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„Schooling as human capital or signal: evidence from polish labor market“

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Introduction

During last 60 years the world is experiencing rapid economical growth, which is hard to compare with anything that happened before. According to the World Bank, world GDP grow from 1.35 trillion USD in year 1960 to more than 61 in trillions in 2008. A key feature of this growth is that previous predictions, which were based on forecasts of the dynamics of the working population and physical capital, were not very reliable.

Because these forecasts were not reliable, people started to pay more attention to workers educational attainment in order to improve forecasts. Two major theories were proposed: human capital and signaling. Although the predictions of both theories are similar if we compare wages and earnings, their policy implications are completely different. One predicts the complete uselessness of education in terms of productivity, another makes it a crucial component of economic growth. There are also some propositions to combine both hypotheses to fit a model better to the data.

In this work I will try to find evidence of existing employees signaling their skill to their employer in the Polish labor market. To achieve that goal I will try to find evidence of a positive relationship between the intensity of tertiary education infrastructure and the probability that an individual will drop out of high school. To do that I will use a sample of the PGSS (Polish General Social Survey – Social Diagnosis), consisting of answers to about 9 thousand respondents who provided information such as their educational attainment, place of living, and parents’ educational attainment. Restricting the sample to the years 1975 – 1998 (due to administrative reforms) I will make a logit estimation, which will help to evaluate the impact of tertiary education on high school dropouts.

In part one of my paper I will concentrate on human capital theory. First, I will present basic concept of this theory, some important facts concerning history of this theory and its development over time. After that I will describe the simplest model: the concept of specific and general training. I will end this section with presentations of empirical results of previous studies concerning human capital.

The second chapter will be devoted to concept of signaling in education. I will briefly explain the theory, assumptions and a basic model proposed by Spence (1973). After that I will extend the model in several ways, by relaxing the assumptions of the strictly informative function of the model, assuming the benefits of signaling, and trying to assess level of investment in education with majority voting.

Later I will present some previous studies, which were aimed at measuring importance of

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1 World Development Indicators 2010 by World Bank
human capital and signaling in the real world. This will include different ways of calculating these impacts, made by different authors on different samples.

I will devote the fourth part to present the database, variables, the motivation of choosing this specific period of time for the sample, and some descriptive statistics.

After that I will present the results of my estimations, different specifications of the model and the results calculated exclusively for male and female subsamples. The work will end with brief conclusions.
PART I. HUMAN CAPITAL THEORY

Human capital theory concerns all activities that may increase wages in the future. According to the theory there is an efficient labor market in which workers are paid according to its productivity. Workers can “invest” in their productivity by attending school, training, or relocating. This investment can lead to a relatively higher level of productivity of workers. Acquired skills give a competitive advantage and help workers to earn higher wages.

1.1. Short history of the theory

In the late 1950's and early 1960's many countries were experiencing fast economic growth and significant increases in school enrollment. At that time, people started to consider educational expenses as an investment. For example, in Hague in 1959, someone suggested that there is a positive correlation between a qualified workforce and economic growth.

Schultz (1961) and Becker (1975) are considered to be the fathers of human capital theory, although even Adam Smith mentions it. Adam Smith (1776) in his famous book Wealth of Nations wrote:

“Fourthly, of the acquired and useful abilities of all the inhabitants or members of the society. The acquisition of such talents, by the maintenance of the acquirer during his education, study, or apprenticeship, always costs a real expense, which is a capital fixed and realized, as it were, in his person. Those talents, as they make a part of his fortune, so do they likewise that of the society to which he belongs. The improved dexterity of a workman may be considered in the same light as a machine or instrument of trade which facilitates and abridges labor, and which, though it costs a certain expense, repays that expense with a profit.”

But no formal theory was made until the second half of the twentieth century. A theory proposing another type of capital – human capital - was proposed by Schultz in a response to the growing discrepancies between the growth rates of the labor force and physical capital, compared to GDP growth. He argued that, with the evolution of labor activities, human capital started to be responsible for a significant share of GDP. In the era of classical economists, workers employed in the manufacturing industries were doing very simple and repeatable tasks which did not demand high skills or education. The great success of Henry Ford in the beginning of the 20th century was to combine division of labor (which increase labor productivity) with delegation of simple repeatable

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tasks to uneducated workers (which made them easy replaceable). But this business model became less applicable in the 50's and 60's.

At that time physical capital as a share of total output was getting lower although in it was assumed to be fixed (for example this is one of the assumptions of Solow Growth Model). However, the lower income for farmer workers who switched to non-farming sectors, or the different employment opportunities for young and old people could not be explained under this assumption. Schultz’ explanation of these phenomena was that one type of capital (physical) was replaced by other one (human). That was the cause of higher economic growth than was expected observing data on hours worked and stocks of physical capital. Farmers employed in other industries were lacking sector-specific knowledge, which made them relatively less productive and resulted in lower wages. He also argued that younger job seekers had a higher probability of being employed because they finished not 6 but 12 years of education on average. Classical theories of economics failed to explain this, so Schultz’ theory of capital formation quickly gained popularity.

1.2. Specificity of Human Capital

There are significant differences between human and physical capital:
1. Human capital theory concentrates on the laborer, not on the owner or manager of the firm.
2. The workforce are “investors” in the scope of this work; they decide whether or not to acquire skills and continue education.
3. Human Capital cannot be acquired by exchange nor in the simple production process.
4. Firm cannot purchase human capital; it can be only rented from the workers.

Schultz anticipated problems with measuring human capital and, therefore, divided the investment expenditure in human capital into five major components: (1) health infrastructure and services, which increases people expected life duration, health and stamina; (2) on-the-job training, including apprenticeship and various trainings organized for the employees by the company; (3) formally organized education at the elementary, secondary, and higher levels; (4) study programs for adults that are not organized by firms, including extension programs notably in agriculture; (5) spending on the migration of individuals to find job which will use larger share of worker skills and which mean higher earning for them. According to Becker (1975) every activity that leads to an increase in human wages by not investing in physical capital can be considered a human capital investment.
1.3. Simple Model

Becker (1962) was the first person to formally propose a human capital theory. His motivation in developing such a model was because “theories of firm behavior, no matter how they differ in other respects, almost invariably ignore the effect of the productive process itself on worker productivity”. He argued that apprenticeship, or on-the-job training, raises worker productivity but is a costly process (which is why demand for such training is limited). The cost must be included not only in the resources devoted for such training, but also in the time and effort of the workers involved. It is assumed that the labor and product markets are perfectly competitive.

In a simple one-period model with these conditions, the marginal product of labor is equal to the wage, because neither the employee, nor employer have an incentive to invest in the given worker’s productivity. This changes when a worker stays on the market for several periods and the possibility of training exists. Then the simple equality between wages and marginal product is transformed into

1. \(MP_0 + G = W_0 + C\), where
- \(MP_0\) – worker productivity in time 0
- \(G\) – discounted present value of investment in training
- \(W_0\) – wages in period 0
- \(C\) – cost of training

Now the marginal product in first period is equal to wages if and only if the net present value of the investment in training is equal to 0. Yet who finances this investment and who will benefit from it? The answer is one of the most popular in economics – it depends. It depends on the type of training this employee receives and whether or not the abilities acquired in the process of training can be used in other firms. Becker proposes to divide the training into two subgroups: general and specific.

1.4. General Training

General training is related to employee attributes such as competency, the ability to apply knowledge, and personality attributes, which increase the potential wage of the worker throughout the labor market. On the other hand, if change of one of this characteristics change only person productivity in given sector/firm without affecting “market valuation” of given person then we can say that this is specific training. Will the company has incentives to invest in the general training of

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employees? Firms would have incentive for such investments only if the productivity of the workers would grow faster than their wages and the firm could at least partially profit from these investments. But this is impossible in a perfectly competitive labor market – workers who receive training can be employed by other companies for higher wages. To secure itself from the loss of the worker, the firm would have to pay wages equal to this marginal cost, in which case it has no incentive to provide general training. Yet firms provide general training, but only when they are not bearing the costs. Workers who want to have this type of training have to finance it themselves.

This can be shown using equation 1. Because the training in general skills increases worker valuation, the net benefit from an investment is equal to 0, because increases in productivity are outweighed by higher wages. So firms do not gain anything. If we calculate the base wage (worker salary in period 1) we have:

2. \( W_0 = MP_0 - C \), because \( G = 0 \)

Wages do not equal the marginal product but is diminished by the cost of training. If the employee wants to earn more in the future, they need to sacrifice present consumption. That is the reason why internship earnings are low and sometimes negative (including cost of accommodation) although these employees’ life-time earning are high.

General training has a large impact on labor earnings. On one hand it lowers wages due to financing the general training; on the other hand new skills increase worker productivity, which increase their productivity. That makes future earnings higher than they would have been without training. The graph below represents the hypothetical evolution of wages in time.
Line UU shows the typical worker’s lifetime wages without receiving general training. His earnings are constant through his whole life (ceteris paribus). When starting work his earnings are the highest compared to other workers, due to a lack of training. The worker earns his potential level of earnings because he is not investing anything in future productivity.

Line TT is an example of a worker who continuously optimizes his level of investment in training. At the beginning of his working career this investment will be beneficial for a long time (whole working life), which makes this kind of investments very attractive. What is more, the worker is young and does not has any type of training so learning is relatively fast and cheap – achieving basic knowledge about the work will significantly raise his productivity. That is the reason why, in the beginning, earnings are so low and rise sharply. Personal incentives to invest are very high, which makes the worker postpone a large share of current consumption for a higher one in the future. During the later stages of a worker’s career, these incentives decrease and earnings increases are smaller; the curve became concave instead of convex. We can see that the difference in earnings between a worker who is optimizing his level of training and his counterpart who has
constant earnings is the distance between U and T. At the beginning of their career, the disproportion in wages is very high. But when time goes by this gap is narrowing and in the end of their careers, person TT earns much more than UU.

Curve T'T' corresponds to the theoretical worker who has invested in training only in first period and after that became passive and was benefiting only from this training in next periods of his working life.

In conclusion, general training should be financed by the worker and not the employer because, due to opportunistic worker behavior and the firm’s inability to extract rent from more educated units, firms have no incentive to invest in workers. Becker (1962) gave the example of staff rotation in the American army. Recruits have a wide variety of training that can be used in the civilian sector like machine repairing or piloting. Training which is mainly provided in first period of military service is negatively correlated with the reenlistment rates; the more training soldiers receive, the higher is the probability that will leave the army. This is because wages are significantly higher in civilian sector than in army, and although there is motivation to join the army to acquire new skills, there is no such motivation to continue a career there. One of the most striking examples are pilots in commercial American airlines who, in an overwhelming majority, began their career in the armed forces.

1.5. Specific Training

On the other hand, there are some jobs in the military that require a high level of skills and training but where the turnover rate is significantly lower. Astronauts or rocket service specialists are less willing to leave the army for the private sector. Questions arise concerning this phenomena: Why do those people not leave army in order to achieve higher wages elsewhere? They are high skilled employees with sophisticated and specialist training. They are eligible for the same wages as pilots. The answer is simple – they are not leaving the army because they would earn less in private sector. Although this group of workers receives significant amounts of training, their resulting abilities have no practical use in the private sector. It is clear that some of the training allows the workers to acquire level skills which can only be implemented in firms that provide the training, and has no impact on worker productivity in other firms/sectors. Training which increases worker productivity in a given firm but keeps productivity of the same worker constant outside the firm is an idealized example of specific training. Job training is often specific to the firm, for example, familiarizing workers with the structure of the firm is a specific type of training, in which company will likely invest because it will benefit the company yet have no impact on worker market
valuation and could not be used in other firms.

The effect of investment in worker skills on productivity in other firms depends to some extent on market conditions. A monopolist has on market more specific knowledge than firms that operate in a highly competitive market. It is due to market concentration – the less firms operate, the more specific is knowledge from given industry.

The fact that specific human capital has a dissimilar impact on different firms has several implications concerning the investment patterns and sources of investments in human capital. In a hypothetical market, where every training is a specific one, wages available on the market would be completely independent from the amount of training a worker received. It is because of specificity of the acquired skills – they are useless in other firms. If that would be the case, workers would not have incentives for paying for training because it would be at a pure economic loss for them. In that case firms will be prone to invest, because they are the only ones to benefit from the workers’ higher productivity. So, whenever costs outweigh the benefits, firms devote resources to training. This can be presented as the following equation:

\[
MP'_0 + G(\sum (MP_t - W_t)/(1+i)^t) = W_0 + C,
\]

where

- \(MP'_0\) – worker productivity in time 0
- \(G\) – discounted present value of investment in training
- \(W_0\) – worker opportunity wage in period 0
- \(C\) – cost of training worker in period 0
- \(MP_t\) – worker marginal productivity in period t
- \(W_t\) – worker wages in period t

In that situation wage rate \(W\) is a wage rate that can be achieved on the market and it does not depend on the quantity of training that the worker received. It is also worth mentioning that \(MP'_0\) should be rather considered as opportunity and not the real marginal product. In that case \(MP_t - W_t\) is a return from the investment which is completely acquired by the firm, employee return to the investment is equal to 0. But does this mean that the situation where employees cover the costs of training and receive all benefits is not possible? It depends on the turnover rate. On one hand it is an undesirable situation for the firm to lose its employee in which they invested, but on the other hand workers also suffer capital losses if they are laid off from the job. If the worker is privately financing his training, the firm has no incentive to keep him employed when layoffs are required. On the other hand, workers with specific knowledge funded by firms is more precious to them and their loss is related with financial losses of firm. Employers recognize this process and offer higher wages in order to stop or decrease the turnover of specialist staff. Firms pay for workers equipped with general human capital wages that they can achieve anywhere else and pay workers with
specialized knowledge higher wages than those that they could potentially earn at a different company. On the other hand, employee-financed specific training has similar effects to general training, making the payout profile of workers steeper and more concave.

Specific (and sponsored by employer) training because of different sources of financing and benefiting in comparison to general training also causes firms to behave differently. Workers are less prone to quit that firm because of their specific training and the firm wants to keep them in order to continue “renting” the workers skill, a result of the investment that the firm made. Lets consider a situation, where a firm is facing a negative shock that decreases employees productivity but is sufficiently small that rest of the economy is not affected. The firm’s response to such a situation is to decrease the wages of workers with general training (or to fire them) to outbalance the costs of the shock. Both of these responses will lead to generally trained workers leaving the firm. The situation is different with specialized workers who earn less than their short-term productivity. If a productivity fall is smaller than company profits for a given person then the firm will have no incentive to layoff this worker. What is more, even in a more severe but temporal crisis when productivity falls below wages, the firm still would not want to lay off specialists because there is a risk that given person will be employed in different firm and its investment in training would be lost forever. So we can see that the probability that that person will be fired is negatively correlated with the amount of investment sponsored by the employer.

1.6. On – the – job training according to different authors

Becker was not the first economist who recognized problem of financing on – the – job training. Even before World War I, Pigou (1912) argued that firms would not have efficient incentives to invest in skills of their workers, due to the uncertainty concerning workers leaving the firm for a better paid job. Rosenstein-Rodan (1943) while analyzing situation and proposing future plans of rebuilding economy in Eastern and South – Eastern Europe, stressed the fact that training would be the factor that boosts the economy and increases the speed of industrialization. But according to him it will not happen only by market forces. He postulate larger share of government spending in GDP of states and international loans to this region. These early contributions to the human capital theory did not distinguishing between specific and general training. That view was created mostly by Becker, who argued that firms should invest (cover the cost of investment) in that kind of human capital to bind the employee with the given firm. This would decrease the risk of losing already invested capital due to worker independence.

Some alternatives to Becker’s theories explaining firm behavior exists. Loewenstein and
Spletzer (1998) using the 1988-91 NLSY data base find out that the employer bears most of the costs related to training. But the stunning thing is that the findings presented above hold even if general training is considered. Authors propose a model which explains this behavior, which at first glance seems to be illogical. Sharing training funding between both sides is caused by the employer’s lack of credibility to commit to future wages. By offering an employee this kind of training, the employer increases the future valuation of the worker. In that case he is forced to pay more to the employee to decrease his quitting rate. The employer may thus shares the cost of specific as well as general training. Autor (2001) proposes a different explanation of these phenomena. He assumes incomplete information in the labor market and complementarity between abilities and general skills training. Usually higher demand for general training in this model means that the worker is more productive. Training induces a self – selection of employees, which is related to the screening hypothesis on which I will concentrate later. Cost of the training is indirectly financed by the employees – their wage level is significantly below marginal productivity.

1.7. Empirical Research

Human capital theory gained popularity very quickly and, although modified, has expanded in past years without losing its validity. Its usefulness is to explain the differences in wages more precisely. Larger variation in income could be explained by the different levels of education or more work experience. So this theory differentiates the labor force and workers were not homogenous any more. Many authors argued that predictions of considered theory fits to the reality based on empirical data. There is a problem with early empirical works. There were not too reliable measures about on-the-job training which seems to largely explain wage levels. But in 1975 Becker (1975) argued that every additional year in college increases an average worker’s salary by 10-12%, which supports human capital theory (HC). Freeman (1976) in his research came to the conclusion that during the 1960's, the relative remuneration of people with college education in comparison with high school alumni rose sharply. Likewise, studies explaining wage growth paths are mostly consistent with human capital theory. Neumark and Taubman (1995) tested a general human capital theory using NLSY database. These authors came to conclusion that young workers who are on the labor market for short period of time, sacrifice their current income in exchange for higher earnings in the future. This relationship maybe opposite for older workers. Also in favor of HC, but using different estimation techniques, was research conducted by Reilly (1995). Results showed that differences in remunerations between small and big companies seem to be insignificant when several proxies of HC are included.
Neal’s (1995) research goes further to suggest some extensions to Becker’s basic theory. Using displaced worker surveys (DWS) he calculated not only the costs of switching to other firms in the same industry but also to switching industries. His results showed that the simple division of human capital (general and specific) is insufficient because some industry-specific human capital also exists.

Unfortunately some studies that are use more direct data about the human capital fail to support Becker’s theory. Hansson (2009) researched the consulting establishment where HC is crucial and concludes that employers are able to extract returns from general trainings. His studies are in line with Barren (1999), who concludes that employers pay for most of the trainings (even general) and extract most of the rent from this investment. Autor (2001) argue that firms can temporarily pay for general skills training because it is in their business. Acemoglu and Pischke (1998) found out that employers take on the costs of apprenticeship although skills learned there are applicable across firms. Becker’s theory predicts that employers are not willing to pay for general training because perfect information and labor mobility is assumed, which is quite controversial. That is why Katz and Ziderman (1990) postulate that an entrepreneur may be willing to invest in general training because workers do not know about their employment opportunities in different firms and are unwilling to pay the transaction costs related to changing to a new workplace.
PART II. SIGNALING THEORY

A simple theory explaining the higher income of more educated persons was presented above. The theory suggested that people who attain higher levels of education are more productive. Does it fully explain this relationship? According to the father of human capital theory (HC): “General observation indicates that college graduates tend to be more "able" than high-school graduates, apart from the effect of college education”⁴ This is an argument against HC and in favor of an alternative wage differential theory, the screening (signaling) hypothesis. The screening hypothesis assumes that schooling does not increase a given worker’s productivity, but helps firms to differentiate low and high productivity workers in the job market.

2.1. Introduction

Micheal Spence is known as the father of signaling theory. In his classic work (1973) he proposed an education model that is significantly different from HC. He argued that Becker’s assumption of symmetric, full, free and instantly achieved information does not match reality, and that hiring is a process that involves uncertainty. Employers are not certain about employee skills or knowledge when employing a new worker. What is more, they may not achieve this knowledge instantly after hiring them because it takes time to learn a worker’s productivity. This is the uncertainty that Spence highlighted. He argued that “To hire someone, then, is frequently to purchase a lottery”⁵, where the cost of purchasing a lottery ticket is identified with the wage paid to the employee. Although the entrepreneur cannot observe productivity characteristics of given workers, but it does not mean he is unable to observe any characteristics. Information about gender, age, education, sex, race, criminal record and many more features are readily available during the employment process.

It is clear that some of these characteristics are exogenous (age, sex) while others can be influenced by the potential employee (for example education). In literature there is a clear division concerning these characteristics; exogenous ones are called “indices” while endogenous ones are “signals”. The former traits are given less consideration due to market participants’ inability to affect them and the latter ones are considered first but are are optimized by employees to maximize their earnings/utility.

According to this model an employer will learn average worker productivity after some

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⁴ Becker, G. (1975) A Theoretical and Empirical Analysis, with Special Reference to Education, 2nd ed. NBER p.232
period of time. On this basis he can evaluate new candidates more precisely. Indices and signals affect conditional probability that the person is (not) a high ability one. Employees also can observe impact of indices and signals on employment opportunities and choose a given level of the latter to maximize their salaries. This in turn affects labor market conditional probabilities.

2.2. Assumptions

Signaling theory assumes that whole population (at least in terms of productivity) can be described by one parameter $\Theta$ which measure personal productivity. In simplest model people can be or high ability $\Theta_1$ or low $\Theta_2$ (its mean that the work which efficient type will make in one hour, for inefficient laborer it takes $\Theta_1/\Theta_2$ hours which is greater than one. It is convenient to set price of produced good to 1. The share of highly productive workers in the population is denoted by $h_1$. Next we assume that although workers know their own type, employers do not posses this information. It is also assumed that firms operate in perfectly competitive environments and are risk neutral (which greatly simplify calculations). Moreover, employers cannot directly observe productivity of given worker or cost of achieving this knowledge is prohibitively high but average workers productivity is observable and free. Next, a simplifying assumption states that there are no others factors of production. In basic model it is also assumed that workers wage is perfectly inelastic

Perfect competition between firms guarantees that workers are remunerated according to their productivity. Because employers are unable to distinguish between the two types of workers, they weight their wages based on both types of productivity, which is equal to:

$$h_1\Theta_1+(1-h_1)\Theta_2=\Theta_{AVERAGE}$$

As we can see $\Theta_1>\Theta_{AVERAGE}>\Theta_2$ so workers from first group have an incentive to identify themselves as highly productive. Unfortunately it is impossible (or not cost effective) to directly sort them according to their productivity. On the other hand, it is possible for able workers to convince employers that they are more productive, or at least that it is more likely that they are more productive. It can be done in two ways:

- by having different indices which is independent of workers will, agent cannot influence this statistics, which Make them less attractive in point of view of optimizing agent

- by having different signals that suggest a workers productivity level and are determined by individual decision making based on a choice that is influenced by an individual’s personal opportunity costs– here agents optimization behavior can be observed.

Spence (1973) proposed to consider education as one of the type of signal. He argues that productive workers will try to invest that much in education to distinguish themselves from workers
with lower productivity levels. The problem they face is in maximizing the difference between offered wages and the cost related to achieving a certain level of education. Here it is worth mentioning one of the most crucial assumption in this theory. It is assumed that costs of education are negatively correlated with a given worker’s productivity. To assume that less able workers are facing greater cost of attending school is so important, because if this condition would not be fulfilled, then they would have incentives to mimic high productivity workers. We should not consider signaling cost only in terms of cash, it involves time and effort as well.

2.3. Simple Model

Lets assume that the cost of education is linear. Higher productivity workers face the cost of education $c_1$ equal to $y_1$, which is the number of years spent in school, while low productivity workers face proportionately higher costs:

2. $y_1 = c$
3. $y_2 = ac$, where $a > 0$

The equilibrium depends heavily on market participants’ beliefs. Spencer (1973) assumed that there is some level of education $y^*$ that guarantees full separation on the market. If a person achieves at least this level of education ($y \geq y^*$), then, with probability equal to one, we can say that this person has high abilities. On the other hand if a person spend less years in school ($y < y^*$) then employer is 100% sure that he employ a low ability worker. With given conditional beliefs about this worker productivity, the employer (firms operate in a perfectly competitive market) will set a wage rate $W(y)$ equal to the suspected marginal productivity of this worker, which is $\Theta_1$ for more productive and $\Theta_2$ for less productive workers.
Picture 2. Relationship between earning and level of education according to simple Signaling Theory.

With the wage schedule as follows, members of each group will choose their level of education optimally. Here we should ask what is the optimal level of education. If a person is of high abilities, then his optimal level of education will be $y^*$. There is no reason to spend more time in the schooling system because, as we assumed on the beginning, education do not increase our productivity and apart of gains from signaling it is purely wasteful. Similarly, people for whom it is beneficial to learn less than $y^*$ will not attend school at all ($y = 0$). So we can see that everyone will be going to school for $y^*$ years or will not attend at all, because it is not productive and does not influence employers’ beliefs. Employees will choose education levels according to employers’ beliefs and by doing so they confirm those beliefs, guaranteeing a signaling equilibrium.
We can now state the conditions that must be fulfilled to confirm entrepreneurs beliefs. Group One will learn exactly $y^*$ years if the cost of achieving this knowledge will be lower than gains from learning (which does not sound really unrealistic).

4. $\Theta_1 - \Theta_2 > y^*$

And for low productivity workers, the cost of education must be higher than any potential benefits:

5. $\Theta_1 - ay^* < \Theta_2$

If we compute both conditions, we will achieve an interval of parameter $y^*$ for which market expectations will be fulfilled. This happens when:

6. $(\Theta_1 - \Theta_2) / a < y^* < (\Theta_1 - \Theta_2)$

Here we see that there is an infinite number of stable equilibria. The optimal value of $y$ is an interval, so if we assume that the variable is continuous, then we also have infinite numbers of $y$ that will fulfill given conditions. For example, if parameter $y^*$ will increase by $\Delta y$ is small enough for optimal level of education to be still somewhere between lower and upper limit, it will hurt group One (more productive), because right now they will have to spend an additional $\Delta y$ on education, while as mentioned before productivity(=gross wages) will not be affected. On the other hand, this will not change the behavior of the second group because they are not investing anything in education. But this group already faced losses when employers differentiated workers for able
and less able based on education levels. If there is no differentiation with respect to education according to equation (1) all employees are remunerated equally. Wage ratio is equal to $\Theta_{\text{AVERAGE}}$ and the difference in their earnings is equal to:

7. $\Theta_{\text{AVERAGE}} - \Theta_2 = h \cdot (\Theta_1 - \Theta_2)$

So the losses are the more severe the bigger is productivity gap, and the larger is the share of laborers from first group. Therefore, unskilled workers are always worse off when differentiation according to education is implemented. On the other hand, skilled workers gain less than the second group losses due to expenditures on education. To be precise, even able workers may be worse off due to signaling. It will be profitable for these workers to attain high levels of education if and only if wage gains will be higher than the cost of signaling their high abilities. Resulting in:

8. $y^* < \Theta_1 - \Theta_{\text{AVERAGE}} \rightarrow y^* < (1 - h) \cdot (\Theta_1 - \Theta_2)$

If the number of unskilled workers will relatively decrease in comparison to skilled ones, or if the wage gap will be lower, the probability that group one will gain from differentiating themselves will be lower. This mean that a higher share of educated people will shift the average wage up, which has 2 simultaneous effects: it makes able workers less willing to invest in education to distinguish themselves, and makes low ability workers more willing to imitate high skilled people. The same effect is when productivity gap is growing. Although every person is acting rationally with respect to their own private interest, the outcome may not be efficient. In that situation limiting access to education would lead to improvement in the Pareto sense. If workers could form sufficiently large coalition, it would pay off not to educate themselves at all. On the other hand if the difference between high and average productivity is sufficiently high to compensate for education spending, “able” rational agents will tend to invest in that signal.

One more thing which requires emphasis is that private and social returns in this model differ significantly! We cannot observe that gross social returns of schooling in this model are equal to 0, because learning does not have productivity effects, but only signaling ones. On the other hand, an individual proving that he is of high productivity results in an increase in his wages. The social return is equal to $[\Theta_1 - \Theta_2)/c] - 1$ for high skilled and $[(\Theta_1 - \Theta_2)/ac] - 1$ for low skilled. But does this mean that government can improve this imperfection? It is impossible because as mentioned before we cannot easily observe productivity of single workers.

2.4. Extensions

2.4.1. Can signals improve the social equilibrium?
During past 40 years this basic model of signalling was developed in many ways. Almost every assumption was lifted or relaxed and the outcomes of such moves were presented. Stiglitz (1975) proposed situations when social returns of signaling can be higher than zero.

The first of such situations deal with the consumption-leisure tradeoff. He argued that imperfect information work like taxes on more able and subsidy on less able. Assuming that cost of education for high-ability people is relatively low in comparison with those who are less productive, and with the assumption that labor is supplied elastically and everyone can be better of due to differentiation. This can be done by using a tailored redistribution tax. This proposal has some drawbacks. First of all, it is not guaranteed that such a tax mechanism could be implemented. It may also be that the administrative costs of sustaining such a system would be greater than the benefits.

Also, the benefits from a social point of view from education is better employee–workplace matching. Let’s relax the assumption of describing worker productivity by one parameter; low productivity workers can be more productive (or at least have a comparative advantage) in working in different professions than highly skilled workers. High ability workers can be very productive while working in office, but while performing physical work their productivity can be less productive than their highly educated counterparts. On the other hand are low skilled workers whose “office” productivity is low and “physical” productivity is relatively better. If we assume that office workers perform relatively better in school, then differentiation will increase the total wealth of society. The effect can be greater if we assume that total productivity is not the sum of all productivity but less able workers have greater impact on rest of the group productivity. In this case, distinguishing workers and employing them even on the same position but in two separate workplaces increases total output.

As we can see above, a private and socially desirable level of investment can differ significantly. On one hand, pooling equilibrium put all individuals to the same group where people support others’ wages, or are supported by more able people. Investment in education can be seen in an individual point of view as profitable, but in general it is only a waste of resources. This is not the case when distinguishing workers allows society to organize workers in way which increases the total output, even while with holding personal characteristics constant. What is more, differentiating eliminates costs related to subsidizing of one group by another, which is strictly private but has no social return. To sum it up, Stiglitz (1975) argued that according to market conditions education investments can be too small or too large from a social standpoint. What is more, there can be no strict market mechanism that will guarantee an optimal level of investments.

2.4.2. Signaling plus Human Capital
Another extension was to relax the assumption of considering education as absolutely wasteful in terms of personal productivity. It was proposed due to many studies testing signaling, with inconclusive outcomes. The theory was divided according to the impact on productivity of the weak screening hypothesis (WSH) and the strong screening hypothesis (SSH). According to the SSH, education has absolutely no impact on given person productivity, while WSH assume that the education is not purely informative but can also have an impact on productivity. While Psacharopoulos (1979) argued that role of education is purely signaling, Arrow (1973) and Spence (1973) admit that increase in productivity caused by education is possible. The second author (2002) proposed an extension in which worker value depends on their level of education. The definitions of new variables are as follows: \( s_i(y) \) is a value of \( i \) – type worker who spend \( y \) years in school. Because there are only two types of workers \( i = 1 \) or \( 2 \), and we assume that \( s_2(y) > s_1(y) \), this means that the impact of education on productivity is greater for able persons and their marginal return of education is higher, ceteris paribus, in comparison with less able counterparts. Another crucial assumption, identical as was made before, states that the cost of education is lower for group one and bigger for group two (\( c_2(y) > c_1(y) \)). Employers still cannot observe worker productivity directly. It is also assumed that the cost function is increasing and convex while the worker productivity function increases in a concave manner. This assumption is important from a technical point of view because it provides the stability of the model. Because of that, the net income function \( N_i = s_i(y) - c_i(y) \) is a concave function. The last function we define is \( V = s_1(y) - c_2(y) \) which illustrates the decision of low ability workers to mimic the skilled ones.
Three different outcomes of this study are possible. The most standard outcome fully separates equilibrium. Points $y_1^*$ and $y_2^*$ are the optimal years spent in school, which maximizes expected return on education. Point $y_{\text{AVERAGE}}$ show the latest range of education, for which it is profitable to mimic high skilled workers. If the $y_1^*$ would lied left to $y_{\text{AVERAGE}}$ then low able people had an incentive to invest more than is local maximum calculated by the returns to education, because profits of playing high skilled are greater that the costs. When the point $y_1^*$ is on the right side (as on the picture) then it does not pay off to invest that much in education, because costs will be greater than the benefits. People invest in optimal levels of education from a social standpoint because of significant differences in education, employers can fully differentiate the people. So, not only is the the investment level optimal, but the market also behaves as if there was perfect competition. Perfect competition can be achieved because the cost of education differs significantly. Without this assumption, rational agents with lower productivity would stay in school as much as
their more productive counterparts.

Let's now consider a situation similar to that one described above. Figure 5

![Diagram](image)

**Picture 5. Signaling Theory with elements of human capital. Outcome with overinvestment in education.**

The only difference is in years of education of able persons for which lifetime income is maximized. Now it is to the left to $y_{\text{AVERAGE}}$. This one detail changes the whole structure of equilibrium. Let's assume that high skilled workers chose education levels where their marginal cost of education is equal to the resulting marginal increase in productivity. Then, low productivity workers have a temptation to educate themselves insufficiently high (in social point of view) just to mimic them. Productive people will tend to invest in their education more just in order to prove that there are more productive. The minimal number of years spent in school for them is more than $y_{\text{AVERAGE}}$, because this is the border point. Right to this point they can be sure that no low productivity workers will try to mimic them. We can observe here the same type of signaling equilibrium as in the pure signaling model. Although a human capital component is included and
The less able group partially participate in education according to this theory, the rest overinvest in education (in human capital point of view) to signal their abilities, which cause losses from a social point of view.

The last hypothesized outcome is when it does not pay off for high ability workers to differentiate themselves. The question is when that kind of equilibrium will occur. Keeping the nomenclature as in the previous example lets define $h$ as the share of high skilled persons in the population. In pooling, equilibrium wage ratio is a weighted average of workers productivity: $h \ast s_1 (y) + (1-h) \ast s_2 (y) = s_{\text{AVERAGE}} (y)$. Let $h$ be close to one because the number of low skilled workers in total population is relatively low. Then the average earnings of these workers are very similar to high skilled workers’ payout profiles. Then, workers have no incentives to differentiate themselves because net payoffs are greater now when the equilibrium is a pooling one. As $h$ decreases in our hypothetical case, pooling equilibrium becomes less and less profitable. When the average earnings fall below more able people earnings in separating equilibrium minus their cost of education, for that values of $h$ equilibrium will be separating because it will not pay off any longer to “subsidize” their less efficient counterparts.

As we could see earlier, if the share of skilled persons is not too high in total population, fully separating equilibrium is possible. A problem arises when education is used not only to maximize worker productivity minus his costs of education, but exceed social optimum. Then, there is wealth loss due to overinvestment in education. Is there a way to improve this market imperfection? It appears that such a policy is possible, net income can be increased by appropriate policy measures. By imposing a tax on education it can increase consumption in the economy. Taxation of education is beneficial in the sense that it discourages overinvesting and makes a threat of low productivity workers pretending to be the more efficient ones less possible.

To sum up, considering a signaling model with an added human capital component it is possible to have three outcomes: a fully efficient separating equilibrium or a separating equilibrium, where educational expenditures are suboptimal. It is also possible to have pooling equilibrium, where both groups earn the same amount of money assuming that the proportion of able workers is sufficiently large. It is also possible to correct market failures using appropriate tax policy on education.

2.4.3. Majority Voting

We can see that the educational system is crucial in signaling models with and without productivity gains from education. It is a crucial tool to signal to the employer (or to be screened
by him) that the person is more productive than the average. Sometimes, due to market imperfections, situation on the market is suboptimal and wisely planned government actions could lead to wealth gains. But, the person could ask if the situation with the state intervening on the market is always a realistic scenario. Does the government under the pressure of some group of voters will put off the actions that would lead to increase in total wealth? For these questions, Stiglitz (1975) was trying to answer this model using slightly different model, which was extended to include some predictions of human capital. Still, it is assumed that individual characteristics can be described by one parameter $\Theta$, and the distribution of parameter $\Theta$ in total population is given by function $h(\Theta)$. New thing in this model is so-called “intensity” of the education marked as $\lambda$. It is assumed that more intensive education

- cost more
- increase productivity of the worker greater (no matter if it is due to acquiring skills or simply by better employee – job matching
- allow workers to better signal their productivity

Which can be identified as $y$ – number of years spent in school in previous model.

Impact of given parameters is as follows:

Productivity effect – $p(\Theta, \lambda)$ described productivity of given person who is of the $\Theta$ type able and received education of intensity $\lambda$. For simplicity it is assumed that output of given worker linearly increase in $\Theta$ and is concavely increase education intensity:

9. $p(\Theta, \lambda) = m(\lambda) \cdot \Theta$, where $m' > 0$ and $m'' < 0$.

Screening effect – educational system improve identifying given person abilities. If $e(\Theta, \Theta_i, \lambda)$ is a probability that given person is of type $\Theta_i$, then this probability increase in $\lambda$.

Educational costs are increase with intensity of the schooling $\lambda$. What is more, this cost are increasing convexly, twice as high intensity will lead to more than two times

10. $c' > 0$ and $c'' > 0$

To determine equilibrium in the model it is required to wages of the worker. If person ability was estimated to be $\Theta_i$, then his expected wage is equal to:

11. $w(\Theta_i) = m(\lambda) \int \Theta e(\Theta, \Theta_i, \lambda) h(\Theta) d\Theta / \int e(\Theta, \Theta_i, \lambda) h(\Theta) d\Theta$

and the wage of a person, whose ability parameter is $\Theta$ is as follows:

12. $W(\Theta) = \int w(\Theta_i) e(\Theta, \Theta_i, \lambda) d\Theta_i$

Maximizing national output minus costs of education it turns out that the marginal cost of education must be equal to marginal average benefit of the education:

13. $c'(\lambda) = \Theta_{AVERAGE} m'(\lambda)$
This is the desired level of investments. Questions arise if this is the level of investment that will be achieved in a state, where decisions are made by majority voting, where educational system is financed by proportional wage tax $\tau$, then:

14. $c(\lambda) = \tau\Theta_{\text{Average}} m(\lambda)$

and consumer want to maximize net income which is equal to $(1 - \tau)W(\Theta)$. By calculating first derivative of net income with respect to $\lambda$ we get:

15. $[(1 - \tau)W(\Theta)]' = (W/m) [m' - (c'/\Theta_{\text{Average}}) + (1 - \tau)m (h'/h) g']$, where $g'$ is a variance of estimation error.

As we can see, this outcome depends on $\lambda$ but also on $\Theta$. If we plug equation 13 into 15 we will see that first term is equal to 0 and is only the second one left. More able individuals (with skills above the mode) will tend to increase education intensity above desired level, while less able people will do the opposite and have less than optimal education expenditures. By assuming that variance increase convexly with costs and productivity increases concavely, a single maximum is guaranteed. If the median lies below the mode there will be not enough investments, while overinvestment will occur if the median is above the mode. Considering income distribution in empirical data, we can come to the conclusion that according to this model, the majority will vote to have more than optimal levels of investment in education.
Of course, the assumption was made that every person knows his own level of abilities. We can also consider the opposite case, where no one knows his abilities to make a decision, solely considering education expenditures he undertakes based on the distribution of abilities in general population. In that case, the situation changes dramatically and the optimal level of investment will be below the optimal one.

As this model of signaling presents, the optimal solution for society may not always be achieved. Although, government regulations may lead to welfare gains, that is not always possible because a majority will rather vote to overinvest and therefore will not achieve a desired level of income.
PART III. EMPIRICAL RESULTS OF PREVIOUS STUDIES

Human capital theory and signaling hypothesis are two competitive and to some extent an elementary hypothesis, which aim at explaining relationships between productivity and education. First, let’s assume that by gathering additional knowledge in the school, persons is becoming more productive, second, let’s assume that education is completely unproductive and students only are proving their high abilities by achieving a higher degree of education. Although, assumptions are completely different, predictions can be similar. Lets consider one simple example: Two students with similar characteristics, after finishing high school, are considering extending their education period at a university. One student has decided to university and after graduating from university, has entered the labor market. It turned out that he found better paying job in comparison to his counterpart who had only graduated from high school. According to the human capital theory, he earns more because he acquired more skills, which had made him more productive. Supporters of the signaling hypothesis would argue that he was productive already, but by finishing his studies, he was able to prove that his productivity. Although their motivation is different, in both cases the outcome is the same – wages are higher for more educated people. It shows that, by having a simple wage regression, dependently from how we formulate the model, the outcomes can differ significantly. The same data may support the human capital theory if we will look for results advocating this theory. If someone prefers screening, he could argue that the data would support this theory. To distinguish effects of these two theories and assess the impact of them on labor and education market, more sophisticated theories were developed.

3.1. Comparisons of returns to accumulated education

One of the first formal procedures of testing validity of the signaling theory were proposed by Layard and Psacharopoulos (1974). The authors based their procedures on Arrow (1973) signaling model, and tested its three predictions:

1) Private returns are rather related to achieved certificates and not to years of schooling. Certificates, according to the theory, are the proofs of the worker’s high abilities. It means that the employer is rather interested in the certificates persons achieve, rather than years devoted for given course. A similar study was conducted by Ashenfelter and Mooney (1968) and was based on 1300 persons sample of Woodrow Wilson fellows. They came to the conclusion that variables like profession, degree level or field of graduation explains more of the variance in earnings than year, when the person graduated. However, the effect of graduating in comparison
with bachelor’s degree was positive for Ph.D. and negative for master degree, which cannot be in favor of signaling hypothesis.

2) Standardized educational differentials fall with age, because employers have better information about older employees’ abilities. Unfortunately, comparing earnings of groups with different education levels shows that this wage gap instead of decreasing, increases over time. One of the explanations of this phenomenon is related to on – the – job training. It may be, that better educated people are spending more than proportionately share of their income on their training, which leads to higher wages growth and lowers the probability of signaling to be true.

3) If screening is the main function of education, it could be done more cheaply by a simpler testing procedure. Existence of a whole well developed education system suggested by Wiles (1974), argues that it is due to some external effects; persons who had finished their studies was (were) tested at the university, so the cost of finding productive graduates is higher than finding some similarly productive counterparts from high school graduates. But Layard and Psacharopoulos argue that if it was true, then instead of universities, on the market would have been agencies specializing in evaluating the skill levels of the people.

Although a similar idea of detecting signaling hypothesis was behind work of Hungerford and Solon (1987), the results were different. The authors argued that the database from a previous study (made by Layard and Psacharopoulos) lacks information about the exact number of years of schooling which high school dropouts attended. They used May 1978 Current Population Survey data on white male nonagricultural wage and salary from workers between the ages of 25 and 64, which is definitely a strong point of the work because of quite reliable and precise data and size of the sample (the sample size) is about 16 500 people. They estimated wage regressions to assess the impact of diplomas and years of education on a person’s earnings. The outcome of this research suggests that the sheepskin effect in the returns of education exists. It is opposite to Layard and Psacharopoulos, which previously argued that these effects do not significantly affect the market. Moreover, most of the results are significant even at the 1% level. One of author’s findings shows that while persons with 16 years of formal education earns almost 14% more than their counterparts with 15 years. But, another additional year of schooling increases on average wages by less than 1%! According to Hungerford and Solon this is strong evidence in favor of the signalling theory.

More research made by basing on a calculated returns to years of education was made by Groot and Oosterbeek in 1994. Innovation in their research was dividing years of schooling into actual, effective, repeated and skipped, which according to the results increased precision of the estimates. They used data for people from the same age cohort (born in 1940) born in the Netherlands came to the conclusion that the human capital theory largely explains education market
situation, while the signaling hypothesis has no use. Results shows negative correlation of skipped classes, class – failing has no effect and positive effect of dropout years. Another crucial finding is that their way of dividing years of education is superior to usually used concept of actual and effective years.

The last paper based on this type of estimation was written by Frazis (2002). His study is on The US Current Population Survey gives ambiguous results. It turned out that graduation is related to a quite high increase in earnings, while the previous 15 years before achieving diploma gives a sub – normal return. He argued that on one hand, the human capital theory is sufficiently elastic to explain this kind of behavior but abnormal behavior of rates of return during these 15 years. If no, one can argue that this result is caused by measurement error and supports the signaling theory. But assuming importance of signaling in determining length of studying, we are facing problem of explaining very low returns to few very last years of studying.

3.2. Comparisons of wages between unmatched job group and matched job (Wiles Test)

The method proposed by Wiles (1974) was based on a comparison of wage differences between people who are working on the position that is consistent with the given person’s education and those whose working profile is different than this in which he specialized during the studies. If a market behaves according to the signaling hypothesis, then the type of knowledge, or skills a person gains in school will have no effect on person’s productivity. Opposite with human capital, then in a job where the person was educated, his productivity will be higher than in unmatched job, because of the courses he had taken, allow him to better understand his field of work. If we assume that the market is perfectly competitive then productivity will be equal to wages. So the differences in wages between matched and unmatched jobs can be good indicator of the significance of two competitive theories. As usual, problems occur with precise definitions of “matched” and “unmatched” jobs. Usually, when conducting this kind of estimation, the researcher must rely on respondent assessment of how the job matches his education. This data may be biased due to big subjectivity of answers. Person who is satisfied with his job and earnings may be more prone to answer that his education is matched. Another argument against this estimation method was proposed by Miller and Volker (1984). They argued that the fact that science graduates do not receive significantly higher wages do not necessarily support the signaling theory. Alternatively, it may mean that skills acquired during science studies may be equally productive in matched and
unmatched professions. They conducted research based on a survey from Australian universities. Two types of students were extracted – economics and science graduates. Results are ambiguous:

- male economics graduates tend to have a similar level of earnings no matter if the job is matched or not
- for females, no matter if they were economic or science graduates, predictions of the signaling theory hold
- male science graduates opposite to the rest of the groups had significantly higher (6% higher) starting wages when they were employed on posts which required science knowledge.

Also using Wiles Test Arabsheibani found strong evidence of human capital on Egypt’s labor market. Graduates in medical, natural and social science, irrespective of the degree, always achieved higher earnings in matched than unmatched jobs. In other words, skill they acquired significantly increased productivity which is completely in line with the human capital theory.

Chung (1990) was another author, who published research based on matched – unmatched job comparison. He used data about different types of vocational education (mechanics, textile production). His results show that the earnings between matched and unmatched jobs were not significant and even sometimes persons employed in unmatched job earn more than his counterpart in matched one. He came to the conclusion that after controlling for different wage determinants, a person’s wage is almost always unrelated to his education, and according to him, not the education but the branch of industry in which given person is employed is main determinant of wages differences. This is another finding that supports signaling.

Last Author I want to mention, which employed Wiles test was Merwe (2010). He based his research on recent graduates’ record from Durban University of Technology. Results of these studies are to some extent inconclusive. It turned out that the more relevant training was, the lower the wages were. One of possible explanation of this phenomenon is that most of the students’ job is related to their internship, so the increase in wages is gradual and in the long run this relationship is positive. On the other hand, employers do not believe that the training increases productivity instantly and treats it as some kind of liability.

3.3. Comparisons of returns to absolute years of schooling and the relative ranking of education

Another interesting way of estimating this effect is comparing total years of education with individual position in the distribution of education in a given cohort. Intuition behind this method of
estimation is as follows: Distribution of education of a given cohort may significantly vary between years (for example, due to limited access to higher education in a war period or shortly after it). If the wages reflect a given person’s number of years in school, then it is an argument in favor of the human capital theory. On the other hand, if wages of people with the same level of education but from different cohorts it suggests that wages depend not only on a given person’s education but its relative position to others. So, high school graduates from a cohort which faced limited access to education earning more than his counterpart from the cohort with better access to education, will mean that education is treated as a signal of higher abilities. That was a method of estimation proposed by Kroch and Sjoblam (1994). The strong point of their research is that instead of estimating a single one regression, they calculated the results for eight independent samples and explored many specifications of time and schooling variables. Although the estimation results are ambiguous, it usually supports the human capital theory. Earnings are rather determined by number of years a person had spent in school than rank of this education in his cohort.

3.4. Comparison of relative access to tertiary education with number of high school dropouts

One of the last methods of estimation I want to mention about the use the prediction that the sheepskin effect is more likely to occur in regions where access to education is limited. If high a productivity worker has only very limited amount of years he can study (for example due to lack of university networks) then low – skilled workers are more prone to finish high school to earn more. When access to a university is assured, low skill workers knows that the equilibrium will be differentiating and not pooling one. Then, this group looses the motivation, because (according to signaling hypothesis) it is completely unproductive. That is the reason why, if signaling holds then having better access to a university will lead to more high school dropouts. Better access to universities will lead to more school dropouts is graphically presented below.

Bedard (2001) conducted research based on National Longitudinal Surveys of Young Men (NLSYM) and Young Women (NLSYW). According to her estimates, we can observe signaling on the market because access to universities significantly explained number of high school dropouts.
3.5. Assessing impact of change in obligatory school attendance age.

Lang and Kropp (1986) were researching the impact of compulsory school attendance laws on groups which attended universities. Their paper was based on selected censuses made in the years 1908–1970 in United States. It occurred that during this period of time, different states were adopting significantly different CALs (Compulsory Attendance Laws) and this structure was not constant over time. In estimation, the authors used GLS method and rejected the human capital theory.

Hamalainen and Uusitalo (2008) were detecting signals on the Finnish labor market. Fortunate circumstances occurred, when government announced educational system reform. Vocational colleges were gradually replaced by polytechnics, which changed the structure of the labor force. The change according to different theories will have different outcomes:

− signaling states that people, from vocational colleges will earn less than their counterparts from polytechnics because their signal is relatively weaker (labor market will percept them as of inferior abilities)
− human capital assumes that this change will not affect wages of vocational colleges
The authors conclude that such decrease in wages occurred so there is some use of signaling theory in explaining labor market behavior in Finland. This way of testing is very similar to Kroch and Sjoblam (1994). The main difference is type of the data. Previous studies used time series while the latter was based on different types of schools in Finland, but at the same time. Although with different estimation techniques, we can achieve different results, which shows how complex is the problem of implementing/rejecting competitive theories.

Chevalier, Harmon, Walker and Zhu (2004) also used obligatory school attendance laws as their method of estimation. Based on UK data concerning the 1970's, they did not find any support to signaling theory.

### Table 1. Summary of previous researches.

<table>
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<th>Author</th>
<th>Estimation method</th>
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Part IV. Data Description

4.1.PGSS

In my model, I am using a data sample from Polski Generalny Sondaż Społeczny - Diagnoza Społeczna (Polish General Social Survey – Social Diagnosis) conducted in years 1992 – 1995 and in 1997. The whole sample consists of 8910 observations, 1647 of which (82,4% of the chosen representative sample agreed to answer questionnaire), comes from 1992, 1649 from 1993 (82,5% of the chosen sample), 1609 from 1994 (80,5% of the chosen sample), 1603 observations were recorded in 1995 (80,2% of the sample) and rest 2402 observations came from year 1997 (which is 75,1% of extended to 3200 people representative sample). PGSS (Polish General Social Survey) is a part of statutory research made by Institute of Social Studies on Warsaw University. The data was collected through surveys on representative samples of household members above age of 18. The main goal of this project is to systematically measure trends and causes of social changes in Poland. It also measure differentiation of personal views, beliefs, social behavior and social – demographic, occupational, educational and economical differentiation of representative social groups in Poland. A large advantage of this program is that questionnaires are only slightly modified and research is conducted on a yearly basis (since 1997 once every three years). Continuation of this research using the same indexes and similar methodological standards make this database unique for Poland and very neat tool to conduct a time series or cross section analysis concerning Polish Society. Another significant advantage of this database is that it is available for free on the website of institute of social studies (www.iss.uw.edu.pl). A very nice feature of this database is that it includes modules which are asked also by institutions in many other countries, like the International Social Survey Programme (ISSP). Some of these modules are repeated every few years in other countries, which allows international comparisons – even in a dynamic perspective. Moreover, part of questionnaires are exactly the same as those conducted by General Social Survey (GSS) made by National Opinion Research Center from University of Chicago and German nationwide program of surveys ALLBUS conducted by Zentrum fur Umfragen, Methoden und Analysen from Mannheim.

Another significant argument in favor of this database is its complexity in dealing with such spheres like:

– Professional position and labor market participation, which comprises international standards of profession classification, sector in which they are employed, type of ownership, size
and localization of the given firm. Also included are variables characterizing working experience and periods of unemployment. Data contains also analogical variables for spouses and parents of the respondent.

− Level and specialization of education with inclusion of analogical variables of respondent spouse and parents.
− Material situation of respondent and his family described by personal level of income, level of income of whole household, accommodation conditions, household goods, satisfaction from income etc.
− Respondent’s subjective perception of social position and its changes over time
− Respondent’s beliefs, views on politics, society, government credibility, participation in civic life, religious view ethics and even on his/her attitude toward alcohol and cigarettes.

Although large sample, multiplicity of questions in questionnaire and possibility of cross-country comparisons, several weak points of the database can be pointed out.

First of all, knowledge about the respondent’s education was sometimes in my opinion not sufficient. An argument supporting my thesis is that additional educational indicators, which represent exact school attendance period of time, precise profile and mode of education, type of ownership of the schools and their localization were not included until 1997. This kind of data could shed new light on signaling and the human capital theory, and provide deeper insight in this problem.

Another troublesome disadvantage of PGSS is its insufficient data about individual migrations within the country. There is a lack of data about respondent’s place of living when he was teenager and was deciding about his level of education. Although this data would have been very useful in my research, a lack of it does not make the estimation impossible. First of all, both models (human capital and signaling) assume that individuals are rational. If that is the case, they are rather concerned not with situation on labor market in region they were raised, but in condition on labor market they were participating during the time survey was conducted. What is more, if they were not rational and choose the education that was not optimal for “their” market conditions, there is always a solution to the problem in the form of migration. Still, the fact is that 66% of individuals that were included in this research, were in time of collecting surveys in a city of similar size that the city of their youth. This means that no mass scale migration was made, that could blur the estimation results.

There are some other imperfections in that data set related with questions concerning respondent youth. For example, Bedard (2001) when trying to distinguish between many factors
affecting people’s willingness to achieve education included dummy variable corresponding having (or not) a library card or number of siblings. Unfortunately, this type of data is does not exists in the questionnaires constructed for PGSS. This makes estimation a bit less precise than with the data. Another stunning thing is when question concern for example father, stepfather or another man that was taking care of a child, answers that there were not such that person are virtually absent. This does not help us to describe more appropriate situation of a person during his childhood.

4.2. Variables in the model

a) Level of education [degree]

Structure of the schooling system in Poland at that time was as follows:

![Schooling structure in Poland](image-url)
The most crucial variable in this model is people from the sample education level. A question that respondents had to ask was: “What level of education have you achieved up till now?”. The nicest feature of this question was that no one answered: not remember or other reasons of lack of data were not pointed out by any of the respondents. The other results are as follows:

Table 2. Distribution of education in the sample.

<table>
<thead>
<tr>
<th>No.</th>
<th>education</th>
<th>entire men</th>
<th>ratio above 1</th>
<th>ratio below 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>none</td>
<td>0,02</td>
<td>0,02</td>
<td>0,01</td>
</tr>
<tr>
<td>3</td>
<td>incomplete primary</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>4</td>
<td>primary</td>
<td>0,13</td>
<td>0,12</td>
<td>0,11</td>
</tr>
<tr>
<td>5</td>
<td>basic vocational</td>
<td>0,44</td>
<td>0,41</td>
<td>0,23</td>
</tr>
<tr>
<td>6</td>
<td>highschool dropout</td>
<td>0,02</td>
<td>0,03</td>
<td>0,03</td>
</tr>
<tr>
<td>7</td>
<td>highschool graduate</td>
<td>0,02</td>
<td>0,03</td>
<td>0,11</td>
</tr>
<tr>
<td>8</td>
<td>secondary vocational</td>
<td>0,24</td>
<td>0,21</td>
<td>0,28</td>
</tr>
<tr>
<td>9</td>
<td>post-secondary</td>
<td>0,02</td>
<td>0,03</td>
<td>0,09</td>
</tr>
<tr>
<td>10</td>
<td>incomplete tertiary</td>
<td>0,03</td>
<td>0,04</td>
<td>0,04</td>
</tr>
<tr>
<td>11</td>
<td>tertiary</td>
<td>0,08</td>
<td>0,11</td>
<td>0,1</td>
</tr>
</tbody>
</table>

The thing which needed here to be explained is so – called tertiary ratio. This ratio shows us the relative share of students in given voivodeship. It is constructed by dividing share of students in population of given voivodeship by share of students in population in Poland. Ratio above one means that in comparison with the country’s average, given administration has a better developed tertiary education infrastructure. On the other hand, ratios lower than one means that the infrastructure in a given year, in given voivodeship, is weaker developed and people are facing more obstacles in continuing education on the universities comparing to country average. Ratio was updated on a yearly basis, every year calculating new values for given voivodeship.

b) Voivodeship [voivo49]

One of the main problems, that researcher needs to face when dealing with Polish data are the very short periods of time when data was collected in the same way. Source of this state of things were quite often changing borders of the country. The oldest persons that were included in PGSS were born in 1897, so before the first World War. At that time Poland was partitioned between three neighboring empires: Austro-Hungarian, German and Russian. Every of the invading countries had its own unique administrative division which makes comparisons between them impossible.

In the period of time between the world wars, when Poland finally regained independence,
comparisons between voivodeship were possible. On the end of 1925, when status of all administrative units was regulated, there were 16 voivodeships (plus the capital city) and 281 districts. But this division was quite often changed in the following years. Some of the districts changed their voivodeships, some were liquidated, etc. This makes comparisons using data from years 1918 – 1939 were hard and results may not be too reliable due to many changes of the system and quite short period of time. Map of this administrative division was presented below.

Picture 9. Administrative map of Poland in 1938
In a short period of time, different administrative units and large scale external effects makes estimation of signaling and human capital theories during World War II impossible.

The most stable over time borders in Poland over time in the 20th century are those after World War II till now. That is the reason why I am focusing on that period of time. At that time, borders of administrative units changed several times. Periods of constant administrative division are as follows:

- Administrative division 1944 – 50
- Administrative division 1950 – 57
- Administrative division 1957 – 75
- Administrative division 1975 – 98
- Administrative division 1998 – present

So as we can see above, the longest period of a stable number of voivodeships are in the years 1975 – 1998. Unfortunately, restricting samples only to people, which were deciding about their education in those years significantly decreased the number of observations. From 8910 observations in whole database, only 3816 were born at that time. It is much lower than 5896 observations which were used by Bedard (2001). But still, it is quite a large sample, which guarantees reliability of the results. Another argument in favor of this division is the average size of the voivodeships, which was 6583 km$^2$ in comparison with 24 357 km$^2$ in period between the World Wars. A large decrease in administrative units’ size allows us to have deeper look at variability of education infrastructure between the regions. A good example here is voivodeship Mazowieckie, which existed before 1975 (as Warszawskie voivodeship) and in slightly different shape, it was reactivated in 1998. According to all statistics, it is one of the best developed regions with the highest average earnings and with very good developed tertiary infrastructure. But when the statistics are calculated for this region without the capital city, then it occurs that the region is much below the average! Using administrative division with such small units like 49 voivodeships makes the view on the problem less blurred and guarantees that only the nearest regional capital city and its neighborhood will be included. It will eliminate the bias of large cities on underdeveloped regions placed few hundred kilometers from each other. Last but not least, an argument in favor of time between administrative reform in 1975 and 1998 is the fact that on one hand it does not include rapid rebuilding shortly after Second World War and also significant increase in number of private colleges and high schools in the second half of the 90's. Administrative map of Poland is presented below.
<table>
<thead>
<tr>
<th>Voivodeship</th>
<th>Shortcut</th>
<th>Capital City</th>
<th>Voivodeship</th>
<th>Shortcut</th>
<th>Capital City</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Stoleczne Warszawskie</td>
<td>wa</td>
<td>Warsaw</td>
<td>26 Olsztyńskie</td>
<td>ol</td>
<td>Olsztyn</td>
</tr>
<tr>
<td>2 Bialskopodlaskie</td>
<td>bp</td>
<td>Biała Podlaska</td>
<td>27 Opolskie</td>
<td>op</td>
<td>Opole</td>
</tr>
<tr>
<td>3 Bialostockie</td>
<td>bk</td>
<td>Białystok</td>
<td>28 Ostróleckie</td>
<td>os</td>
<td>Ostrołęka</td>
</tr>
<tr>
<td>4 Bielskie</td>
<td>bb</td>
<td>Bielsko Biała</td>
<td>29 Piłskie</td>
<td>pi</td>
<td>Piła</td>
</tr>
<tr>
<td>5 Bydgoskie</td>
<td>by</td>
<td>Bydgoszcz</td>
<td>30 Piotrowskie</td>
<td>ptt</td>
<td>Piotrków Trybunalski</td>
</tr>
<tr>
<td>6 Chelmiskie</td>
<td>ch</td>
<td>Chelm</td>
<td>31 Płockie</td>
<td>pl</td>
<td>Płock</td>
</tr>
<tr>
<td>7 Ciechanowskie</td>
<td>ci</td>
<td>Ciechanów</td>
<td>32 Poznańskie</td>
<td>po</td>
<td>Poznań</td>
</tr>
<tr>
<td>8 Częstochowskie</td>
<td>czz</td>
<td>Częstochowa</td>
<td>33 Przemyskie</td>
<td>pr</td>
<td>Przemyśl</td>
</tr>
<tr>
<td>9 Elbląskie</td>
<td>el</td>
<td>Elbląg</td>
<td>34 Radomskie</td>
<td>ra</td>
<td>Radom</td>
</tr>
<tr>
<td>10 Gdanskie</td>
<td>gd</td>
<td>Gdańsk</td>
<td>35 Rzeszowskie</td>
<td>rz</td>
<td>Rzeszów</td>
</tr>
<tr>
<td>11 Gorzowskie</td>
<td>go</td>
<td>Gorzów</td>
<td>36 Siedleckie</td>
<td>se</td>
<td>Siedlec</td>
</tr>
<tr>
<td>12 Jeleniogórskie</td>
<td>jg</td>
<td>Jelenia Góra</td>
<td>37 Sieradzkie</td>
<td>si</td>
<td>Sieradz</td>
</tr>
<tr>
<td>13 Kaliskie</td>
<td>kl</td>
<td>Kalisz</td>
<td>38 Skiermiewice</td>
<td>sk</td>
<td>Skierniewiec</td>
</tr>
<tr>
<td>14 Katowickie</td>
<td>ka</td>
<td>Katowice</td>
<td>39 Słupskie</td>
<td>sl</td>
<td>Słupsk</td>
</tr>
<tr>
<td>15 Kieleckie</td>
<td>ki</td>
<td>Kielce</td>
<td>40 Suwalskie</td>
<td>su</td>
<td>Suwałki</td>
</tr>
<tr>
<td>16 Koninie</td>
<td>kn</td>
<td>Konin</td>
<td>41 Szczecinie</td>
<td>sz</td>
<td>Szczecin</td>
</tr>
<tr>
<td>17 Koszalińskie</td>
<td>ko</td>
<td>Koszalin</td>
<td>42 Tamobrzeskie</td>
<td>tg</td>
<td>Tamobrzeg</td>
</tr>
<tr>
<td>18 Miejskie Krakowskie</td>
<td>kr</td>
<td>Cracow</td>
<td>43 Tamowskie</td>
<td>ta</td>
<td>Tamów</td>
</tr>
<tr>
<td>19 Krośnieńskie</td>
<td>ld</td>
<td>Krosno</td>
<td>44 Toruńskie</td>
<td>to</td>
<td>Toruń</td>
</tr>
<tr>
<td>20 Legnickie</td>
<td>lg</td>
<td>Legnica</td>
<td>45 Wałbrzych</td>
<td>wb</td>
<td>Wałbrzych</td>
</tr>
<tr>
<td>21 Leszczyńskie</td>
<td>le</td>
<td>Leszno</td>
<td>46 Włocławskie</td>
<td>wl</td>
<td>Włocławek</td>
</tr>
<tr>
<td>22 Lubelskie</td>
<td>lu</td>
<td>Lublin</td>
<td>47 Wrocławskie</td>
<td>wr</td>
<td>Wrocław</td>
</tr>
<tr>
<td>23 Łomżyńskie</td>
<td>lo</td>
<td>Łomża</td>
<td>48 Zamojskie</td>
<td>za</td>
<td>Zamość</td>
</tr>
<tr>
<td>24 Miejskie Łódzkie</td>
<td>ld</td>
<td>Łódź</td>
<td>49 Zielonogórskie</td>
<td>zg</td>
<td>Zielona Góra</td>
</tr>
<tr>
<td>25 Nowosądeckie</td>
<td>ns</td>
<td>Nowy Sącz</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Picture 10. Administrative map of Poland in years 1975 - 1998**
c) Tertiary ratio [tertiary_ratio]

As we can see below there is no strict geographical rule conditioning being or not local center of tertiary education. A bit less developed is eastern part of Poland comparing to the west. The only two big exceptions are in Białystok and Lublin, major cities in the east, which had almost twice as many students comparing to average. On the center, not counting Warsaw, there are no leading voivodeships. Most of them are in interval between 0,5 and 1,5. The western part is characterized by large differences between two main centers of tertiary education: Poznań and Wrocław comparing to neighboring voivodeships.
As a rule monocentric agglomeration (Warsaw, Cracow, Poznań or Wrocław) tend to have better developed networks of universities than conurbations (Tricity or Upper Silesian conurbation).

d) Size of the city [size]

Another important variable, which was used in estimations was the size of the city, in which the respondent lives. Respondents were asked about:

Table 3. Relationship between place of residence and access to universities.

<table>
<thead>
<tr>
<th>No.</th>
<th>residence in</th>
<th>Tertiary ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>village</td>
<td>0,72</td>
</tr>
<tr>
<td>2</td>
<td>Town&lt;10</td>
<td>0,6</td>
</tr>
<tr>
<td>3</td>
<td>Town 10-24</td>
<td>0,8</td>
</tr>
<tr>
<td>4</td>
<td>Town 25-49</td>
<td>0,72</td>
</tr>
<tr>
<td>5</td>
<td>Town 50-99</td>
<td>0,56</td>
</tr>
<tr>
<td>6</td>
<td>Town 100-249</td>
<td>0,6</td>
</tr>
<tr>
<td>7</td>
<td>City 250-499</td>
<td>1,28</td>
</tr>
<tr>
<td>8</td>
<td>City&gt;500</td>
<td>2,6</td>
</tr>
</tbody>
</table>

We can see that people living in cities with a population bigger than 500 thousands citizens have on average, 2,6 times bigger access to tertiary education in comparison with the countries average. Surprisingly, not the people living on (in) the village have the most difficult access to tertiary education. It is because that, although polish villages are characterized by underdeveloped infrastructure, some of them are located quite close to big academical centers, which shifts the average up. On the other hand, there are towns sufficiently large enough to be capital of a voivodeship, but are insufficiently large enough to develop universities. That can be the reason why PGSS respondents have in general higher tertiary ratio if are leaving in the village in comparison with towns between 50 and 250 thousands people.

e) Parents Education

Parents’ education is thought to have significant impact on a degree a person achieves. In the Polish General Social Survey respondents were asked, what is their parents their highest
attained degree? As can be observed below, in general the more educated respondent parents were, the more on average he had spent in school.

**Table 4. Impact of parents education on respondent achieved degree.**

<table>
<thead>
<tr>
<th>No.</th>
<th>attained level of education</th>
<th>father education</th>
<th>mother education</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>none</td>
<td>7,33</td>
<td>7,33</td>
</tr>
<tr>
<td>2</td>
<td>incomplete primary</td>
<td>7,43</td>
<td>7,25</td>
</tr>
<tr>
<td>3</td>
<td>primary</td>
<td>7,43</td>
<td>7,22</td>
</tr>
<tr>
<td>4</td>
<td>basic vocational</td>
<td>8,42</td>
<td>8,13</td>
</tr>
<tr>
<td>5</td>
<td>highschool dropout</td>
<td>9,96</td>
<td>9,05</td>
</tr>
<tr>
<td>6</td>
<td>highschool graduate</td>
<td>10,3</td>
<td>9,99</td>
</tr>
<tr>
<td>7</td>
<td>secondary vocational</td>
<td>9,5</td>
<td>9,01</td>
</tr>
<tr>
<td>8</td>
<td>post-secondary</td>
<td>10,05</td>
<td>9,87</td>
</tr>
<tr>
<td>9</td>
<td>incomplete tertiary</td>
<td>11,99</td>
<td>11,76</td>
</tr>
<tr>
<td>10</td>
<td>tertiary</td>
<td>11,81</td>
<td>11,21</td>
</tr>
</tbody>
</table>

f) Other control variables

In estimating intensity of the signaling in polish labor market other control variables were included in order to prevent results to be biased. This includes respondents’ sex [sex] and year he was born [cohort].
PART V. ESTIMATION

Before estimating results, several changes in the data were made. First of all, levels of education needed to be reorganized slightly because of relatively high abundance of degree levels but relatively small abundance of observations in some levels. No education or not full primary was chosen by about 0.2% of the people. Percentage of people that finished post – secondary schools, secondary school dropouts or those who did not managed to finish their studies are also not too big. I combined groups together with degrees as high as completed primary education and named this group 1. Group 2 includes secondary school dropouts and basic vocational school alumnus. Their main feature is that although they were attending some post-primary school, but did not finish their studies with Matura exam (it is a polish counterpart of the British GCSE). So, this group is not allowed to apply to university. To do that they should have finished secondary school or go to secondary technical/general supplementary school. That is the motivation behind organizing in group 3, high school and technical secondary graduates together. The last – 4th group consists of alumnus of post– secondary schools, universities and university dropouts.

To estimate if the students’ behavior is according to the human capital or signaling theory, I used multinomial logit and ordered probit models. Comparing access to universities with people, who continued school after finishing primary but did not take the Matura exam, is analogical type of estimation Bedard (2001), which was wider described in third chapter.

Another important thing worth mentioning is before proceeding to estimation, is that I assumed a rational agent to decide at the age of 16 on his future education. Primary school at that time lasted 8 years and general secondary school 4 years. So in general, we can say that persons leave (or decide to continue education to achieve Matura exam) his secondary school after two years of studies. Time, when rational agents are making decision about their studies, they are on average 16. That is the reason why tertiary ratio of given year was matched with the respondents that were 16 at that time. After restricting the data, it turned out that the sample consists of 3374 observations; 1620 of them are men and 1754 women. Below given is following multinomial logit regression. The base outcome of this regression is group 2, so here are presented impacts of different variables in comparison with people from high school dropouts and basic vocational school graduates. As we can see, all of the signs are correct with predictions. The most crucial variable for this paper is tertiary ratio. As we can see for the third group (secondary schools graduates), this variable is significant at 1%! So the access to university in the region has an impact on post-primary students who do not take Matura exam. What is more, this effect is negative, which support the predictions of the signaling theory. People with worse access to universities have greater
motivation to finish secondary education and not to be recognized as low productivity

Table 5. Multinomial logistic regression determining respondent education level

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Size 2</td>
<td>-0.18</td>
<td>0.25</td>
<td>0.79*</td>
<td>0.18</td>
<td>1.06*</td>
<td>0.23</td>
</tr>
<tr>
<td>2</td>
<td>Size 3</td>
<td>-0.62*</td>
<td>0.23</td>
<td>0.66*</td>
<td>0.15</td>
<td>0.52**</td>
<td>0.20</td>
</tr>
<tr>
<td>3</td>
<td>Size 4</td>
<td>-0.5**</td>
<td>0.24</td>
<td>0.53*</td>
<td>0.16</td>
<td>0.51**</td>
<td>0.21</td>
</tr>
<tr>
<td>4</td>
<td>Size 5</td>
<td>-0.42***</td>
<td>0.23</td>
<td>0.67*</td>
<td>0.15</td>
<td>0.67*</td>
<td>0.20</td>
</tr>
<tr>
<td>5</td>
<td>Size 6</td>
<td>-0.51**</td>
<td>0.23</td>
<td>0.61*</td>
<td>0.15</td>
<td>0.45**</td>
<td>0.20</td>
</tr>
<tr>
<td>6</td>
<td>Size 7</td>
<td>-0.22</td>
<td>0.28</td>
<td>0.78*</td>
<td>0.19</td>
<td>0.84*</td>
<td>0.23</td>
</tr>
<tr>
<td>7</td>
<td>Size 8</td>
<td>-0.48</td>
<td>0.33</td>
<td>1.14*</td>
<td>0.20</td>
<td>1.12*</td>
<td>0.25</td>
</tr>
<tr>
<td>8</td>
<td>sex</td>
<td>0.19***</td>
<td>0.12</td>
<td>0.89*</td>
<td>0.09</td>
<td>1.10*</td>
<td>0.12</td>
</tr>
<tr>
<td>9</td>
<td>cohort</td>
<td>-0.24**</td>
<td>0.01</td>
<td>-0.04*</td>
<td>0.01</td>
<td>-0.08*</td>
<td>0.01</td>
</tr>
<tr>
<td>10</td>
<td>paeduc</td>
<td>-0.11*</td>
<td>0.03</td>
<td>0.14*</td>
<td>0.02</td>
<td>0.25*</td>
<td>0.03</td>
</tr>
<tr>
<td>11</td>
<td>maeduc</td>
<td>-0.06***</td>
<td>0.03</td>
<td>0.12*</td>
<td>0.02</td>
<td>0.31*</td>
<td>0.03</td>
</tr>
<tr>
<td>12</td>
<td>tertiary ratio</td>
<td>-0.10</td>
<td>0.07</td>
<td>-0.15*</td>
<td>0.06</td>
<td>-0.07</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>constant</td>
<td>46.6228**</td>
<td>19.0146</td>
<td>66.4589***</td>
<td>14.0200</td>
<td>148.0935</td>
<td>18.0883</td>
</tr>
</tbody>
</table>

*-significance level 1%  secondary school dropouts and basic vocational alumnis are base level
**-significance level 5%  Pseudo R2=13%
***-significance level 10%

On the other hand, people living in regions with better access to tertiary education knows that they cannot pretend to be high quality, because finishing university would cost them too much and it is better to not have even secondary education finished and be recognized as less able worker.

To check the robustness of my estimation I have made another regression. Using the same data I estimate ordered probit model. The results are as follows:
Table 6. Ordered probit regression determining respondent education level

<table>
<thead>
<tr>
<th>No.</th>
<th>school</th>
<th>Coef.</th>
<th>Std. Err.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Size 2</td>
<td>0.45*</td>
<td>0.08</td>
</tr>
<tr>
<td>2</td>
<td>Size 3</td>
<td>0.38*</td>
<td>0.07</td>
</tr>
<tr>
<td>3</td>
<td>Size 4</td>
<td>0.34*</td>
<td>0.07</td>
</tr>
<tr>
<td>4</td>
<td>Size 5</td>
<td>0.38*</td>
<td>0.07</td>
</tr>
<tr>
<td>5</td>
<td>Size 6</td>
<td>0.33*</td>
<td>0.07</td>
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<tr>
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<td>Size 7</td>
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<tr>
<td>7</td>
<td>Size 8</td>
<td>0.57*</td>
<td>0.09</td>
</tr>
<tr>
<td>8</td>
<td>sex</td>
<td>0.37*</td>
<td>0.04</td>
</tr>
<tr>
<td>9</td>
<td>cohort</td>
<td>-0.02*</td>
<td>0.01</td>
</tr>
<tr>
<td>10</td>
<td>paeduc</td>
<td>0.11*</td>
<td>0.01</td>
</tr>
<tr>
<td>11</td>
<td>maeduc</td>
<td>0.11*</td>
<td>0.01</td>
</tr>
<tr>
<td>12</td>
<td>tertiary ratio</td>
<td>-0.16</td>
<td>0.02</td>
</tr>
</tbody>
</table>

*-significance level 1%  
Pseudo R2=11%

Table 7. Ordered probit regression determining respondent education level with inclusion of tertiary ratio squared

<table>
<thead>
<tr>
<th>No.</th>
<th>school</th>
<th>Coef.</th>
<th>Std. Err.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Size 2</td>
<td>0.45*</td>
<td>0.08</td>
</tr>
<tr>
<td>2</td>
<td>Size 3</td>
<td>0.39*</td>
<td>0.07</td>
</tr>
<tr>
<td>3</td>
<td>Size 4</td>
<td>0.35*</td>
<td>0.07</td>
</tr>
<tr>
<td>4</td>
<td>Size 5</td>
<td>0.39*</td>
<td>0.07</td>
</tr>
<tr>
<td>5</td>
<td>Size 6</td>
<td>0.35*</td>
<td>0.07</td>
</tr>
<tr>
<td>6</td>
<td>Size 7</td>
<td>0.46*</td>
<td>0.08</td>
</tr>
<tr>
<td>7</td>
<td>Size 8</td>
<td>0.54*</td>
<td>0.09</td>
</tr>
<tr>
<td>8</td>
<td>sex</td>
<td>0.37*</td>
<td>0.04</td>
</tr>
<tr>
<td>9</td>
<td>cohort</td>
<td>-0.02*</td>
<td>0.01</td>
</tr>
<tr>
<td>10</td>
<td>paeduc</td>
<td>0.11*</td>
<td>0.01</td>
</tr>
<tr>
<td>11</td>
<td>maeduc</td>
<td>0.11**</td>
<td>0.01</td>
</tr>
<tr>
<td>12</td>
<td>tertiary ratio</td>
<td>-0.14*</td>
<td>0.06</td>
</tr>
<tr>
<td>13</td>
<td>ratio squared</td>
<td>0.05**</td>
<td>0.02</td>
</tr>
</tbody>
</table>

*-significance level 1%  
Pseudo R2=12%

**-significance level 5%

***-significance level 10%

Almost the same as before, most of the variables are important and with signs as expected. The stunning variable is tertiary ratio which is insignificant at any reliable significance level. Does
it mean that in the previous model tertiary ratio was significant only due to specification of the model. Not necessary, Bedard argued that better access to university causes more high school dropouts on one hand, but on the other, of course, more people will go to university. So the impact of tertiary ratio is according to the signaling theory non-linear. That's why I made additional regression with tertiary ratio to the power of 2.

The results shows that impact of easy university access has a parabolic shape. On both endings it is positive (higher quantity of less educated people and university alumnus). This is another argument in favor of existence of ability signaling on labor market in Poland during the end of communistic and beginning of capitalistic period.

In the end I estimated the model separately for males and females.

---

**Table 8. Multinomial logistic regression determining respondent education level calculated exclusively for men**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Size 2</td>
<td>-0.63</td>
<td>0.37</td>
<td>0.83*</td>
<td>0.26</td>
<td>1.16*</td>
<td>0.35</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 Size 3</td>
<td>-1.15*</td>
<td>0.35</td>
<td>0.63*</td>
<td>0.23</td>
<td>0.85*</td>
<td>0.31</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 Size 4</td>
<td>-0.99*</td>
<td>0.37</td>
<td>0.47***</td>
<td>0.24</td>
<td>0.43</td>
<td>0.34</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 Size 5</td>
<td>-0.70**</td>
<td>0.31</td>
<td>0.45**</td>
<td>0.23</td>
<td>0.63**</td>
<td>0.31</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 Size 6</td>
<td>-1.02*</td>
<td>0.36</td>
<td>0.85*</td>
<td>0.22</td>
<td>0.53**</td>
<td>0.32</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 Size 7</td>
<td>0.02</td>
<td>0.41</td>
<td>0.98*</td>
<td>0.30</td>
<td>0.93**</td>
<td>0.37</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>7 Size 8</td>
<td>-0.40</td>
<td>0.47</td>
<td>1.33*</td>
<td>0.31</td>
<td>0.81**</td>
<td>0.38</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8 cohort</td>
<td>-0.01</td>
<td>0.01</td>
<td>-0.04*</td>
<td>0.01</td>
<td>-0.08*</td>
<td>0.01</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9 paeduc</td>
<td>-0.07***</td>
<td>0.04</td>
<td>0.20*</td>
<td>0.03</td>
<td>0.32*</td>
<td>0.04</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10 maeduc</td>
<td>-0.11**</td>
<td>0.04</td>
<td>0.12*</td>
<td>0.04</td>
<td>0.28*</td>
<td>0.04</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11 tertiary ratio-0.20**</td>
<td>0.10</td>
<td>-0.27*</td>
<td>0.09</td>
<td>0.07</td>
<td>0.12</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12 constant</td>
<td>30.1069</td>
<td>25.7001</td>
<td>78.7547*</td>
<td>20.5968</td>
<td>143.6721</td>
<td>27.6434</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
If we look carefully, we can see that crucial variable (impact of tertiary ratio on secondary schools dropouts comparing to secondary schools graduates) is strongly significant for men but completely insignificant for women. This result is completely astonishing due to the fact we are talking about the same labor market, officially without any discriminatory laws introduced. I have two explanations of this result or outcome. First, it can be the case of “lower level equilibrium trap” proposed by Spence(1973). He argued that even if we have two groups with the same characteristics, but with different one indices (for example sex) that is correlated with the signaling process. According to him, “M and W, at the level of signaling, (...) can generate many different possible equilibrium configuration.” It can be true because women, usually study longer than men. In the sample from PGSS average man had studied 10,02 years while woman on average had studied for 11,55 years before finish her education. So if a man was thinking about taking or not Matura exam, woman may decided between finishing general secondary and post – secondary school.

Another possible explanation is due to market discrimination. It may be that on more creative positions, men are employed. These positions require rather than certain skills, which can be learned in school, unobservable abilities, which cannot be learned but able person can somehow signal that he is appropriate for this post. So due to discrimination, different theories may explain the behavior of men and women even if they are of the same productivity.

---

PART VI. CONCLUSIONS

Two competitive theories try to explain human behavior during decision making about prolonging (or not) their education. Both of them predicts that peoples’ motivation for investing in education is related to hope of having privileged position on the labor market. Both predict that better educated persons can expect higher earnings. But the impact of education on the overall economics differs significantly among the models.

Human Capital assumes that the outcome of perfectly competitive markets without any interventions will maximize the total output of the economy. It is because personal return to education is equal to the social one. That provides a Pareto efficient solution.

The situation is completely different when a competitive theory is applied. According to the simplest model of signaling skills, education decreases net output of the economy and increases inequalities in earnings. Although Stiglitz (1975) argued that “if, as a result of better organized (for example, by using more homogenous assembly lines) then there is a kind of externality provided by the availability of information”\textsuperscript{7}, even he came to the conclusion that there is no certainty that the market outcome will be the efficient one. This suggests that government can by use of appropriate tools to improve the situation on the market. It is argued that by levying tax on educational institutions, obtained equilibrium will be better than market outcome. By equalizing social and private benefits of education, we can improve situation of all market participants. It is especially important if the government could find and limit phenomenon of investing “too much” in education in order to distinguish low from high productivity workers.

As this research has shown on Polish labor market, there exists an effect of signaling skills to potential employers. It shows that role of the state on education is crucial and may improve present condition of the economy. Governance by lowering age till which school attendance is compulsory may increase overall wealth. Another important policy that I recommend is easing the barriers for people living far from traditional academic centers to have better access to tertiary education. In total, these two policies (assurance of more equal access to tertiary education and a decrease in an average number of years spent in schools) may on one hand decrease spending on education and on the other side increase matching of people with appropriate skills to appropriate post.

On the other hand, lawmakers should have on their mind that the equilibrium differs not only for people with access to universities in comparison with those without, but also between genders. Women’s behavior is rather determined by the human capital theory than the screening...

hypothesis. It means that different policy must be implemented to both sexes. As summary statistic shows, women usually spend more years in schools, although on average their earnings are lower. This is one of the predictions of signaling model, which state that more education (which is not productive) if do not improve information about the skills lead to decrease in income. On the other hand, results of the logistic estimation suggest that this theory fails to explain women’s behavior. It could mean strong discrimination based on a sex. That is the reason why anti-discriminatory police is also required.
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Abstract

This work discusses the impact of signaling on individuals’ decisions to continue education. Based on a variety of predictions of signaling and human capital theory, this work empirically examines the importance of signaling education system alumnus about his productivity. The data used in research came from PGSS (Polish General Social Survey – Social Diagnosis), sample restricted for the years 1975 – 1998 due to administrative changes. It proves that the signaling hypothesis cannot be omitted if the behavior of Poles in the education market is to be fully explained.

Zusammenfassung

Curriculum Vitae

Jarosław Hornowski

Education

07/2009-06/2010 University of Vienna Vienna, Lower Austria
- Finished a one year exchange programme Double Diploma in Vienna
- Achieved Master degree on University of Vienna

07/2008-06/2009 University of Warsaw Warsaw, Mazowieckie
- Started a two-year course in English on International Economics at the Faculty of Economic Sciences
- Completed sub-courses: Advanced Microeconomics, Mathematical Methods in Economics, Microeconometrics, Research Seminar, Labour Migration, Monetary Economics, Macroeconometrics, Trade Theory and Macroeconometrics,
- Achieved Master degree on University of Vienna

07/2007-06/2008 University of Warsaw Warsaw, Mazowieckie
- Started a three-year course on Finance and Banking at the Faculty of Economic Sciences
- Completed sub-courses: Finance, Accounting; Financial Investments, Investment Funds and Asset Management, Financial Instruments, Foundations of Law, Demographics

10/2005-07/2007 University of Warsaw Warsaw, Mazowieckie
- Completed a two-year course on General Economics
- Including the following sub-courses: Macroeconomics, Microeconomics, Linear Algebra, Mathematical Analysis, Mathematical Programming, Probability Calculus, Introduction to Statistics, Mathematical Statistics

09/2002-03/2005 I Liceum Ogólnokształcące w Łosicach Losice, Mazowieckie
• Matura in Advanced Mathematics, Advanced English, Advanced History and Standard Polish

Achievements
• Best score in an internationally renowned mathematical competition Kangaroo in 2004
• Academic scholarship at the Faculty of Economic Sciences, at Warsaw University since 2006 and 2007
• Partial academic performance tuition waiver in 2006 through 2008
• Member of Economic Strategy Student Group; responsible for organising gatherings
• MFDB (Inter-University Bank Dealers Forum) Certificate. Additional training in Thomson Reuters (for 25 top scores participants)

Languages
• English: fluent – Proficiency level in both speaking and writing, in particular in areas of economics and business
• Russian: intermediate level
• German: basic level

Skills
• Working knowledge of Microsoft Office
• Complete knowledge of Mathematica – software widely used in the finance and mathematical fields
• Full familiarity with renowned econometrics software Stata
• Presentation and speech delivery expertise

Interests
• Music: 80’s rock,
• The cinema: mainly science-fiction films, Paul Verhoeven’s films,
• Passive interest in politics.