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A developed theoretical model of paid and unpaid work in healthcare supply.

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Abstract

We investigate how the increase in the rate of performance related payment affects the healthcare supply in paid and unpaid work. The developed theoretical model shows that a higher price incentivises the supply of paid work. Its impact on unpaid work is determined by the trade-off between crowding effect, effects of the increased opportunity costs and available income. This note provides one of the first attempts in health economics to incorporate the crowding effect and opportunity costs of supply unpaid work into health providers' utility functions and to consider the effect of a change in income within this theoretical framework.

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1. Introduction

Performance related payments are increasingly used in the UK's National Health Service to motivate healthcare providers, e.g. the introduction of the General Medical Services contract in 2004 and the England's Payment by Results initiative in 2003. However, evidence suggests that the impact of financial incentives on the labour supply of healthcare professionals can be modest or even negative (Gillam *et al.*, 2012). One explanation is that financial incentives undermine healthcare professionals' non-monetary incentivised behaviours (Cupple *et al.*, 2008; Morris *et al.*, 2009; Alabbadi *et al.*, 2010). As a consequence, health professionals could either reduce their labour supply in non-monetary motivated areas or switching efforts from non-monetary motivated tasks to monetary motivated tasks.

The developed theoretical model in this note shows that an increase in the rate of performance related payment increased healthcare professionals' paid outputs. However, the impact on the supply of unpaid work and therefore the overall outputs remains uncertain.

This finding is consistent with the evidence in the health economics literature that employees could respond to financial incentives in any way. The positive relation between the piece-rate type of compensation and employees' productivity or outputs is clearly established (Krasnik *et al.*, 1990; Conrad *et al.*, 2002). Further evidence exists of the negative effect financial incentives can have on individuals' performance (Le Grand, 2003). There is also evidence suggests that financial incentives may have little or no effect on individual's performance (Farrar *et al.*, 2006; Siciliani, 2009).

The developed theoretical model mainly contributes two points to the existing health economics literature of labour supply in paid and unpaid work. First, our model augments principal-agent theory by integrating the unpaid activities into healthcare professionals' utility functions. Economists argue that the predictive strength of the single principal-agent theory could be weakened in the healthcare sector. One of the explanations is that healthcare employees are not only motivated by money (Chalkley and Malcomson, 1998; Scott and Farrar, 2002).

Our model proposes a second modification to principal-agent theory by linking financial incentives and the supply of unpaid work. Principal-agent theory has established the link between item payment rates and paid outputs. This paper argues that the changes in remuneration can also affect healthcare providers' supply of unpaid work, through affecting *the utility they derive from unpaid work* and the *income they forgo by working unpaid*. Frey's crowding theory (1997) is used to link income and the marginal utility that derived from unpaid work, while Becker's time allocation theory (1965) provides support for the inclusion of forgone income. This note provides one of the first attempts in health economics to incorporate both factors (crowding effect and opportunity costs) into the health providers' utility functions and to consider the effect of a change in income within this theoretical framework.

Healthcare professionals are used as an example to illustrate these thoughts. The theoretical model could however be applied to explain the labour supply of other professionals who are strongly incentivised by non-monetary motivation, e.g. teachers and scientists.

2. The model

2.1 Equilibrium condition

The objective is to maximise the health professionals' utility gained from supplying paid and unpaid work. Paid work is defined as labour that brings additional income and is carried out during contracted working hours. Unpaid work is defined as work that does not generate additional income but which is carried out during contracted working hours, e.g. the time that the healthcare professionals may spend on tasks which could improve patient's health but are not linked with their payment.

Define the subscripts p and u as paid an unpaid work respectively. It is assumed that money is the only source of utility gained from paid work. Individuals convert materials input (x_p) to produce paid work. x_p is determined by the unit price of the material input (p_p) and the quantity needed (Z_p). It is assumed that non-monetary utility is the only type of utility derived from unpaid work. Individuals combine material inputs (x_u) and time (T_u) to produce unpaid work. x_u is determined by the unit price of material input (p_u) and the quantity needed (Z_u). Individuals choose the best combination of the paid and unpaid outputs to maximise their utility function (Eq. (1)).

$$U = U(x_p, x_u) = U(p_p, Z_p, p_u, Z_u, T_u) \tag{1}$$

The maximisation of utility is constrained by budget (Eq. (2)) and time (Eq. (3)). The budget constraint (Eq. (2)) requires that money spent on materials for both paid and unpaid work equals to the combination of income from paid work and all the other income. V is all other income, $\bar{w}$ is earnings per unit of time that spent on paid work.

$$p_p Z_p + p_u Z_u = V + \bar{w} T_p \tag{2}$$

The time constraint (Eq. (3)) suggests that the combination of time spent on paid and unpaid work is a constant (T_w). Define t_u as the time input to produce one unit of unpaid work.

$$T_p + T_u = T_p + t_u Z_u = T_w \tag{3}$$

Substitute Eq. (3) into Eq. (2) get:

$$p_p Z_p + p_u Z_u = V + \bar{w}(T_w - t_u Z_u) \tag{4}$$

The problem that healthcare professionals face is how to allocate their contracted hours between paid and unpaid work could be formalised as Eq. (5) (using Eqs. (1) and (4)):

$$Max \;\; U(x_p, x_u) \qquad \text{s.t.} \qquad p_p Z_p + p_u Z_u - V - \bar{w}(T_w - t_u Z_u) = 0 \tag{5}$$

The Lagrangean is:

$$\begin{aligned} L &= U(x_p, x_u) - \lambda \times [p_p Z_p + p_u Z_u - V - \bar{w}(T_w - t_u Z_u)] \\ &= U(x_p, x_u) - \lambda \times [p_p Z_p + (p_u + \bar{w}t_u) Z_u - V - \bar{w}T_w] \end{aligned} \tag{6}$$

where λ is the marginal utility of money and $\lambda > 0$.

Taking the derivative of L with respect to Z_u and Z_p we get:

$$\frac{\partial U}{\partial Z_p} = MU_p = \lambda p_p \tag{7}$$

$$\frac{\partial U}{\partial Z_u} = MU_u = \lambda(p_u + \bar{w}t_u) \tag{8}$$

The utility from contracted hours will be maximised when conditions specified by Eqs. (7) and (8) are satisfied. Eq. (7) suggests that the equilibrium condition is achieved when marginal income from paid work equals to the marginal material input. Eq. (8) suggests that the equilibrium condition is achieved when the marginal utility that derives from unpaid work equals to the sum of the material cost and opportunity cost. The opportunity cost is equal to the income that would have been earned for the same period of paid work. This follows Becker (1965) in that when forgone income is unobserved it can be treated as the value of paid income for the same services. The utility function is assumed differentiable, increasing and concave in Z_p and Z_u, with $MU_p > 0$, $MU_u > 0$, $\frac{\partial MU_p}{\partial Z_p} < 0$ and $\frac{\partial MU_u}{\partial Z_u} < 0$.

2.2 Effects of increased income on the supply of unpaid and paid work

When the piece rate from paid work (c_p) increases, the earning per unit of time $(\bar{w})$ increases accordingly. The relation between $\bar{w}$ and c_p could be presented as the following:

$$\bar{w} = c_p Z_p / T_p \tag{9}$$

The optimal amount of supply in paid and unpaid work, which are shown by Eqs. (7) and (8), no longer holds as the result of the increased piece rate from paid work.

We assume that the productivities of doing paid and unpaid work will not be influenced by the changes in the piece rate from paid work.

2.2.1 Paid work

Continuing with Eq. (7), the increased piece rate from paid work will incentivise the supply of paid work as the marginal income exceeds the marginal cost:

$$\lambda c_p^{after} > \frac{\partial U}{\partial Z_p} = MU_p = \lambda p_p = \lambda c_p \tag{10}$$

where c_p^{after} is the increased piece rate from paid work.

2.2.2 Unpaid work

To find out how the supply of unpaid work alters as pay per unit of paid work increases, we follow Frey (1997).

Taking the first derivative of both sides of Eq. (8) with reference to $\bar{w}$ gives:

$$\frac{\partial MU_u}{\partial Z_u} \times \frac{\partial Z_u^*}{\partial \bar{w}} + \frac{\partial MU_u}{\partial \bar{w}} = \lambda t_u \tag{11}$$

where Z_u^* is the optimal amount of unpaid work supplied under the equilibrium condition, which is specified by Eq. (8)) .

Rearranging Eq. (11), we get:

$$\frac{\partial Z_u^*}{\partial \bar{w}} = \frac{\frac{\partial MU_u}{\partial \bar{w}} - \lambda t_u}{-\frac{\partial MU_u}{\partial Z_u}} \tag{12}$$

Eq. (12) suggests that the increased piece rate from paid work affects individuals' provision of unpaid work through crowding effect and the effect of opportunity costs.

Crowding effect $(\frac{\partial MU_u}{\partial \bar{w}})$*:* How the changes in piece rate from paid work have impact on the supply of unpaid work through crowding effect is an empirical question. As marginal utility from unpaid work is a matter of personal judgement, the way in which it responds to changes in income will vary from one person to another.

Opportunity costs (λt_u)*:* An increased unit time earnings has negative effect on the supply of unpaid work through the effect of opportunity costs. The increased piece rate from paid work suggests the value of time goes up.

In addition, the *available income* is positively associated with the supply of unpaid work. An increase in income suggests a higher level of budget constraint.

2.3 Figure illustration

Fig. 1 describes the effect of the increased performance related payment on the supplies of paid and unpaid work. It shows only one of a multitude of possible outcomes.

U is the indifference curve for paid work and unpaid work (Eq. (1)). l is the productivity possibility frontier. Its slope equals to $((\overline{wt}_u + p_u)/p_p)$, which developed from Eqs. (7) and (8).

The initial indifference curve U_1 is tangential to the productivity possibility frontier l_1 at point A. It is the equilibrium condition that is specified by Eqs. (7) and (8). The optimal supplies of paid and unpaid work are Z_{p1} and Z_{u1} respectively. When the unit payment for doing paid work increases, the cost of supplying unpaid work goes up accordingly as an individual's time becomes more valuable. The productivity possibility frontier moves clockwise from l_1 to l_2. The optimal point is B, which is the tangency between U_2 and l_2. U_2 is parallel with U_1. In this example, it is assumed that the marginal utility derived from unpaid work declines as income increases. This indicates that individuals' motivation of supplying unpaid work is crowded out by the changes in financial incentives. The assumption in the microeconomics about indifference curves, that they must be paralleled, is not hold here. The utility curve moves anticlockwise from U_2 to U_3. In order to keep at the same level of inputs shown by l_2, the indifference curve moves parallel with U_3 to U_4. The optimal combination of paid and unpaid output moves from point A to point C. The optimal supplies of paid and unpaid work under the new equilibrium condition are Z_{p3} and Z_{u3} respectively.

The overall effect of the increased unit price on the supply of unpaid work is to decrease by $|Z_{u3}Z_{u1}|$. $|Z_{u2}Z_{u1}|$is the result of opportunity costs and changes in the available capital. $|Z_{u3}Z_{u2}|$ is the result of the crowding effect. Its effect on the supply of paid work is to increase by $|Z_{p3}Z_{p1}|$.

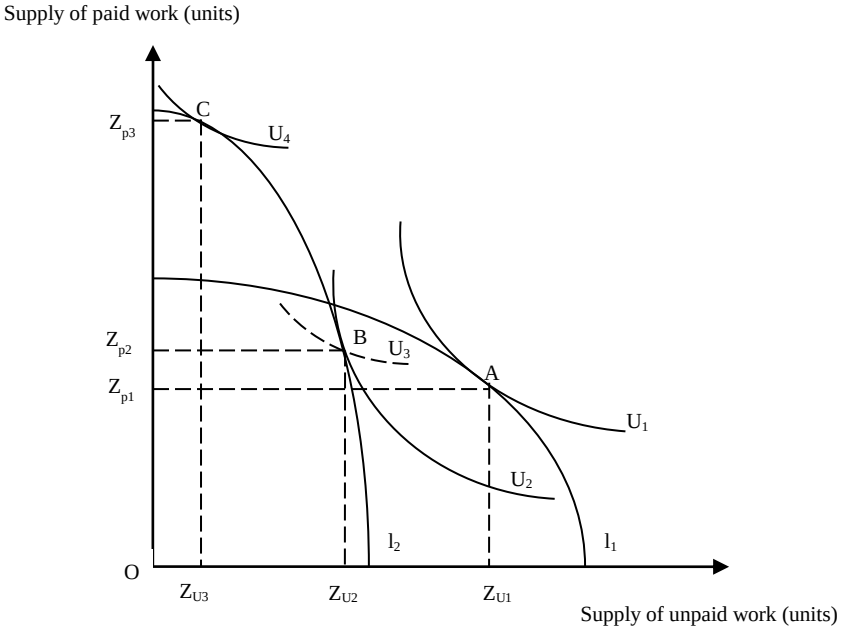

Figure 1: Effects of increased income on the supplies of paid and unpaid work

3. Conclusion

The developed theoretical model shows the complex relationship between changes in the rate of performance related payment and two types of activities - paid and unpaid work - during the contracted hours. The model suggests that a higher price will enhance the labour supply of paid work. The effect on unpaid work is determined by the trade-off between the effects of increased opportunity costs, available income and crowding effect. Furthermore, the developed model provides a theoretical framework for the empirical analysis of healthcare providers' labour supply.

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