THE ECONOMICS OF WAGE DETERMINATION IN Mt. 20, 2–15

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Introduction

Jesus Christ spoke many things in parables for those »Who has ears to hear, let them hear« (Mt. 13, 9).

Some of the parables are not easy to understand. One of them is the parable of the workers hired to work in the vineyard: Matthew 20, 2–15:

> »... an householder... went out early in the morning to hire laborers into his vineyard.
>
> And when he had agreed with the labourers for a denarius a day, he sent them into his vineyard.
>
> And he went out about the third hour, and saw other standing idle in the marketplace.
>
> And said unto them; Go ye also into the vineyard, and whatsoever is right I will give you. And they went their way.
>
> Again he went out about the sixth and ninth hour, and did likewise.
>
> And about the eleventh hour he went out, and found others standing idle, and saith unto them. Why stand ye here all the day idle?
>
> They say unto him. Because no man hath hired us. He saith unto them. Go ye also into the vineyard; and whatsoever is right that shall ye receive.
>
> So when even was come, the lord of the vineyard saith unto his steward. Call the labourers, and give them their hire, beginning from the last unto the first.
>
> And when they came that were hired about the eleventh hour, they received every man one denarius.
>
> But when the first came, they supposed that they should have received more: and they likewise received every man one denarius.
>
> And when they had received it, they murmured against the goodman of the house.
>
> Saying: these last have wrought but one hour, and thou hast made them equal unto us, which have borne the burden and heat of the day.
>
> But he answered one of them, and said, Friend, I do thee no wrong: didst not thou agree with me for one denarius?

> Take that thine is, and go thy way; I will give unto this last, even as unto thee.
>
> Is it not lawful for me to do what I will with mine own? Is thine eye evil, because I am good?«

The question that is not easy to grasp is: Why each laborer got equal wage (one denarius), although they worked different number of hours and (assuming the same productivity) produced different quantities of product?

The new theory of wages in the science of economics could suggest the answer to this question. This theory says that the wages are determined by the value of the marginal product of of labour. Since the marginal product (and its value if we assume the constant price on the product market) is declining, **each worker gets the wage equal to the value of the marginal product of the last labour unit.** And the last labor unit, the labor hired last, has the smallest marginal product. This theory thus explains why the workers hired early in the morning and those »hired about eleventh hour« got the same wage.

The householder who hired the workers determined in advance the wage (one denarius). He kept on hiring the workers untill the value of marginal product of the last worker (the least one) reached the value of the predetermined wage (one denarius). He behaved in a reasonable way like any modern enterpreneur who aims at maximizing his profit.

That is the essence of the modern theory of wages in economics defined already in the New Testament. This theory could help us in the interpretation of this part of the New Testament.

This paper has the objective to explain, in very elementary way, this theory and shows that the householder (entrepreneur) in the New Testament behaved in the same way as the modern enterpreneur.

The distribution of production among the factors

The main objective of any enterpreneur is the maximization of his profit. Morever, in economics we define the objective function of a firm as the mximization of profit. Profit D is defined as the difference between the total revenue R and the total costs C. So: D=R–C (1)

The necessary condition for the maximization of the profit is the equality of marginal revenue and marginal cost[1].

$$dR/dQ=dC/dQ \qquad (2)$$

1 Mathematically this is derived in the following way: The necessary condition for the equation of profit to be maximized is that its first derivative is zero:
$dD/dQ = dR/dQ — dC/dQ = 0$
From this, the necessary condition for the maximum of the function (1) is: $dR/dQ = dC/dQ$.

The principle applies to all profit–maximizing firms in perfect and imperfect goods makets. It is known as the marginal productivity theory. It asserts that a firm maximizes profits by employing units of each variable factor up to the point where the marginal cost of the factor to the firm, equals the addition to the firm's total revenue from the employment of the last unit of that factor. This latter concept is called the marginal revenue product (MRP) of a factor.

The profit can be increased by increasing input if the marginal revenue productivity of the input is greater than its MC. Similarly, D can be increased by decreasing input if MR is less than MC. This means that the firm will increase employment of an input as long as it increases its revenues more than its costs.

We shall start with the standard assumption in microeconomics that the objective function of each firm is the maximization of its profit. In order to achieve this objective, the firm will hire the factors of production so that it achieves the equality between marginal cost and marginal revenue for each factor of production.

The labour is one (although the most important) factor of production. Therefore the profit–maximizing firm will always want to hire an additional unit of labour untill it reaches the equality of its marginal cost and marginal revenue.

Now let us define and explain marginal cost and marginal revenue of labour.

Marginal cost of labour, or extra cost of hiring an additional unit of labour is the wage rate of labour w. In our case it is one denarius.

Marginal revenue is the value of the marginal product of labor. It is the product of marginal physical product of labour MP and the market price of that product, P.

So the profit–maximizing firm will hire the labour untill it reaches:

$$w = MPxP \tag{3}$$

This means that the profit — maximizing firm will increase the input of labour in the process of production untill the value of production of the last unit of labour MP. P is equal to the wage rate w. This means that each worker is worth to the firm, the dollar value of the last worker's marginal product; As a result, the entrepreneur will pay to all employed workers the wage which is equal to the value of last worker's marginal revenue.

If we asume the perfect competition on the product market (the assumption of the market of imperfect competition would slightly complicate the analysis, but the results would be the same), then the price of the product P is constant. So it is the marginal product curve that should adapt to the exogenously determined wage rate w, one denarius set up by the householder in our case.

This is why we have to explain the behaviour of the marginal product curve of labour. In order to do this we have to introduce elementary theory of production.

Elements of the theory of production

The theory of production begins with the notion of the production function. The production function shows the maximum output of a particular good that we can produce, if we have given quantities of land, labor, and capital.

The production function is the technical name given to the relationship between the maximum amount of output that can be produced and the inputs required to make that output. It is defined for a given state of technical knowledge.

Once a firm's production function has described how inputs are transformed into outputs, we can calculate important production concepts: total product, average product, and marginal product. We begin by computing the total physical product, or total product, which designates the total amount of output produced.

The total product is the function of the quantities of factors of productin used in the proces of production given the state of technology. The production function can be expessed mathematically in this way:

$$Q=f(q1, q2,... qn) \tag{4}$$

where q, is the quantity of a factor i used in the production process.

The marginal product of an input is the extra product or output added by one extra unit of that input while other inputs are held constant. This means that the labor's marginal product is the extra output the firm produces by adding 1 unit of labor into the production process. In our case it is the product of the laborer hired in the subsequent period of time.

There is a fundamental law in the theory of production. This is the law of diminishing returns which says that each additional unit of labor adds less and less of the output.

The rationale for diminishing returns is quite straightorward: As more and more of an input like labor is added to a fixed amount of land, machinery, and other inputs, the labor has less and less of the other factors to work with. The land gets more crowded, the machinery is overworked, and the jobs done become less efficient.

Using the production–function concept, we can define declining marginal product which shows how each successive unit of labor adds less and less output. Declining marginal product is another name for the law of diminishing returns.

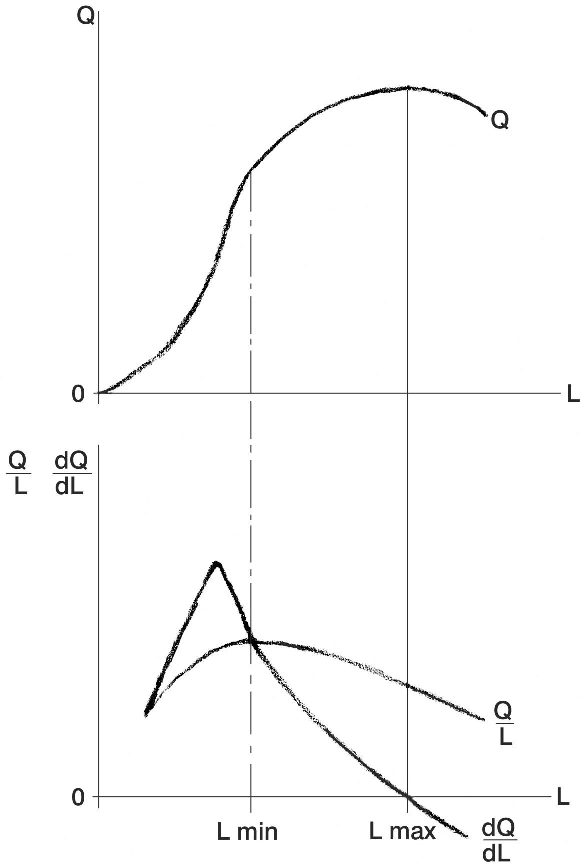
This is shown by this production function:

$$Q=f\,(T, Z, K, L) \tag{5}$$

Assumming that the stock of technology T, the quantity of land Z, and capital K, is given, (in the short run) the production function is the function of labour inputs, L.

In microeconomic textbooks the stylized graph that shows short run functions of total, average and marginal product is the following;

Figure 1



If a firm wishes to vary its production in the short run, it can do so only by changing its labour input, since capital, land and technology are fixed.

This necessitates changing the proportions in which labour and capital are combined, which causes declining marginal returns.

The law of diminishing returns states that when increasing quantities of a variable factor are used in combination with a fixed factors, the marginal and average product of the variable factor will eventually decrease. Another name for the law of diminishing returns is law oof variable proportions. In some ways it is a better descriptive title, as we shall later explain. We can look at the effects of changing the quantity of labor input on total product, average product, and marginal product in the following table:[2]

Table 1

Capital	*Labor*	*Total product*	*Average product*	*Marginal product*
K	*L*	*Q*	*Q/L*	*dQ/dL*
1	2	3	4	5
2	0	0	0	—
2	1	5	5	5
2	2	16	8	11
2	3	22	7 1/3	6
2	4	27	6 3/4	5
2	5	31	6 1/5	4
2	6	34	5 4/6	3
2	7	36	5 1/7	2
2	8	37	4 5/8	1
2	9	37	4 1/9	0
2	10	36	3 6/10	–1

In Table 1 column 1 shows the fixed amount of land and capital (2 units). Column 2 shows the units of labor inputs in the process of production. Column 3 shows the resulting total output. Column 4 shows the average output per unit of labor input and the column 5 shows the marginal physical product of labor.

If the firm does not use any labor, when L=0, there is no production, i. e. the total product Q=0.

2 The table is taken from my textbook *Mikroekonomska analiza* Fourth Edition, MATE, Zagreb, 1997, p. 5o.

In order to increase the production the firm uses more and more of labor input on the same area of land with the same amount of capital. Because the proportion of variable input, labor and fixed inputs (land, capital and technology) are changing, the productivity of labor changes.

In the beginning when the firm uses less than 2 units of labor, the productivity of labor increases. This results in the increase of marginal and average productivity of labor. This is called increasing returns. If we look at Fig 1, we see that in the beginnging the curves of marginal and average productivity are increasing and the curve of total product is steeper and steeper. After the second unit of labor input (when the firm achieved the optimal combination of labor and the fixed factors of production) the increase of labor inputs results in decreasing productivity. In the Figure 1, this is shown downward sloping by the curves of marginal and average product. The curve of total product is still increasing although less and less.

When the firm employs 8 units of labor, the total product is maximum, and the marginal product is zero. The firm will not continue to add more than 9 units of labor (even if it were costless) because the 10th unit would have a negative marginal product. The total product would decrease since there are too many of workers that they got into each other's way. So the ninth unit of labor is the upper limit of labor input. We assume that the firm will behave in the economically rational way and not employ more than 9 workers in order not to enter the area of negative marginal product of labor. In the same way we shall assume that the firm will not employ less than 2 units of labor because in this area the marginal product of fixed factor is negative.[3] Tis is why we shall restrict our analysis of production only to the range 2–9 units of labor input since only this range is relevant for economic analysis.

Now that we have defined marginal product of labor, we shall analyse the decision of a firm how much units of labor to employ in order to get maximum profit. In order to make the analysis more simple and more understandable (especially for noneconomists) we shall use an example based on the previous Table 1.

We shall suppose that the wage is $w=1$ (as in the Mt. 20, 1 one denarius), and that the price of the product is $p=1$ and the fixed costs (of land and capital) $FC=5$. With these assumptions and the data of Table 1 we can calculate the values of marginal product, marginal cost, total revenue, total costs and profits of a firm:

3 The proof is given in my *Mikroekonomska analiza*, p. 54 or in any other intermediate textbook in microeconomics.

Table 2

Units of Labor	*Product*		*Total*		*Profit*	*Marginal*	
	Total	*Marginal*	*Revenue*	*Costs*		*Revenue*	*Cost*
L	*Q*	*dQ/dL*	*R=Q.p*	*L.w+C*	*D=R–C*	*dQ/dL.p*	*w*
1	2	3	4	5	6	7	8
0	0	—	—	0	—	—	1
1	5	5	5	6	–1	5	1
2	16	11	16	7	9	11	1
3	22	6	22	8	14	6	1
4	27	5	27	9	18	5	1
5	31	4	31	10	21	4	1
6	34	3	34	11	23	3	1
7	36	2	36	12	24	2	1
8	**37**	**1**	**37**	**13**	**24**	**1**	**1**
9	37	0	37	14	23	0	1
10	36	–1	36	15	21	–1	1

The first three Columns are taken from Table 1. The fourth Column is total revenue R equal to the product of total production Q and the price of the product p=1. The fifth column shows total costs C as the sum of fixed costs FC=5 and variable costs VC=L. w which is equal to the product of different units of labor and fixed wage rate w=1. Column 6 shows the profit D which is equal to the difference between total revenue R and total costs C. Column 7 shows the values of marginal revenue dR/dQ which is equal to the product of the marginal physical product (column 3) and the price of product p=1. The last column shows the marginal cost which is equal to the wage rate w=1.

If we look at the sixth column we see that the profit D of a firm is increasing as the firm increases the use of a variable factor, labor. When the firm employes more than 2 and less than 9 units of labor, its total revenue increases more than its costs, so its profit rises. The third unit of labor employed increases the firm's total revenue R by 6 denarius and the total costs by 1 denarius (which is equal to the wage rate w=1 denarius), so that the firm's profit D is increased by 6 denarius.

The fourth unit labor adds 5 denarius to the revenue of the firm (less than the third) and 1 denarius (w=1) to the total costs so that the firm's profit D increases by 5 denarius.

We can see that each additional unit of labor increases the firms profit by smaller amounts (because of the diminishing returns). The third unit of labor increased the firm's profit by 6 denarius, the fourth by 5, the fifth by 4, the sixth by 3, the seventh by 2, the eight by 1. If the firm continues to employ the ninth unit of labor, its revenue would not increase at all, but its total costs would increase by 1 denarius so that the firm's profit D would decrease by 1 denarius. Obviously the the firm will not increase the employment of additional unit of labor if the increase of its costs is higher than the increase of its revenue. It is also obvious that the firm will increase the employmant of the additional unit of labor when it adds more to the firm's revenue than to its costs. So the firm will continue to add more labor units to its production process as long as each additional unit of labor increases the value of the production more than total costs. Said in more technical terms, the firm will continue to increase the labor inputs as long as marginal revenue of additional labor unit is greater than its marginal costs. This is why our householder continued to hire more and more workers in his vineyard, untill each of them increased his revenue more than his costs.

When the firm employs the eight units of labor its revenue R increases from 36 to 37 denarius and the total costs increased from 12 to 13 denarius. So the marginal revenue (the difference between the total revenue of the employment of 8 and 7 labor units 37–36=1) increased by 1 denarius. But its marginal cost (the difference between the total costs employing 8 and 7 units of labor 13–12=1) increased also by 1 denarius. So we have the equality between the marginal revenue and marginal cost $dR/dQ=dC/dQ$. This according expession (2) is the necessary condition for the maximum profit of the firm. Our exemple shows that if the wage rate w=1 denarius (for all workers irrespective when they were hired) and the price of output p=1 denarius, the optimum employment of labor is 8 units.

Let us summarize our findings. The firm's profit reaches its maximum when the firm employs 8 units of labor. When the firm employs 8 units of labor, its product is maximum Q=37. So is its total revenue R(8) = Q(8). p = 37.

For this number of labor units the firm reaches the equality between its margined revenue

$dR/dQ=dQ/dL.\ p$ and its marginal costs MC = w which is necessary condition for the maximization of profit as shown in expession (2) above:

$$dR/dQ = dC/dQ$$

or in our example for the employment of 8 units of labor:

$$dR/dQ = dQ/dL.\ p= 1.\ 1=1$$
$$dC/dQ = w = 1$$

In this way we have demonstrated that the firm will have maximum profit when it employes the quantity of labor for which the value of marginal product is equal to the marginal cost of labor which in our case is the predetermined wage rate of 1 denarius.

This helps us to understand why the owner of the vineyard continued to employ more and more workers untill he reached, the equality of the value of the marginal product (which was the product of the decreasing marginal physical product and the price of the product of the last worker) and the predetermined wage rate (marginal cost of labor) of one denarius. He wanted to maximize his profit. He behaved in the same way as the modern enterpreneur.

Summary

In the New Testament, Christ spoke many things in parables. Some of these parables contain certain most up–to–date achievements in modern economic theory. So the explanations of these achievements in economic theory could help us to understand the meanings of the parables.

This is the case with the parable in the Matthew 20, 2–15. The answer to the question: Why each laborer recieved equal wage of one denarius in spite of the fact that they worked different number of hours and eventually produced different quantities of labor inputs.

The modern theory of wages suggest the answer to this question. This theory says that the wages are determined by the value of the marginal product of labour. Since the marginal product (and its value if we assume the constant price on the product market) is deciling, each worker gets the wage equal to the value of the marginal product of the last labour unit. And the last labor unit, the labor hired last, has the smallest marginal product. This theory thus explains why the workers hired early in the morning an those »hired about eleventh hour« got the same wage.

So this modern theory of wages has been written in the New Testament, but it could explain the parable contained in Matthew 20, 2–15.