	0.09 (0.29)
TRAINING	Dummy variable indicating access to further training is the most important job characteristic	0.33 (0.47)

*US$777; **maximum score is by construction, 48.

sample that includes both nursing and medical students are very similar.[19] The dummy for doctors is significantly different from zero, confirming that doctors have a significantly higher reservation wage to accept a post in rural areas.

Table 3 reports the results of the maximum likelihood estimation of the payment cards as set out in equation (4).[20] Columns 1 and 2 show the results for nursing students only, and columns 3 and 4 for nursing and medical students together. Two variables are highly significant (1% level): expenditures of the parents' household (*EXP*) and willingness to help the poor (*HELPPOOR*), our proxy for intrinsic motivation. The first indicates that students from better-off households are less likely to want to work in a rural area, presumably because they can afford to be more choosy about a job, not facing a binding budget constraint. The second result suggests that students who have higher intrinsic motivation are more likely to work in a rural area.[21]

A further interesting result is that although women tend to be less likely to want to work in a rural area (a fact usually explained as being related to personal safety concerns of women in rural and isolated areas), the effect is not significant when controlling for other characteristics.

We find no evidence that less-skilled health workers—those with lower test results—self-select into rural areas. However, being more familiar with rural areas increases one's willingness to work there, but only weakly: having a permanent personal address in Addis Ababa decreases the reservation wage to work in a rural area and is significant at the 10% level; but distance from school at age 6 is not significant.

The effect of Tigray is not significant. Catholics are more likely to have a preference for working in rural areas, but this may be because they attend a (catholic) NGO nursing school that encourages them to do so. Other religions have no effect.

As pointed out earlier, one of the advantages of maximum likelihood estimation of the payment cards is that the standard deviation σ is estimated separately. It is interesting to note that the estimate of σ is very stable across specifications, confirming that the results are robust.

The preference for an urban job

As set out in the introduction, we find that about two-thirds of the nursing students and 90% of the medical students prefer to work in an urban area in the long run. So far we have concentrated on the individual characteristics that determine why new health workers, choosing their first job, do or do not want to work in a rural area and we have paid little attention to the job attributes associated with an urban or rural posting. What job attributes make the urban sector so attractive? To see this, we model the premium to work in a rural area (reservation wage—the reference wage) on variables indicating the rank of the job characteristic by each individual. Since the choice is between two public sector jobs, job stability and salary are the same (by design) and do not enter the equation. We focus on the individual evaluation of the following job characteristics: promotion opportunities (*PROMO*), access to other income opportunities (*OTHINC*), access to good education for children (*EDU*), access to good health care (*HEALTHC*),

Table 2 Ordinary least squares estimation of the reservation wage to work in a rural area

	Nursing students		Nursing and medical students	
AGE	−0.02	−0.02	−0.02	−0.01
	(2.81)***	(2.23)**	(2.94)***	(2.08)**
FEMALE	0.03	0.03	0.03	0.03
	(0.60)	(0.63)	(0.69)	(0.82)
EXP (in 000)	**0.04**	**0.04**	**0.03**	**0.03**
	(3.00)***	**(2.96)*****	**(2.84)*****	**(2.74)*****
TSCORE	−0.21	−0.12	−0.16	−0.11
	(0.85)	(0.48)	(0.79)	(0.54)
ADDIS	**0.11**	**0.11**	**0.07**	**0.07**
	(1.89)*	**(1.96)***	**(1.91)***	**(1.91)***
DIST (in 000)	−0.06	−0.16	−0.13	−0.24
	(0.07)	(0.21)	(0.21)	(0.41)
HELPPOOR	**−0.17**	**−0.14**	**−0.14**	**−0.12**
	(3.65)***	**(2.84)*****	**(3.93)*****	**(3.14)*****
TIGRAY		0.11		0.09
		(1.12)		(1.34)
CATHOL		−0.12		−0.14
		(1.81)*		(2.44)**
PROTEST		0.07		0.04
		(1.35)		(1.00)
DOCTOR			0.83	0.80
			(16.22)***	(15.75)***
Constant	7.03	6.91	7.03	6.92
	(33.57)***	(32.77)***	(40.39)***	(39.59)***
Observations[a]	158	158	220	220
R-squared	0.20	0.24	0.75	0.76

Absolute value of t statistics in parentheses.
*significant at 10%; **significant at 5%; ***significant at 1%.
[a]The number of observations is smaller than the initial sample size because of the combined non-response to some questions. Using a Heckman selection model that includes a selection term for non-response confirms that the results do not suffer from a selectivity bias.

Table 3 Maximum likelihood estimation of the reservation wage to work in a rural area (payment cards)

	Nursing students		Nursing and medical students	
AGE	−0.01**	−0.01*	−0.01**	−0.01
	(−2.43)	(−1.77)	(−2.52)	(−1.62)
FEMALE	0.02	0.01	0.02	0.02
	(0.33)	(0.19)	(0.51)	(0.57)
EXP (in 000)	**0.05**	**0.05**	**0.04**	**0.04**
	(3.29)***	**(3.24)*****	**(3.12)*****	**(3.06)*****
TSCORE	−0.38	−0.31	−0.28	−0.25
	(−1.26)	(−0.99)	(−1.20)	(−1.04)
ADDIS	**0.13**	**0.15**	**0.11**	**0.10**
	(1.76)*	**(1.87)***	**(2.17)****	**(2.07)****
DIST (in 000)	−0.01	−0.01	−0.01	−0.03
	(−0.06)	(−0.17)	(−0.16)	(−0.38)
HELPPOOR	**−0.20**	−0.14***	**−0.17**	−0.12**
	(−3.04)***	**(−2.04)*****	**(−3.20)*****	**(−2.30)*****
TIGRAY		0.17		0.15**
		(1.63)		(2.00)
CATHOL		−0.23**		−0.21***
		(−2.32)		(−2.73)
PROTEST		0.06		0.06
		(1.07)		(1.26)
DOCTOR			0.88***	0.86***
			(13.70)	(13.30)
Constant	6.58	6.52	6.77	6.69
	(18.20)	(17.58)	(23.46)	(22.85)
σ	0.28	0.27	0.25	0.24
	(11.81)	(11.98)	(14.63)	(14.82)

Absolute value of t statistics in parentheses.
*significant at 10%; **significant at 5%; ***significant at 1%.

physical conditions of the work place (*WORKPL*), and access to further training (*TRAINING*). Table 1 reports the descriptive statistics for these variables. The model we use is very simple:

$$P_i = \beta_0 + \beta_1 PROMO_i + \beta_2 OTHINC_i + \beta_3 EDU_i + \beta_4 HEALTHC_i + \beta_5 WORKPL_i + \beta_6 TRAINING_i + \beta_7 DOCTOR_i + \sum_j \beta_j X_{ij} + u_i$$

where P is the premium required by an individual to work in a rural area. X is the individual characteristics controlled for; they are the same as those included in the model described by equation (5). The premium follows the same distribution as the reservation wage, plotted in Figure 2. Table 4 shows the results for estimation of equation (6). The first column reports the results from OLS estimation for nurses only,[22] while column 2 reports the results for both doctors and nurses. Because the variables are not measured in absolute units, the usual coefficients have no interpretation; we therefore report the x-standardized coefficients. A large x-standardized coefficient indicates a high relative importance of the underlying variable.

The individual evaluations of three attributes are significant: access to education for children, promotion opportunities and access to training. Access to education for children has the highest significance and the highest x-standardized coefficient, indicating that it is the most important attribute. 'Opportunities for promotion' has the second highest coefficient for nursing students, and comes third when including doctors, but it remains highly significant. Access to training seems especially relevant for medical students. The results confirm those from qualitative research reporting that health workers 'fear to get stuck in a rural area', but they also show that reasons beyond professional isolation are important, namely living conditions for their families.

Policy implications and simulation

In this section we carry out a number of simple simulations to quantify how much it would cost to get a target number of senior nurses and doctors to take up a rural post. As stated previously, Ethiopia has one of the lowest health worker/

Table 4 Ordinary least squares estimation of the required wage premium to work in a rural area

	Nursing students	Nursing and medical students
PROMO	**49.35**	**43.06**
	(2.61)**	**(2.66)****
OTHINC	19.72	13.70
	(1.11)	(0.84)
EDU	**61.87**	**51.65**
	(3.52)**	**(3.33)****
HEALTHC	−12.84	−8.29
	(0.65)	(−0.50)
WORKPL	−3.67	−3.27
	(−0.19)	(−0.20)
TRAINING	**29.18**	**43.13**
	(1.45)**	**(2.55)***
Observations	148	210
R-squared	0.38	0.55

The reported coefficients are x-standardized coefficients; the coefficient for the constant is not reported. The regression includes all control variables included in the model in Table 3.

Absolute value of t statistics in parentheses.

*significant at 5%; **significant at 1%.

population ratios. The government is well aware of this and has invested substantially in human resources for health over the last years. The number of nurses has increased from 3168 in 1998 to 8572 in 2002, while the number of physicians has increased from 1415 to 1888 over the same period. Together, senior nurses and doctors represent about 39% of the health workforce.

The following simulations are presented. First, we determine the premium that is required to get 80% of senior nurses and doctors taking up a post in a rural area, and the corresponding increase in the health budget needed. In a second simulation we analyse how this premium changes if the underlying distribution of health worker characteristics is altered. We consider two cases: first that more health workers come from a rural area, and secondly that more health workers are highly motivated. Finally, we calculate how much it would cost to get 80% of the entire health workforce into rural areas, assuming that they require the same salary premium in percentage as the cohort studied.

Throughout our simulations, we make two assumptions. The first is that health workers can choose freely between two contracts: work in an urban area and earn the base salary (contract U), or work in a rural area and earn a higher salary (base salary + premium, contract R). We also assume that our sample reflects the distribution of characteristics of the entire population of new nurses and doctors (household background, motivation etc.). Because of the limitations of the underlying data, the simulation also has a number of limitations. There are three relevant issues. First, the data are censored: 17% of nursing students and 34% of medical students have a reservation wage higher than the maximum salary we present, but we do not know how much higher. Secondly, the contingent valuation question, following best practice, was specific, focusing on a 3-year contract and 500 km from the capital. Although this would cover most remote postings, we do not know what the premium would be for a rural post further away from the capital or for a contract lasting longer than 3 years. Thirdly, we surveyed newly qualified nurses and doctors only, and have no information on the reservation wages of more experienced health workers.

The first limitation is only relevant for the doctors. Since the reservation wages for nurses are censored only at the 83rd percentile, we can use the observed premium to get 80% in rural areas. For medical doctors, however, the data are censored at the 66th percentile; therefore we will predict the premium at the 80th percentile. To address the second limitation we report required changes in the health budget *per year*. The third restriction is addressed by focusing on nurses and doctors just starting their careers. Despite these limitations, the exercise illustrates some important policy implications.

Figure 1 shows that at the current monthly wages,[23] about one-third (36%) of the surveyed nurses and 4% of the doctors are willing to work in a remote area. Since there is no clear target on the number of health workers in rural areas, we assume that the distribution of health workers should reflect the distribution of the entire population. This is a crude approach but has the advantage of being transparent and simple. Under this assumption, with 83% of Ethiopia's population living in rural areas, we aspire to get 80% of health workers taking up a rural post. To reach this, we find that a nurse's salary needs to increase to 1100 Birr per month, or a premium of 57%, while doctors need to be paid 2562 Birr per month, or a premium of 83%. This premium is also a measure of the average welfare cost imposed upon a health worker by the current random allocation system. To get these 80% of health workers taking up a rural post, health expenditures would have to increase by 0.9% per year.

Would the premium and required health budget be different if we consider an alternative distribution of health worker characteristics? From the analysis of the empirical results, we learned that students with a rural background have lower reservation wages to work in a rural area. Therefore, if more students come from rural areas, we expect a lower average premium and corresponding budget increase. If we increase the number of nurses with a rural background from the current 60% to 90%, and the number of doctors with a rural background from 80% to 90%, the required premium to get 80% of health workers taking up a rural post is now 49% for nurses and 71% for doctors (expressed as a percentage of the respective base salary). Applying these premiums to the current cohort would require a budget increase of 0.8% per year (instead of 0.9% before). A change in distribution of motivation of health workers also has a limited effect. When we assume that 90% of all nurses and doctors have high intrinsic motivation, i.e. want to help the poor, instead of the current 29% of nurses and 18% of doctors, we find that the required premium is now 44% for nurses and 75% for doctors (as a percentage of the respective basic salaries), implying a corresponding budget increase of 0.7%.

However, so far, the simulations have been based on the assumption that only new cohorts of health workers are given the choice between the two contracts. In reality, existing health

workers will have to be offered the same choice, since it would be impossible to implement salary premiums only for the new cohort. But given that we do not have any information on the reservation wages of the existing health workers, it is difficult to make a precise simulation of the premium and the implied health budget that this requires. In what follows, we consider that existing health workers can choose between the contracts R and U, where the rural contract (R) pays the same percentage premium as calculated above (57% for nurses and 83% for doctors). With the average monthly salary for a professional nurse being 1569 Birr, and that for a general practitioner 2010 Birr, we find that to offer the entire population of nurses and doctors a premium of, respectively, 57% and 83% of their salary, the health budget needs to increase by 42% per year. If, however, we increase the number of health workers from a rural background in line with the exercise above, and we assume that they require a similar percentage premium as new health workers, we find that the required health budget increase is 30% per year. If we assume a different distribution of motivation, as set out above, for all health workers, the budget increase is 39%. Both suggest that there is a benefit from taking into account health workers' preferences.

The above analysis focuses on how health worker characteristics affect the salary premium required to work in a rural area. A complementary approach is to focus on offering other job attributes, for example access to school for children, and access to training and promotion opportunities. This requires a detailed costing exercise and falls outside the scope of this paper.

Conclusion

This paper analyses the willingness to work in a rural area of final year nursing and medical students in Ethiopia. We use contingent valuation data, obtained from 'payment cards' questions and find that there are two main determinants of the willingness to work in a rural area: the income of the parents' household and the students' willingness to help the poor. The first result is in line with results from labour economics which show that income from other household members affects labour decisions (see, for example, Mroz 1987). The second result indicates that a health worker's motivation has a strong influence on her preference for a rural posting. We also find that medical students are less likely than nursing students to prefer to work in a rural area. The results are very robust: they are very similar when using OLS estimation or when using maximum likelihood estimation that uses the full information of the 'payment card'. The latter method also allows a direct estimate of the standard deviation, which appears to be constant across different specifications, a further sign of the robustness of the results.

Since two-thirds of the nursing students and 90% of the medical students want to work in an urban area in the long run, we investigate what makes an urban job so attractive. Analysing the premium to work in a rural area, we find that this is explained, in particular, by access to education for children and promotion opportunities. For doctors, access to further training seems to play an important role as well. This points to potential alternative strategies to attract health workers to rural areas, as there is at present virtually no training or continued education for health professionals in Ethiopia.

To make the policy implications explicit, we carry out a simple thought experiment, where newly trained nurses and doctors can choose between two contracts: an urban post with basic salary or a rural post where they receive basic salary plus premium. The main message of this simulation is that it should be affordable to get graduating health workers to take up a rural post, even when increasing the health workforce substantially. It also suggests an alternative approach to the current job 'lottery', where health workers are not able to choose.

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Endnotes

[1] The issue of preferences changing over time has remained largely unstudied; we hope to address this in future analysis using the data from follow-up visits to the same students.

[2] This is the estimated average for the 1990s (Serneels *et al*., forthcoming). PPP = purchasing power parity.

[3] There are no detailed figures available for the urban–rural distribution, but from partial analysis it is clear that the distribution is biased in favour of urban areas. Data from the survey used in this paper suggest that 67% of nursing students and 92% of doctors prefer to work in an urban area in the long term. In the context of Ethiopia, this implies a strong preference for Addis Ababa.

[4] Students from private schools formally do not have an obligation. But private for-profit schools are a very new phenomenon (only one school is listed to transfer from pre-accreditation to full license; the school is part of the sample, and all the others remain pre-accredited), and students from non-profit schools often participate in the lottery.

[5] None of the private schools has full accreditation; the maximum they have is 1 year pre-accreditation. Although local health sector specialists and officials zdid not see a need to take the private schools into account, we decided to include one private school with a strong reputation, because it is likely to receive full accreditation in the near future. Other private schools were not willing to communicate the number of students enrolled.

[6] In one school, the students were engaged in field work and not available at the time of the survey, but since similar activities take place at the other schools at a different time of the year, dropping this school does not introduce a sampling bias. Two other schools were dropped on the grounds that they ran a programme for experienced health workers, and that the preferences of the health workers have already been shaped by their experience in the labour market.

[7] In two cases, there were not enough students in the schools, so we ended up having less than 30 students. In one case, 32 students showed up, and we decided to include the extra two to somehow compensate for the loss of observations in the two other schools.

[8] The questionnaire was designed in English and translated by a professional translator into Amharic; both versions were adapted after the pilot. All students were presented with the option to take the Amharic or the English version of the questionnaire. The test was prepared by a team of health professionals from Addis Ababa University, under supervision of Gebreselassie Okubaghzi and Agnes Soucat to ensure that it takes both the curriculum and Ethiopian conditions into account. On their advice, and after a pilot, the medical test was conducted in English. For detailed information on the survey and its instruments, see Serneels *et al*. (forthcoming).

[9] Contingent valuation questions can take three basic forms: open-ended, closed-ended (also called referendum) and 'payment card'. The typical open-ended questions take the form: 'What is the most you would be willing to pay for…?'. However, experimental evidence has shown that this formulation has a high hypothetical bias (Harrison 2002). Closed-ended questions ask individuals for their willingness to pay a particular amount of money (x dollars). In general respondents are presented with a random value and have to answer yes or no. If there is only one question, this is called a single-bound closed-ended question. More sophisticated versions use a follow-up question phrased in the same terms but offering a higher (or lower) amount depending on the answer of the individual (called double-bound) (Cameron and Quiggin 1994; Alberini 1995). The 'payment card' goes one step further and asks the individual to answer yes or no for a list of different amounts.

[10] One Birr is approximately US$0.125.

[11] The validity of the reservation wages obtained from contingent valuation is supported by two additional results. We asked the students whether their long-term preference is to work in an urban or a rural area, and what they think their employment situation will be in 5 years. The answers to both questions are highly correlated with the reservation wages obtained from contingent valuation, with correlation coefficients of −0.43 and −0.83, respectively.

[12] The choice between using closed-ended questions or 'payment cards' depends on several factors. Because of their specific nature, closed-ended questionnaires 'eat up' a lot of data. Since the identification of an effect rests on the random amounts offered to different individuals, a large sample is needed to achieve statistically significant effects. The results are therefore more likely to be misleading when a single closed-ended question approach is applied to a small sample. See also Cameron and Huppert (1989).

[13] The reason is the following. Imagine that we ask individuals to report their willingness to pay an amount of taxes T in order to enjoy a new national park. If they accept to pay that amount then $I=1$. Otherwise $I=0$. Then $I_i = 1 \Rightarrow \Pr(T_i^* > T_i|x_i)$ where T_i^* is the unobserved upper limit of the willingness-to-pay of individual i. The willingness to pay is a function of some variables which we can group under $x_i \cdot T_i^* = x_i'\beta + u_i$ where u_i follows a normal distribution. By the usual reasoning in probit models then:

$$\Pr(T_i^* > T_i|x_i) = \Pr\left(x_i'\beta + u_i > T_i\right) = \Pr\left[\frac{u_i}{\sigma} > \frac{T_i - x_i'\beta}{\sigma}\right] = 1 - \Phi\left[\frac{T_i - x_i'\beta}{\sigma}\right].$$

Since T_i is the value of the offer, we can identify the parameter of T_i as $-1/\sigma$ and the parameters of the x's as β/σ. Since invariance is one of the properties of the maximum likelihood estimator, we can transform the coefficients to obtain the parameters we are interested in. The calculation of the standard deviation of the parameters β is a little more convoluted. There are basically two alternative approaches: either one can estimate a simple probit and use the Delta method to calculate the standard error of the transformed coefficients; or one can programme the likelihood function and use a non-linear maximization routine to obtain estimates of β and the standard deviation σ.

[14] We also considered a variable for own current expenditures, but it had no statistically significant effect in any of the estimations.

[15] Where D_i represents a dummy variable indicating whether the asset is present in the household. The regression uses population weights as calculated by the Central Statistical Authority. Since the estimates of the coefficients are relatively sensitive to outliers, we exclude the richest 10% of households in our prediction and only consider households with expenditures equal to or below 10 000 Birr (US$1176) per year.

[16] Deci (1975) was one of the first to recognize the role of professional commitment, or intrinsic motivation, while Dixit (2002) and Wilson (1989) emphasize its role in organizations and its importance for public service delivery. Benabou and Tirole (2003) also attribute a central role to intrinsic motivation and contrast it with motivation triggered by extrinsic incentives. Studies applied to the health sector also underline the importance of worker motivation.

[17] The importance of motivation is best reflected in the Hypocratic Oath: 'treat the sick to the best of one's ability'. The variable we use is based on a pre-coded survey question about the relative importance of different job attributes. All listed attributes are driven at least partially by extrinsic motivation (career concerns, salary etc.), with the exception of 'opportunity to help the poor'. The intrinsic motivation variable is then constructed as a dummy variable indicating that 'opportunity to help the poor' is ranked highest.

[18] The model passes tests for homoscedasticity and omitted variable. When we include interaction terms of each variable with Medical Student, none of them is significant. To see whether the left and right censoring of our data affect the results, we also run a Tobit model, a Censored Least Absolute Deviation (CLAD) model and trimming models; they confirm the results.

[19] Additional estimations results (not shown in Table 2) point out that the coefficients of the explanatory variables are not different for doctors and nurses, with the exception of the dummy variable and, in some cases, the age.

[20] Estimation was performed using nonlinear routines in TSP 4.5. We included interaction terms between each of the variables and medical student, but none of them is significant.

[21] We find that women in particular, and to some extent those from NGO schools, are more likely to give a high ranking to helping the poor.

[22] Estimation by two-sided tobit gives similar results.

[23] 700 Birr per month for nurses and 1400 Birr per month for doctors.

References

Ahmed A, Bouis H. 2001. *Identifying the needy: proxy means tests for targeting food subsidies in Egypt*. Washington, DC: The International Food Policy Research Institute.

Alberini A. 1995. Efficiency versus bias of willingness to pay estimates: bivariate and interval models. *Journal of Environmental Economics and Management* **29**: 169–80.

Anderson M, Rosenberg MW. 1990. Ontario's underserviced area program revisited: an indirect analysis. *Social Science and Medicine* **30**: 35–44.

Benabou R, Tirole J. 2003. Intrinsic and extrinsic motivation. *Review of Economic Studies* **70**: 489–520.

Bolduc D, Fortin B, Fournier M-A. 1996. The effect of incentive policies on the practice location of doctors: a multinomial probit analysis. *Journal of Labor Economics* **14**: 703–32.

Cameron TA, Huppert DD. 1989. OLS versus ML estimation of non-market resource values with payment card interval data. *Journal of Environmental Economics and Management* **17**: 230–46.

Cameron T, James M. 1987. Efficient estimation methods for 'closed-ended' contingent valuation surveys. *Review of Economics and Statistics* **69**: 269–76.

Cameron T, Quiggin J. 1994. Estimation using contingent valuation data from dichotomous choice with follow-up

questionnaire. *Journal of Environmental Economics and Management* **27**: 218–34.

Chomitz KM, Setiadi G, Azwar A, Ismail N, Widiyarti. 1998. *What do doctors want? Developing incentives for doctors to service in Indonesia's rural and remote areas*. Policy Research Working Paper 1888. Washington, DC: The World Bank.

Ciriacy-Wantrup SV. 1947. Capital returns from soil conversation practices. *Journal of Farm Economics* **29**: 1181–96.

CSA/ORC Macro. 2001. Ethiopia Demographic and Health Survey 2000. Addis Ababa, Ethiopia and Calverton, MD: Central Statistical Authority and ORC Macro.

Deci EL. 1975. *Intrinsic motivation*. New York: Plenum Press.

Diamond P, Hausman J. 1994. Contingent valuation: is some numbers better than no numbers? *Journal of Economic Perspectives* **8**: 45–64.

Dixit A. 2002. Incentives and organizations in the public sector: an interpretative review. *Journal of Human Resources* **37**: 696–727.

Easterbrook M, Godwin M, Wilson R *et al.* 1999. Rural background and clinical rural rotations during medical training: effect on practice location. *Canadian Medical Assocation Journal* **160**: 1159–63.

Grosh M, Baker J. 1995. *Proxy means tests for targeting social programs: simulations and speculation*. LSMS Working Paper No. 118. Washington, DC: World Bank.

Hanemann M. 1994. Valuing the environment through contingent valuation. *Journal of Economic Perspectives* **8**: 19–43.

Harrison G. 2002. Experimental economics and contingent valuation. Working paper. Columbia, SC: Department of Economics, Moore School of Business, University of South Carolina.

Hays RB, Veitch PC, Cheers B, Crossland L. 1997. Why doctors leave rural practice. *Australian Journal of Rural Health* **5**: 198–203.

Hurley J. 1990. Simulated effects of incomes-based policies on the distribution of physicians. *Medical Care* **28**: 221–38.

Joint Learning Initiative. 2004. *Human resources for health: overcoming the crisis*. Cambridge, MA: Harvard University Press.

Kamien M. 1998. Staying in or leaving rural practice: 1996 outcomes of rural doctors' 1986 intentions. *Medical Journal of Australia* **169**: 318–21.

Kristiansen IS, Forde OH. 1992. Medical specialists' choice of location: the role of geographical attachment in Norway. *Social Science and Medicine* **34**: 57–62.

Laven G, Wilkinson D. 2003. Rural doctors and rural backgrounds: how strong is the evidence? A systematic review. *Australian Journal of Rural Health* **11**: 277–84.

Lindelow M, Serneels P. 2006. The performance of health workers in Ethiopia: results from qualitative research. *Social Science and Medicine* **62**: 2225–35.

Lockwood M. 1998. Contribution of contingent valuation and other stated preference methods to evaluation of environmental policy. *Australian Economic Papers* **37**: 292–311.

Mroz TA. 1987. The sensitivity of an empirical model of married women's hours of work to economic and statistical assumptions. *Econometrica* **55**: 765–99.

Nigenda G. 1997. The regional distribution of doctors in Mexico, 1930–1990: a policy assessment. *Health Policy* **39**: 107–22.

Peters DH, Yazbeck A, Sharma R *et al.* 2002. *Better health systems for India's poor: findings, analysis and options*. Washington, DC: World Bank.

Portney PR. 1994. The contingent valuation debate: why economists should care. *Journal of Economic Perspectives* **8**: 3–17.

Rabinowitz HK, Diamond JJ, Markham FW, Hazelwood CE. 1999. A program to increase the number of family physicians in rural and underserved areas: impact after 22 years. *Journal of the American Medical Association* **281**: 255–60.

Rolfe IE, Pearson SA, O'Connell DL, Dickinson JA. 1995. Finding solutions to the rural doctor shortage: the roles of selection versus undergraduate medical education at Newcastle. *Australia and New Zealand Journal of Medicine* **25**: 512–7.

Schelling T. 1968. The life you safe may be your own. In: Chase S (ed.). *Problems in public expenditure analysis*. Washington, DC: Brookings Institution.

Sempowski I. 2004. Effectiveness of financial incentives in exchange for rural and underserviced area return-of-service commitments: systematic review of the literature. *Canadian Journal of Rural Medicine* **9**: 82–88.

Serneels P, Lindelow M, Montalvo J, Barr A (forthcoming). An honorable calling? Findings from the first wave of a cohort study with final year nursing and medical students in Ethiopia. World Bank Africa Region Working Paper. Washington, DC: World Bank Group.

Shields MA. 2004. Addressing nurse shortages: what can policy makers learn from the econometric evidence on nurse labour supply? *Economic Journal* **114**: F464–98.

USAID. 2003. *The health sector human resource crisis in Africa: an issues paper*. Washington, DC: USAID.

WHO. 2002. *Human resources and national health systems: shaping the agenda for action*. Geneva: World Health Organization. Document WHO/EIP.OSD/03.2.

Wibulpolprasert S, Pengpaibon P. 2003. Integrated strategies to tackle the inequitable distribution of doctors in Thailand: four decades of experience. *Human Resources for Health* **1**: 12.

Wilson JQ. 1989. *Bureaucracy: what government agencies do and why they do it*. New York: Basic Books.

World Bank. 2004. *The Millennium Development Goals for health: rising to the challenges*. Washington, DC: World Bank.