DEMAND FOR EDUCATION UNDER SIGNALLING

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Abstract

This paper deals with the problem of asymmetric information in the labour market. The starting point of the research is the seminal work of Michael Spence and his notion of signalling. Following research in this field has been aimed either at the employers' side (theory of screening) or at the side of prospective employees and their demand for education as the determinative signal. In the paper, I focus on the employees' side of the market. One of the purposes is to model the demand for education with the necessary respect to the informational characteristic of education. I start with a simple model combining basic motives to invest in education and expected results of that decision. The model is employed to demonstrate the demand for education and is combined with the utility function of education in one's lifetime. Finding the way how people decide about the amount of education they want to receive shows me the way to two basic theories of education.

Key words: signalling, education, demand for education, human capital

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Introduction

In the present paper[1], I deal with the question of education from different points of view. The general issue is the usability of education at the labour market. It is obvious that more education results in higher salary and generally better position in the labour market. Simple statistics easily reveals that. Nevertheless, what makes this difference? The well-known concepts of human capital known from Becker (Becker, 1993) and signalling behaviour at the labour market introduced by Spence in his seminal work (Spence, 1973) are the main competing explanations of this phenomenon.

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Before I will be able to look closely on their specific differences in terms of demand for education, I have to explain the general question how this demand is formed. This will be my task in the first part of this paper. After that I will explain briefly the main differences between the two concepts mentioned above and outline the differences from the demand point of view.

The method of my paper is a theoretical one; I am going to build a simple model and show theoretical differences between two different approaches. Foundation of my paper is broadening of the model used by Checchi (2006) for the human capital approach and invention of my own model for the signalling approach. I will be able to provide more precise characteristics of employment and education demand by pinpointing the theoretical differences between these two concepts. Both models are necessary simplifications and are not able to capture all the variables having impact at the demand, but, as it is said, a model able to capture all the aspects of reality is as useful as a map in scale 1:1.

I deal with the problem of education in a specific way, in order to take advantage from using concepts and methods well-known from the theory of information. Education can assume three different meanings and their distinction is very important for us. Firstly, education can be a product. People can buy it for cost (monetary and, more importantly, non-monetary) and consume. Their utility is set by their evaluation of education benefits compared with cost. In this sense, education is very similar to any other product that provides utility and where we can find specific buying decision.

Secondly, education can be seen as a form of investment and then we are able to assess, whether cost of acquiring an amount of education is surpassed by its long-term and necessarily depreciating benefits. In this sense, we work in time specified cost-benefit analysis environment. The precision of our assessment of the education value depends solely on the precision of the cost and benefit definition and information we have.

Finally, education might have been seen as information of its sort. This gives us chance to look at education in a very different way. When we want to theoretically describe education, we can (and should) use terms as asymmetry, imperfection and agent. Terms widely used in information theory, but very rarely in theory of education.

1. Demand for education

First of all, I start with basic principles how the demand for education is modelled in economic theory. This theory sees education as a means how to produce human capital, i.e. investment in human capital. Checchi (2006) tackles this issue from the human capital view and I will follow, in order to emphasize the differences between his approach and the signalling approach I describe later.

Demand for education is seen as the cost-benefit decision, simply weighing if marginal revenues from education prevail over (or at least balance) marginal costs. As a result, we have to deal with the cost and revenue sides of the equation.

Let's start with the revenue part of the model.[2] This is a two-period model where an individual lives in two periods verbally denoted as youth and adulthood, mathematically as period *t* and period *t+1*. Revenues are meant earnings in both periods and these earnings are the labour market's valuation of the individual's human capital. Wage is then a function of (the stock of) human capital (*H*) and productivity (β) with necessary attributes of human capital depreciation (δ) over time.

$$w_t = H_t \beta_t \tag{1}$$

$$w_{t+1} = \left[H_t(1-\delta) + \Delta H_t\right]\beta_{t+1} \tag{2}$$

Now we can constitute the long-term earnings as present value of earnings in both periods, where the discount factor ρ is determined by the character of the financial markets.[3]

$$W_T = W_t + \frac{w_{t+1}}{1+\rho} \tag{3}$$

The most important things here are factors that have more or less direct impact on the change of human capital between the two periods. Intuition says that it is the first period when an individual gains education in order to increase his or her human capital. This is simply because the earlier you gain an amount of education the more can you utilize it. But which aspects contribute to changes in human capital. In other words; what are the reasons that can

[2] Hence I follow the procedure outlined in Checchi (2006); however I have simplified some and extended other parts of his model.

[3] The discount factor depends on the financial markets' (im)perfection. However this goes beyond the topic of this paper.

lead someone to gain more education, or any education at all? What increases the required stock of human capital? Checchi (2006, p. 21) defines four such attributes: unobservable ability of an individual (*A*), external resources (*E*), time devoted to education (*S*) and finally the actual stock of human capital (*H*). Thus, the change in human capital is function of these four quantities and can be expressed as follows:

$$\Delta H_t = \left(\underset{+}{A}, \underset{+/-}{S_t}, \underset{+}{E_t}, \underset{+}{H_t} \right)^{\alpha}, \alpha < 1 \tag{4}$$

The impact of all these quantities on the change of human capital is positive, except for the actual stock of human capital, since its effect is ambiguous. The impact of an unobservable ability (this ability cannot be mistaken for humancapital itseelf) is positive because the higher is the original ability, the better is the utilization of any additional unit of human capital. This presumption is based on the fact that to utilize education, one has to have good basics to analyse it, digest it and eventually use it.

The impact of external resources is obvious enough. The better is the equipment, the easier the process of acquiring education (or any change of human capital). Time devoted to education (*S*) has positive impact because we assume that education is time-consuming and with growing amount of time devoted to education increases its volume. Only the impact of the actual stock of human capital is ambiguous. That is because on one hand, the positive impact is similar to the impact of innate ability. But on the other hand, decreasing returns to scale induce decreasing marginal returns from education.

Function (4) shows the four major impacts on the human capital changes. We put this impact aside for a moment and return to them when we compare these impacts with the signalling theory. Now we turn to the cost side of the human capital theory of education.

When we analyse the cost of education, we can see at a glance the basic difference between monetary and non-monetary cost. Because we have ignored the non-monetary benefits (which no doubt exist), we disregard the non-monetary cost as well. The monetary costs can be either direct or indirect. Direct costs are first and foremost the tuition fees and costs like books and transport to the educational facility. Unlike Checchi (2006, p. 21) I don't consider costs that would have been spent no matter what the decision an individual makes (e.g. living costs that an individual expends whichever level of duration she chooses). I denote the direct costs by

c_d. The indirect costs (c_i) are opportunity costs represented by foregone income and they can be expressed as follows:

$$c_i = S_t H_t \beta_t \tag{5}$$

Where S_t denotes the time devoted to education in the first period. This expression formulates the foregone income (level of human capital/human capital stock H combined with the productivity β) in time. By taking the first-order condition with respect to S_t, the (direct and indirect) marginal cost of education is $\beta_t H_t$.

From the previous, we can derive the education demand function as an amount of time that an individual wants to sacrifice to education. The marginal cost of education must equal the marginal revenues from it. The final demand is function of six variables and can be expressed as follows:

$$S^* = S\left(\underset{+}{A}, \underset{+/-}{H_t}, \underset{+}{\frac{\beta_{t+1}}{\beta_t}}, \underset{-}{\theta_t}, \underset{-}{\gamma_t}, \underset{+}{E_t} \right) \tag{6}$$

Demand for education according to the theory of human capital is then positive function od ability A, productivity growth β_{t+1}/β_t and external resources E. Increase in these three variables causes increase in time devoted to education and thus generally in education demand. At the same time it is negative function of direct (γ) and indirect (θ) costs that are expressed in their dynamic version, because faster cost growth definitely reduces the demand for education. As was explained above, the impact of the actual stock of human capital (H) is ambiguous.

2. Information in education – signalling vs. human capital

In this part, I start dealing with a different concept of education; concept which has been introduced by Spence (1973). Spence doesn't consider education as a means of enhancing person's productivity, but as a proof someone already has this productivity (hidden ability). The signalling theory is well-known, so I will not explain it in detail and I will take advantage of the model presented in previous part instead. Before I get to this task, let's look at education in (for someone) maybe surprising perspective of the information theory.

At first glance, the similarity is quite easily visible and understandable. Potential employees enter the labour market with information about their education. Very often there is the

"education" part at the very beginning of curriculum vitae. Very often it is also the initial question of a job interview. But what information does it really carry? The human capital theory states that this information is "what the person in question can do, what he/she knows". The signalling approach is different. The information is not what a person can actually do but what a person has achieved to show (signal) what he/she can do.

If we look closer at the theoretical background, we can see plethora of attributes that information should or shouldn't carry. I'll only briefly highlight the most important ones to show how education can be seen in its informational nature. However, it is very important to distinct when we talk about education that is seen as (and gains attributes of) information and when it is only information about education. Let's get through basic features of information.[4]

Firstly, it is **costly to produce and cheap to reproduce**. Education just as information is very costly to produce. Information as something new and original is costly, but once this information is out, it is very easy to reproduce it. In contrast to that, education is very costly to gain and is very closely bound up to the person that has received it, so its reproduction is not easy and cheap.

Another feature of information is that it **cannot be actively disposed of and that it can be sold or told without being given away**. Yes, people may forget, but in this meaning forgetting works like depreciation of capital. Capital inevitably ages, so does information. But you can't sell it to someone else and not have it from that moment on. The same holds for education, the moment you acquire it, you have it forever. You can spread your education, but that doesn't mean that you lose it. Information and education are not standard goods, because those can usually have only one owner.

Information cannot be **prevented from spreading**. In this sense, again, it is very similar to education. Education, when acquired, is very hard to be kept secret. Of course, if you are a civil engineering graduate and don't tell it to anyone, people don't know. But your education reveals itself in your decisions, in this example the job you choose.

Finally, the two very important features of information hold for education, too. **Information cannot be detected in a person and it cannot be valued before it is known**. You don't know if someone possesses a specific piece of information, you don't know if someone knows something. The same situation comes with education. When you meet someone, you don't

[4] Here I use the taxonomy used in Birchler, Büttler, 2007.

know if he or she has a degree or masters three foreign languages. This person must want to show its abilities, knowledge and skills to other people.

And at last, until information is known, you don't know the value of it. Maybe you already know the fact, then that specific piece of information is worthless, or it can significantly change your decision and its value is enormous for you. Exactly the same holds true for education. You cannot assess the value of someone's education, e.g. if you are an employer wanting to hire new labour force, until you know more. And exactly this feature of information and education leads us to the theory of signalling.

3. Signalling demand function

After previous outline of how education can be seen as information, I can fulfil the promise to set the demand model for education with respect to its signalling quality. It is obvious this model will have different attributes than the model explained in part 1 since the cost and benefit sides of the equation differs, more or less significantly. Since the Spence's model of signalling is very well-known, I will repeat only its basic features.

Firstly, the **individual productivity is not observable**. No one can know or estimate the productivity of someone else before he can be seen at work. This is mostly important for the employee-employer relations, where hiring an employee under a specific wage rate is an act of risk, because the optimal solution of balancing productivity with wage is not ensured.

That's why, secondly, employees try to send specific **signals** to show that their productivity is high and they deserve higher salary than the rest of the pool. This signal is education and employees show their productivity level by sending signal of the education level. The prerequisite for this is that people with higher education level reach higher productivity level.

And finally, but most importantly, the **cost of education** is different for differently endowed individuals. Why don't all the people aspire to the highest possible level of education? Because for some, the cost of reaching it is higher than for others, so high, that benefits are exceeded by cost. We can imagine it as a scale of education, where with every step a group of individuals drops out. The logic is simple; firstly the less productive group drops out, because reaching the next level poses too high costs. That is why signalling can work, for the most productive group the cost of reaching the highest levels of education poses lower costs.

Now we can constitute the demand model including the signalling function. The model works differently for employees and employers. Both need to make a decision but only employers' decision includes risk. Prospective employees choose the education level according to their productivity which means cost. They choose between two possibilities. Either they can start immediately and expect lower lifetime earnings, or they can sacrifice certain amount of time for education and after that period start working with higher expected lifetime earnings.

Employers have to set up different wage scales for different education levels and then assign employees to appropriate wage rate according to their productivity. The only chance how to estimate the productivity level is employee's education level. This is the first period decision. After a time, in next period, the employers discover the actual productivity of novice employees and they find out whether the wage scale has been set appropriately. If not, they change its setting for next round of hiring. This is how we get multiple subsequent rounds of this game. If employers don't have to adjust the wage scheme for next round, Spence (1973) calls it confirmation of their beliefs.

Now, let's compose the demand function in a similar way as in first part of the paper, yet with the signalling function of education in mind.

Wage is no longer function of human capital and productivity, but function of a signal.

$$W_t = f(L_t) \tag{7}$$

where L means a specific signal. Naturally we have to ask, what affects the strength of this signal. Apparently it is its reliability, but this reliability depends on the fact if employers can trust the signals that prospective employees send. As we have stated above, this system works as repeated games and employers adjust their decisions until their beliefs about the signal-productivity relation are confirmed. So, the higher is the number of rounds, the more are signals reliable. Wage is then composed of two elements, an autonomous part of the signal L_A and the part depending on its reliability r:

$$w = rL + L_A \tag{8}$$

When employers confirm or fine-tune their believes in repeated games, there is no need to doubt the signal and the reliability coefficient rises to 1. But in the initial rounds it can be significantly lower. Reliability itself is function of the game round g and signal specifics α:

$$r = f(g, \alpha) \tag{9}$$

Where α represents so called signal specifics, i.e. ability of the signal to be reliable. In the case of education, this can be for example how exactly the education content matches employers' demand.

The cost side of the model offers another sight at the problem of education as signal. Again, we neglect non-monetary cost. As for monetary cost, we can differ direct costs (fees, books etc.) and indirect. Direct costs are very similar to the situation described above while focusing on human capital theory. Nevertheless, indirect costs are slightly different. Similarly, there is foregone income that we have to count as a cost. But his foregone income is derived from the wage function in equation (8). We transform this equation to:

$$w = r\Delta L + \bar{L} \tag{10}$$

The $\bar{L}$ part of the wage is the wage acquired without a signal (let's say without a university degree) – we call it **generic signal wage.** The part $r\Delta L$ is real impact of an acquired signal depending on its reliability r.

We use a multi-period model to show how foregone income can gain different values. Let's assume that an individual worker faces a decision between two options. Either she can start working from now on and continue for a limited amount of time until T. Her long-term earnings are the simply sum of present values of generic signal wages:

$$w_g = \sum_{n=1}^{T} \frac{\bar{L}}{(1+\rho)^n} \tag{11}$$

Or this worker can wait and start earning later more. Formally, this worker earns an amount corresponding to wage in (10), which is apparently higher than generic signal wage. But she starts earning later, not in period 1, but in period t such that $t>1$. Her long-term earnings are then:

$$w_s = \sum_{n=t}^{T} \frac{r\Delta L + \bar{L}}{(1+\rho)^n} \tag{12}$$

The present value of education expressed in long-term wage differentials is then the difference between generic and signal wage w_g-w_s and depends positively on t and negatively

on r, ΔL and ρ. Foregone income is than the income that our worker could have earned while she was studying, thus from period *1* to period *t*:

$$w_f = \sum_{n=1}^{t} \frac{\bar{L}}{(1+\rho)^n} \tag{13}$$

Another sort of cost, and very important one, is the cost of acquiring the signal. In human capital theory these costs are not calculated, since education really enhances productivity. So these costs are directly balanced by productivity growth. But, in signalling theory we face different situation. Productivity is already presented "in a person" and everyone has a theoretical chance to reach the highest level of education. But for some, the less endowed, the cost of achieving this highest level are substantially higher than for others. That's why we have to calculate these costs separately. Formally, the costs of acquiring education are function of endowed productivity:

$$c_a = f\left(\underset{-}{\beta}\right) \tag{14}$$

Let's now compose the cost function of education in signalling situation. We have three partial cost functions, direct costs (c_d), foregone income (w_f) and acquiring costs (c_a).

$$c = c_d + w_f + c_a \tag{15}$$

Now we can advance to how the demand for education is constructed in situation of signalling behaviour. What affects the decision? It is the net present value of education expressed as:

$$NPV_E = (w_g - w_s) - (c_d + w_f + c_a) \tag{16}$$

And the demand for education in years can be then expressed via a simple model. Let's suppose that an individual faces decision between two possible scenarios. Either he can work for a longer time A and receive the generic wage w_g, or can he devote some time to studying and work shorter time B for signalling wage w_s. There are two preconditions for that model, apparently that $A > B$ and that $r\Delta L+\bar{L} > \bar{L}$. Our individual will be indifferent between these two options if:

$$A \cdot \bar{L} = B \cdot (r\Delta L + \bar{L}) \tag{17}$$

We can interpret this as an optimum condition and modify it as follows:

$$\frac{A}{B} = \frac{r\Delta L + \bar{L}}{\bar{L}}$$

That means the relation of two education lengths equals the relation of two wage schemes. We know that the length of education is $S=A-B$, thus $A=B+S$, and can modify:

$$\frac{B+S}{B} = \frac{r\Delta L + \bar{L}}{\bar{L}}$$

$$1+\frac{S}{B} = 1+\frac{r\Delta \bar{L}}{\bar{L}}$$

$$\frac{S}{B} = \frac{r\Delta \bar{L}}{\bar{L}} \tag{18}$$

From (18) we can see that the ratio between study years and after-study working years must be the same as the per cent increase of salary (with coefficient of signal reliability *r*). If we denote the salary increase by coefficient *l*, we can express the function of education demand in years as:

$$S = r \cdot l \cdot B \tag{19}$$

The number of years someone is willing to devote to education positively depends on the number of years he will be earning (*B*), the salary increase after his studies (*l*) and the reliability of the signal he's sending for the employer (*r*).

Finally, we get to the general expression of demand for education under the signalling behaviour assumption.

$$S^* = S\left(\underset{+}{A}, \underset{+}{E}, \underset{-}{\bar{L}}, \underset{+}{r}, \underset{+}{B}, \underset{-}{\gamma}, \underset{-}{\theta}\right) \tag{20}$$

where ability (*A*),external resources (*E*), reliability of a signal (*r*) and remaining earning years (*B*) have positive impact, whereas the impacts of generic signal wage ($\bar{L}$) and direct, resp. indirect cost (γ, θ) are negative.

If we compare the two demand functions in (*6*) and (*20*), we can see similarities but also some significant differences. The impact of external resources, ability and direct costs are very similar. But we have some different variables in respective equations. The indirect costs seem to have similar impact as well, but remember that they are constructed differently in both

approaches, especially forgone income. In both human capital theory and the signalling theory the foregone income depends on wage (productivity times human capital, resp. generic signal wage scheme) and time devoted to education, but the construction is different. In addition to that, there is another sort of indirect cost in signalling theory, acquiring costs that are directly related to productivity.

On the other side we have differences in "revenue" part of the demand. In human capital theory, this revenue part is represented by the actual stock of human capital and growth of individual productivity. In signalling theory, demand for education depends on the generic signal wage (negative reliance), that means the higher is the wage that an individual can gain without education; the lower is the educational demand. Furthermore, demand grows with reliability of the signal. This simply means that if employers trust signals they receive from the labour market, prospective employees will demand more education. And lastly and possibly most importantly, demand for education grows as the time someone earns the signalling salary extends (variable *B* in *20*). So, to exactly model demand we have to predict the life-working time.

Conclusion

From the previous we have seen that variables constructing demand for education depend on the model environment we accept. If we work under the human capital assumptions, we use variables of productivity and human capital stock, i.e. endowment of human capital that causes a certain level of productivity. Productivity then has direct impact on wage scheme that is offered to specific employees.

However, if we work under the signalling behaviour assumption, we work with productivity as well, but here productivity is important not for the wage scheme. Here it is importnant for cost that individual has to expend to gain certain level of education, level that that guarantees higher wage scheme. Another factor, the reliability of the signal for employers, comes into discussion as well, because there is situation of uncertainty on the employers' side.

We can conclude by a remark that in signalling theory education becomes much more risky in terms of gaining such wage scheme that leads to full counterbalancing the cost than in human capital theory. Demand for education will then be lower under that condition.

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