Hours and Wages: A Bargaining Approach

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Abstract

In a recent paper, Bick et al. (2022) show the presence of a hump-shaped relationship between hours and hourly wages with a maximum around 50 hours worked. We show that a model with fixed labor costs where workers and firms bargain in wages and hours can help explain this non-linear relationship. Also, a quantitative version of the model is able to match the empirical hourly-wage to hours worked relationship estimated by those authors for the US.

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1 Introduction

Most of the empirical literature assumes a constant elasticity between earnings and hours (See, for example, Goldin (2014), Cortés and Pan (2019) and Denning et al. (2021)). The assumption of a constant elasticity, however, may hide important non-linearities in the data. In a recent paper, Bick et al. (2022) show that hourly wages in the US increase for workers below 50 hours, but decrease when individuals work more hours. These authors show that this non-monotonic relationship is robust to different datasets, different individuals and it is happening in different countries like US and Denmark.

To reproduce this relationship between wages and hours, Bick et al. (2022) assume increasing returns to hours worked when workers work short hours (below 40 hours per week) and decreasing returns for greater numbers of hours worked. However, previous works such as Pencavel (2015) find that returns are decreasing for more than 48 hours per week but constant for shorter hours worked.

The aim of this paper is to show that simultaneous bargaining over wages and hours between workers and firms with fixed labor costs can also explain the aforementioned non-linear relationship between hours and hourly wages. In contrast to Bick et al. (2022), we depart from the competitive market assumption where wages equal the marginal product of labor and assume decreasing returns in hours worked.

Similar to Pissarides (2000) (Chapter 7.3) and Kudoh et al. (2019) among others, in our model workers and firms bargain over wage and hours. If an agreement is reached, firms incur a fixed training cost. If an agreement is not reached, workers remain jobless and suffer a fixed cost that can be interpreted as the cost of continuing the job search. Since search is costly in terms of time, this cost can be increasing in the value of leisure. Fixed costs reduce wages because, on the one hand, firms share part of the training costs with workers, and, on the other, worker search costs increase the value of reaching an agreement for a given wage.

We account for worker heterogeneity in terms of preferences for leisure.[1] Higher preferences for leisure improve the outside option and the bargaining position of workers, and wages increase. Fixed costs, in contrast, reduce wages and, for sufficiently high preferences for leisure (low hours), hourly fixed costs become too large and wages start to fall. This generates an inverted-U shape relationship between equilibrium hourly wages and hours.

We perform a simple numerical exercise and find that the model can reproduce the hump-shaped relationship observed in the data. We also show that removing either the fixed firm's training costs or worker's search cost from the model generate a negative relationship between hourly wages and hours worked. Starting with Cogan (1981), fixed costs have been introduced in several labor supply models (see, for example, French (2005) and Erosa et al. (2016)). However, we are the first to analyze the role of these type of costs to generate the hump-shaped relationship between hours and wages.

[1]The value of the alternative use of time needs not only be interpreted in terms of leisure, it may also be motivated by the existence of home production. Having to perform these other activities makes work more costly.

2 The model

We consider the simultaneous bargaining over wages and hours of work by firms and workers at a given point in time. If an agreement is reached, workers obtain

$$W = hw - xh^{\mu} \tag{1}$$

where h stand for hours, w for hourly wage and xh^{μ} is the cost of working h hours with $\mu > 1$ and x an idiosyncratic component of the cost that measures preferences for leisure and characterises workers. If an agreement is not reached, workers continue the job search incurring a fixed cost F. Hence, upon reaching an agreement, workers obtain W plus F, the cost they do not incur. In turn, if an agreement is reached, the firm obtains

$$J = ah^{\lambda} - hw - T \tag{2}$$

where ah^{λ} is the output generated in h hours of work, with $\lambda < 1$. T stands for a fixed hiring cost incurred by firms. It includes training and administrative costs of signing the contract.

Hours and wages are determined simultaneously by Nash bargaining:

$$\max_{h,w} \; (W+F)^{\beta} (J)^{1-\beta} .$$

The first order condition that determines wages is

$$\beta J \frac{\partial W}{\partial w} = -(1-\beta)(W+F)\frac{\partial J}{\partial w},$$

since $\frac{\partial J}{\partial w} = -\frac{\partial W}{\partial w} = h$, this implies

$$\beta J = (1-\beta)(W+F) \tag{3}$$

Substituting (1) and (2) in (3), and manipulating, we obtain

$$w = \beta a h^{\lambda-1} + (1-\beta) x h^{\mu-1} - \frac{(1-\beta)F + \beta T}{h} \tag{4}$$

Similarly, the first order condition that determines hours of work is

$$\beta J \frac{\partial J}{\partial h} = -(1-\beta)(W+F)\frac{\partial W}{\partial h}, \tag{5}$$

which can be simplified using (3) to obtain

$$\frac{\partial J}{\partial h} = -\frac{\partial W}{\partial h}.$$

From (1) and (2)

$$\frac{\partial W}{\partial h} = w - \mu x h^{\mu-1}$$

$$\frac{\partial J}{\partial h} = -\left(w - \lambda a h^{\lambda-1}\right),$$

Then, (5) implies

$$h_x^* = \left(\frac{a\lambda}{\mu x}\right)^{\frac{1}{\mu-\lambda}}. \tag{6}$$

Substituting (6) into (4) we obtain the equilibrium wage

$$w_x^* = \beta a \left(h_x^*\right)^{\lambda-1} + (1-\beta)\left(h_x^*\right)^{\mu-1} x - \frac{(1-\beta)F + \beta T}{h_x^*} \tag{7}$$

Hence, at equilibrium, each individual x agrees with the firm on a number of hours of work and a wage that are given by (6) and (7). The equilibrium hourly wage depends positively on output produced and costs incurred by worker and negatively, on firms's costs of hiring and worker' search costs, i.e. fixed costs.

We now study how hours of work and the hourly wage change with the individual preferences for leisure x. Clearly, from (6):

$$\frac{dh_x^*}{dx} = -\frac{1}{\mu-\lambda}\frac{h_x^*}{x} < 0$$

Higher preferences for leisure unambiguoulsy lead to lower hours of agreed work. The effect of individual preferences for leisure on hourly wages is more involved:

$$\begin{aligned} \frac{dw_x^*}{dx} &= \beta a(\lambda-1)\left(h_x^*\right)^{\lambda-2}\frac{dh_x^*}{dx} + (1-\beta)\left(h_x^*\right)^{\mu-1} \\ &\quad + (1-\beta)x(\mu-1)\left(h_x^*\right)^{\mu-2}\frac{dh_x^*}{dx} + \frac{(1-\beta)F+\beta T}{(h_x^*)^2}\frac{dh_x^*}{dx} \end{aligned} \tag{8}$$

The first two terms are positive. First, higher preferences for leisure reduce hours of work and, since returns are decreasing, increase hourly output. This has a positive effect on the hourly wage. Second, individuals demand a higher compensation if their preferences for leisure are higher. This also has a positive effect on the hourly wage.

In contrast, the last two terms in (8) are negative: since higher preferences for leisure reduce hours of work, this reduces the compensation workers receive for x and increases the size of fixed costs per hour. The effect of these two terms on the hourly wage is negative.

Further manipulation of (8) allows us to identify the range of x for which this derivative is positive or negative. In particular, we can show that

$$\frac{dw_x^*}{dx} > 0 \leftrightarrow \hat{x} = \lambda\left(\frac{a}{\mu}\right)^{\frac{\mu}{\lambda}}\left[\frac{(1-\lambda)(\beta\mu + (1-\beta)\lambda)}{(1-\beta)F+\beta T}\right]^{\frac{\mu-\lambda}{\lambda}} > x. \tag{9}$$

Therefore, the equilibrium hourly wage first increases in the individual preference for leisure x and, after $\hat{x}$, it decreases. While as working costs increase from zero workers are increasingly compensated for these costs, and hours fall, after a certain point the low hours make working costs too small and fixed costs too large. Then wages start going down. In Fig. 1, we represent the equilibrium wage as a function of x (Quadrant II), the equilibrium hours as a function of x (Quadrant IV) and the resulting relationship between w_x^* and h_x^* (Quadrant I).

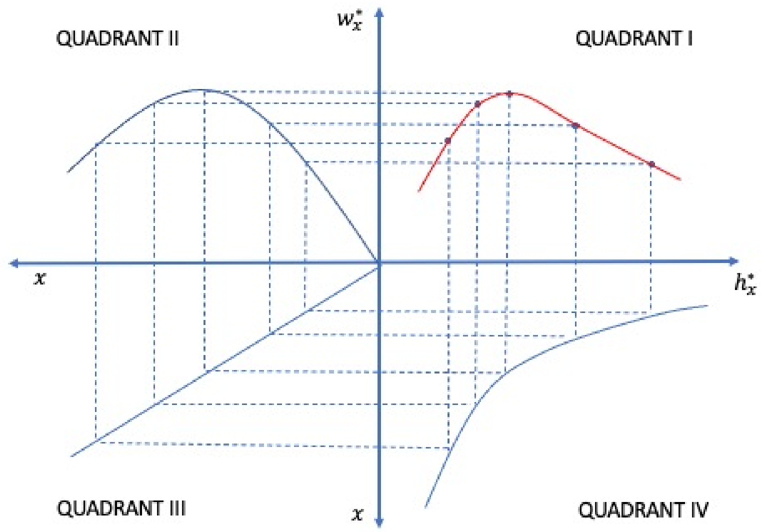

Figure 1: The relationship between wages and hours at the bargaining equilibrium

3 Numerical exercise

We have seen that a bargaining model with fixed labor costs is able to generate an inverted U-shape relationship between hours worked and hourly wages. In this section we set the model's parameters to be consistent with reasonable labor costs. Table 1 shows the obtained parameter values. The goal is to see if a quantitative version of the model is able to match the empirical hourly-wage relationship estimated by Bick et al. (2022) for the US.

We start by setting the workers bargaining power parameter to $\beta = 0.5$ and assume the presence of quadratic costs of working $\mu = 2$. We parameterize the model in annual basis and consider an individual working 40 weekly hours when setting the different parameters. Thus, we normalize to one both her weekly hours worked ($h_{40} = 1$) as well as her annual wage ($w^a_{40} = w_{40} \times h_{40} \times 52{=}1$). We also assume that there are 300 different x ranged between 0.001 and 0.025.

Following Silva and Toledo (2009), the firm's on-the-job training fixed costs $T = 0.14$ are set to match 14% of annual wages (55% of quarterly wages). To match the data, it is convenient to assume that worker search costs F are linearly increasing in the value of leisure: $F(x) = \chi \times x$. That is, individuals with higher working costs per hour also show higher fixed costs of looking for jobs since leisure is relatively more important for them. From a theoretical point of view, note that this assumption adds an additional negative term to (8) but does not change the main result on the hump-shaped relationship between hourly-wages and hours worked.

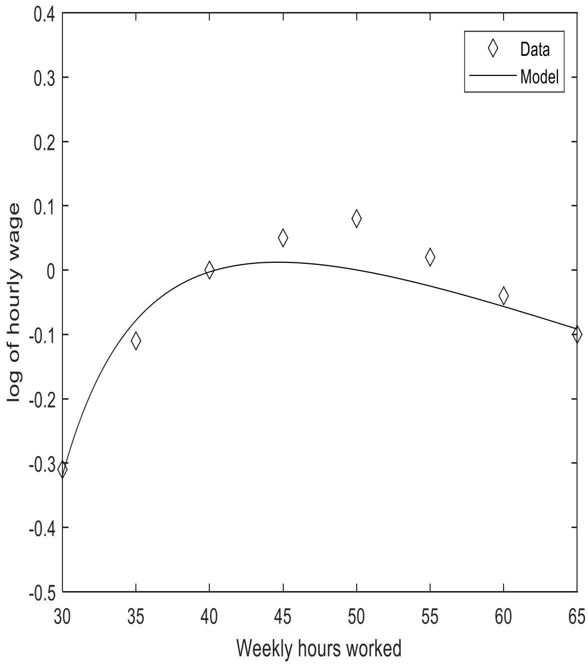

Figure 2: Hourly-wage relationship

Next, $\chi = 2$ and $\lambda = 0.06$ are set to match the log of wages observed in the data for 30 and 65 weekly hours worked, respectively. Notice that this implies that the fixed costs of looking for a job $F(x)$ range between 0.002 and 0.05 for individuals with the lowest and highest working costs x, respectively. In the case of a worker working 40 hours per week, we obtain an annual job searching cost of 1% of her wage ($F(x_{40}) = 2 \times 0.005 = 0.01$). Finally, the productivity parameter $a = 0.1682$ can be obtained by substituting our obtained parameters in the normalized annual wage equation for an individual working 40 weekly hours. That is, we multiply 52 by equation (4) and obtain:

$$a = (1/52 + \beta \times T + (1 - \beta) \times F40)/(\beta + (1 - \beta) \times \lambda/\mu).$$

Finally, we keep the parameters unchanged and depart from our benchmark 40 weekly hours scenario by calculating the optimal hourly wage w_x^* and weekly hours worked h_x^* for each x by using equations (6)-(7).

Table 1: Calculated parameter values

Parameter	Value	Rationale
Parameter of worker's job searching costs, χ	2	Log wages at 30 hours worked
Fixed firm's cost of training a worker, T	0.14	Silva and Toledo (2009)
Worker's bargaining power, β	0.5	Own assumption
Parameter of working variable cost, μ	2	Quadratic costs
Parameter of the production function, λ	0.06	Log wages at 65 hours worked
Aggregate productivity, a	0.1682	Wage equation

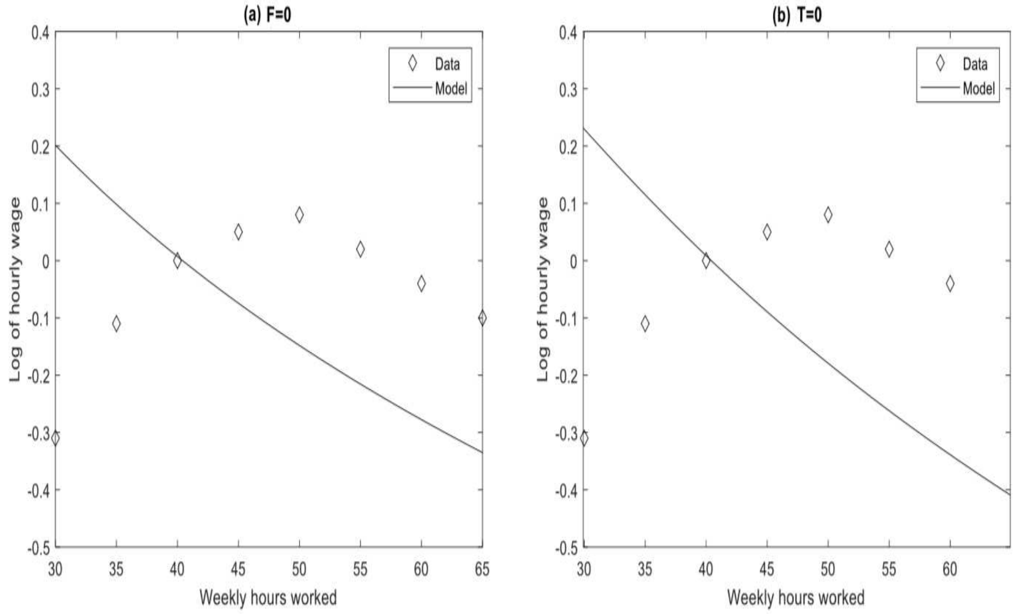

Figure 3: Hourly-wage relationship with non Fixed costs

Figure 2 compares the log hourly wage of our simulated scenarios with the estimated data in Bick et al. (2022). It matches quite well the inverted U-shape relationship between hours and wages. However, it reaches the maximum log wages around 45 hours instead of 50. To show the importance of having fixed costs in the model, we next simulate two alternative scenarios where we eliminate either the training costs $T = 0$ or the job searching costs $F = 0$. The rest of parameters remain unchanged. Figures 3 (a)-(b) show a monotonically decreasing relationship between hours and wages in both cases within the range of 30 to 65 hours.

4 Final comment

Introducing fixed labor costs in a scenario of simultaneous bargaining in hours and wages, we have created a non-linear relationship between hours and hourly wages. Further, we have been able to match the empirical hourly-wage relationship estimated by Bick et al. (2022). This paper suggests that further empirical research should evaluate the role of fixed costs behind the inverted-U relationship between hourly wages and hours worked.

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