UNIVERSIDAD SAN FRANCISCO DE QUITO USFQ

Colegio de Administración y Economía

Effect of government spending on the allocation of human capital, a theoretical approach.

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Danny Alejandro Villarruel Arcos

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Danny Alejandro Villarruel Arcos

Calificación:

Nombre del profesor, Título académico **Santiago José Gangotena, Ph.D.**

Firma del profesor: _____

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Firma del estudiante: _____

Nombres y apellidos: Danny Alejandro Villarruel Arcos

Código: 00129072

Cédula de identidad: 2100513411

Lugar y fecha: Quito, 20 de diciembre de 2019

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RESUMEN

El concepto de adquisición de capital humano es amplio a lo largo de la literatura. Los incentivos hacia la adquisición de educación son por lo general entendidos bajo la perspectiva de Mincer. Por el contrario, bajo un modelo de señales, la inversión en educación es resultado de la interacción entre empleado y empleador en función de transmitir información de habilidad. Este proyecto desarrolla un modelo teórico que permite analizar y evaluar el efecto de elementos del entorno que afectan la decisión de inversión en educación. Las señales emitidas por el gobierno hacia el mercado laboral pueden modificar los incentivos hacia la adquisición de educación, dando como resultado una mayor masa de personas educadas, sin embargo, se demuestra que el mercado será forzado a la búsqueda de una mejor señal. Este trabajo busca entender el fenómeno experimentado en el Ecuador en la última década denominado “Titulitis”.

Palabras claves: Capital humano, modelo de señales, inversion en educacion, gasto del gobierno.

ABSTRACT

The concept of human capital acquisition is broad among the literature, the incentives towards the acquisition of education are usually understood from a Mincer perspective. In contrast, under a signaling framework, the educational investment decision will be a result of the interaction between employers and employees to communicate skills. Other environmental variables, like government decisions can modify this interaction. The project set a theoretical framework of analysis, that can evaluate the effect of environmental actors in the investment decision process. Government signals towards the job market can modify the incentives to acquire education in a way. A bigger mass of educated people will be a possible outcome however it is shown that, it will force the market to find a better signal. The research aims to understand the phenomena of "Titulitis" experienced in Ecuador in the last decade.

Keywords: Human capital, Signalling framework, education investment, government expenditure.

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1. Introduction

The following work aims to provide a general framework of analysis, about government influence in the job market, from a signaling labor market perspective. Human capital is understood from the point of view of acquiring abilities through schooling, especially a third-degree level of education. The model conceives acquiring a degree as a signal towards the job market and shows the implications of the government decisions for the educational investment process. Modeling the government decision allows the evaluation of the signaling process and the implications towards the job market and further individual investment decisions.

The political implications of economic policy have always played a key role in emerging markets. Investment in education has become a main topic in many government administrations. The basic framework of this model follows the work of Michael Spence and incorporates the effect of government expenditure into the educational investment decision. Through game theory, it models the decision between two markets, private and public, and two types of workers, high and low skill, in order to conceptualize the effect of government expenditure in education towards the educational investment decision of workers.

The acquisition of third level degrees is understood from a screening process perspective. The labor market is segmented into public and private in order to show the implications of a signal towards both markets. Firms will use the signal perceived to screen out those workers who are considered low skilled. Under a perfect market competition, the signal will be reliable and able to screen out low skill workers. However, the existence of a public sector that does not follow a competitive market will end up damaging the signal and forcing the market to find a better signal equilibrium or switch-

ing the signal mechanism.

Government expenditure in education helps in the process to acquire third degree level of education for low skilled workers. The implications of the government decision include increasing the incentives towards acquiring education. According to some views, it will increase productivity of the whole country. However, it also damages the signal and forces the market to demand other proof of high talent. From the perspective of signaling, a non-costly signal does not work to screen and the market will switch to more efficient ways to prove high ability.

In Ecuador, during the last decade the investment in education, scores historical levels; ending up increasing the population that holds a second degree level. An inflow of people to the labor market using the same degree in order to prove ability will damage the signal and the market will require a higher degree level. The empirical implications are shown on (Márquez Jijón, 2019). The consequences towards Ecuadorian public policy become relevant, specially when the democratization of high levels of education is in constant debate. During the last administration, we tend to believe that acquiring master's and PhD degrees will give us enough human capital, in a paradox pointed out by Gòmez Tejada (2018). It is important to rethink the role of education, and the public expenditure towards it. Like Pritchett (1996) points out the institutional framework of a country could be perverse enough that "the accumulation of educational capital lowered economic growth". Until what point the democratization of education increases salaries of the ones who are acquiring high level degrees, but reduces the signalling purpose and end up harming those who are investing on it.

2. Literature Review

The differences in wages across industries can be understood through the differences in worker's characteristics. According to labor market literature, skills are a part of workers capital, therefore the acquisition of a set of skills should be considered a worker's investment decision. Acemoglu & Autor (2009) characterizes human capital as "any stock of knowledge or characteristics the worker has that contributes to his or her productivity". We must be careful not to extend the concept of Human Capital too far, since there are heterogeneity issues which are not observable in the data and can determine the wage spectrum.

The concept of human capital is widely discussed among those involved in the literature. Becker's view suggests that human capital increases worker productivity in all tasks (Acemoglu & Autor, 2009). The production process benefits from workers who know how to do things and do it in a more efficient way, considering the set of skills as an uni-dimensional object. On the other hand, Gardiner suggests that human capital has multiple dimensions, addressing it in the multiple-intelligences theory (Acemoglu & Autor, 2009). Bowles and Gintis have a more extreme perspective, considering: "human capital as the capacity to work in organizations and adapt to a capitalist society" (Acemoglu & Autor, 2009). The same line followed by Shultz and Nelson-Phelps, arguing that human capital is only the capacity to adapt (Acemoglu & Autor, 2009). Such a broad range of definitions make it difficult to build a framework that applies to a specific issue. The one used in this research is the Spence (1973) view, which suggests that the observable characteristics of human capital are a signal towards the job market.

A signal is any message with the capacity to suggest a specific characteristic of those who are sending it. According to Spence, the signal's purpose is to project abil-

ity to a future employer (Page, 2010a). In this framework there are different sources of human capital, therefore different incentives in the investment process. Schooling is the most observable characteristic of human capital and works as a good signal of ability. It is important to consider that human capital is not only schooling; however, non-schooling and schooling investment decisions are influenced by the same forces.

Schooling is far from being considered a perfect signal; however, it works for the purposes of this research. We must be careful with the heterogeneity of abilities; those unobserved and the self-selection of individuals towards certain degrees and industries. Also relevant is the quality of schooling and other investment decisions which influence ability and wages. There are several factors determining different wages across individuals from different universities and even those who come from the same Alma Matter. The importance of unobserved characteristics cannot be underestimated in order to fully understand the wage structure; however, this issue is not addressed in this paper.

The determinants of the decision behind acquiring a degree are not straight forward. Some sociologists suggest that diplomas serve as measurement of performance instead of accounting for acquired skills. Some radical economist argues that education is a process of socialization (Acemoglu & Autor, 2009). Arrow (1973) explores the idea that "higher education serves as a screening device, in that it sorts out individuals of differing abilities, thereby conveying information". He also suggests that the filtering role of education can add productivity, from the private viewpoint that an individual certified to be more valuable is more valuable. The main conclusion of the author is that "the improvement in the equality of income due to increased college education may therefore be offset by the decrease in alternative filters leading to qualification" meaning that any criteria used to select a worker will become narrower in scope, bottom line efficiency, and equity will suffer. The implications of Arrow are important to an extent for the main

model developed in this paper.

The investment decision of education is understood from a "signalling screening framework". Most of the literature suggests that education is a strong enough signal to filter between high and low skilled workers. Educational investment becomes a mechanism to signal higher cognitive skills to the labor market (Spence, 1973). It makes possible an allocation of different wages to different type of workers. Therefore, there is a framework of incentives towards the specialization decision of young adults.

There is a great variety of literature arguing that learning explains all the wage differences. The empirical evidence is not completely analyzed in this research; however, it is important to point out some conclusions from Weiss (1995). The author suggests that workers are not a random sample, since better educated workers will have lower propensity to quit and have different propensities to be absent. Under this framework employers will tend to favor better-educated workers, giving strong support to the model developed in this work. The main conclusion of Weiss suggests that "students will choose a length of schooling to signal their ability to employers, and they will demand a minimum level of schooling in order to screen workers" (Weiss, 1995). The mechanism of signaling for workers and screening for firms allows the existence of the model, which could be understood from an extension of the human capital model. The focus of this research is the dynamic in which schooling is a signal or a filter of productivity that firms will reward.

Through experimentation coming from competition, it is possible to unravel signals that do not convey accurate information. Riley (1975) suggests the existence of a family of potential "signaling equilibria" under a competitive economy, where only one is Pareto-dominant. Information can spread over the market and the doubtful signals will be removed from the set of reliable signals. Allowing for a private-public job mar-

ket would help to understand the dynamics to distinguish proper signals. It is possible for a central planner to skip the market interaction and deliberately set a new minimum educational requirement. This implication is further explored in this research.

In a competitive market, there is a wide range of economic variables in the environment that determines the flow of "talent" towards a certain sector. The idea follows the work of Murphy et al. (1991) who developed the concept of a "compensational contract".The profit that an individual can receive from a certain sector is not only monetary. Some non-observable elements like transfers, prestige, potential effort and career development drives the labor decision (Murphy et al., 1991).For the basic framework of this research we will assume that salary and costs are the driven elements of the educational decision investment.

Government can play an active role in the job market, especially in countries with weak institutional frameworks. Governments can send signals that modify the agent's choice and end up affecting the labor market. The dynamic is further explored in this research. The core model of Spence only takes into consideration the direct actors involved in the economic dilemma, firms, and potential workers. In the present research we incorporate a third actor: the government decision.

From a behavioral perspective, government decisions could be part of the investment function of education. In "Behavioral economics of education"Koch et al. (2015) provides a framework between educational investment and its expected payoffs. One of the main conclusions is that the investment function of education incorporates additional elements as soft skills and environmental inputs, like family or social preferences. There is little literature that incorporates government actions under this framework, which makes it relevant especially to countries highly sensitive to political affairs.

It is possible to add the role of government as an exogenous variable that affects

the signal “educational decision”. Spence (1973) suggests the existence of multiple dimensions of information and Koch et al. (2015) exposes the role of the environment in the educational investment decision. Therefore, workers can observe government decisions in their investment evaluation. It is important to consider that any signal should be costly to acquire in order to be efficient. Otherwise, the signal could be easily replicated from other groups and will lose its purpose of suggesting higher cognitive skills. Government can have a wide range of effect towards the educational decision. We must be careful when limiting the effect of government investment in the educational decision.

Government expenditure decision is not independent and does affect the set of individual incentives. An extension of the basic model of this research aims to find a relationship between government expenditure on education and the implications for the general equilibrium of acquiring education.The increase in the public sector size in Ecuador is pointed out by Uribe & Gachet (2019). The governmental incentives towards the development of the public sector could be understood from the framework of Pritchett & Viarengo (2009). They suggest that states with a weak state capacity will try to show a false image of equality. The overall educational outcomes of the public system is lower than the one achieved in the private system, therefore there is an incentive of the government to send a signal to the job market in order to create and image of “learning achievement equality” (Pritchett & Viarengo, 2009).

This research explores two mechanisms of government signals towards the job market. The first implication suggests that government expenditure on education decreases the costs of acquiring education for a low skilled worker. The next implication argues that the government hires high and low skilled workers without any distinction. The ones coming from the public educational system are not properly screened regardless of their real productivity but with a third-degree level. According to Pritchett &

Viarengo (2009), the mechanism sent a signal of equal learning to justify the decision of government to acquire large amounts of unskilled workers with third level degrees.

3. Model

3.1. Players

Taking into consideration the work of Michael Spence “Job Market Signaling”, the author explores a framework of sources of information. The main purpose is to find a potential signal that helps the market to clear. The basic model faces two players “students/workers” and the firms; both groups will be divided into two types. Students will choose an amount (x) of education and firms will observe and choose a salary (w). The basic set up is as follows:

1. Students/Workers
2. Firms

Where: Students/Workers: choose a level of education (x)

3.1.1 Students/Workers

Two types of students: t_i from a set of feasible types

T = (high skills, low skills)

$$\eta = productivity\ ability: \quad (high, low)$$

Workers choose a level of education: (x)

$$x \geq 0$$

Firms observe education and make a wage offer:

$$w(x)$$

3.1.2 Timing

The timing of the model and the main assumptions are the same as in the Michael Spence basic framework (Gibbons, 1992), and follows:

1. **Nature** determines a worker type. **Productivity** ability η

$$Prob(\eta = H) = q$$

$$Prob(\eta = l) = 1 - q$$

2. Workers choose level of education after learning ability η
3. Firms observe education and simultaneously offer wage to worker.
4. Workers accept the highest wage.

The representation of the game in extensive form is the following, figure 1. The set of payoffs shown will be understood as the only incentive in this model.

Within the idea of Kahneman (Krueger, 2012), and the work previously exposed by Spence (1973) and Koch et al. (2015), it is possible to set a basic framework of educational investment. The model will set up the existence of two working sectors, public and private as job demanders. Therefore, the expected payoff for workers towards joining a sector will be reflected as the expected salary $w(\cdot)$, which in this model will

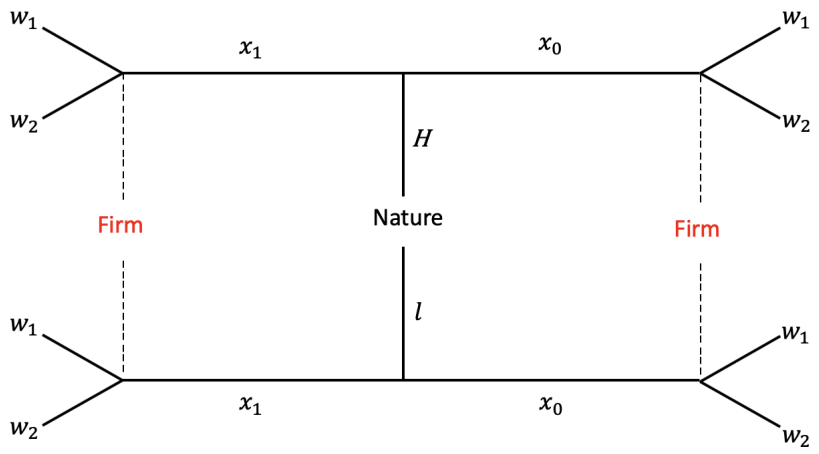

Figure 1: Extensive form of the game

incorporate the whole vector of incentives. Bottom line, educational investment decision is only wage driven.

Education choice:

$$x_1 = \text{B}achelors\ degree$$

$$x_0 = No\ degree$$

3.2. Extension of the Model

The basic model will be extended in a way that can incorporate the effect of the active role of government. This new variable could give additional information in order to adjust the "expected payoffs" or could modify the educational investment decision function. Spence points out that the existence of an expected wage makes possible the efficiency of the labor market towards an equilibrium. In the current research, the additional variable would lead the model towards a different equilibrium point, and through an empirical discussion, the new equilibrium will be evaluated.

$$Cost\ function = C(\eta, x, \theta)$$

Where:

$$\eta = \ productivity$$

$$x = \ education$$

$$\theta = \ government\ expenditure$$

The assumption of Spence (1973) is that the cost of education is a function of workers type. The basic difference between a low and high skill worker is the capacity to acquire education, for a low skill worker will be more difficult to acquire a bachelor degree, therefore:

$$C(l, x_1, \theta) > C(H, x_1, \theta)$$

The dynamic of government decisions and the implications of the new equilibrium are the two main objectives of this research. Since the scope of government actions are wide on the economy, this research set the new parameter. θ = government expenditure as the government expenditure on education, therefore:

$$w(\cdot) = w(x, \eta).$$

Where x = education. The main assumption in this model is towards the interaction of government spending, through out the reduction in costs faced by each group of workers. The different effect towards the two groups allows the existence of an equilibrium. The key assumption is the different effect of government spending over the cost function.

$\eta = l$

$$\frac{d}{d\theta}(C) = C_\theta(\cdot) < 0$$

$\eta = H$

$$\frac{d}{d\theta}(C) = C_\theta(\cdot) = 0$$

The effect of government spending is towards the low skilled worker, since it becomes more affordable to acquire education, easier access to higher educational institutions and a bigger sphere of support can reduce the cost to acquire education. For a high skill worker acquiring education is only a function of its own productivity. A self selection bias could appear in the case for high skill workers since this group is going to look for more demanding degrees. For both workers.

$$C_x(\cdot) = \frac{d}{dx}(C) > 0$$

$$C_x(l, x_1, \theta) > C_x(H, x_1, \theta)$$

The acquisition of education is costly for both types, however, a low skilled worker will find it more difficult to acquire x.

3.3. Worker Setup

In the first stage of this model we will only contemplate the existence of two groups, high and low skilled workers. Each group will face a different constraint. For the high skilled workers, the acquisition of education will be cheaper, since they have

high intrinsic ability. Therefore it is necessary furthermore to assume that the cost of education is a function depending on intrinsic ability and the government expenditure on education.

$$C(\cdot) = c(\eta, x, \theta)$$

Where

$$\eta \in (high, low)$$

For simplicity of the analysis, the expected payoff "wage" would be a function of the signal observed "degree acquired". Worker utility will be a function of the wage, the intrinsic ability and the government decision.

$$U_i(w, x, \theta) = w_i(x) - C(\eta, x, \theta) \tag{1}$$

Where

$$\theta = exogenous$$

$$w(x) = wage\ is\ a\ function\ of\ the\ education\ level$$

$$x(\eta) = education\ chose\ is\ a\ function\ of\ the\ workers\ type.$$

The indifference curves for the two workers are represented in figure 2

I_i = indifference curve of worker with type i

For a move from no education, x_0, towards acquiring a degree x_1

1. A worker type $High$, must be compensated with wage w_H.
2. For worker type low, must be compensated with wage w_l.

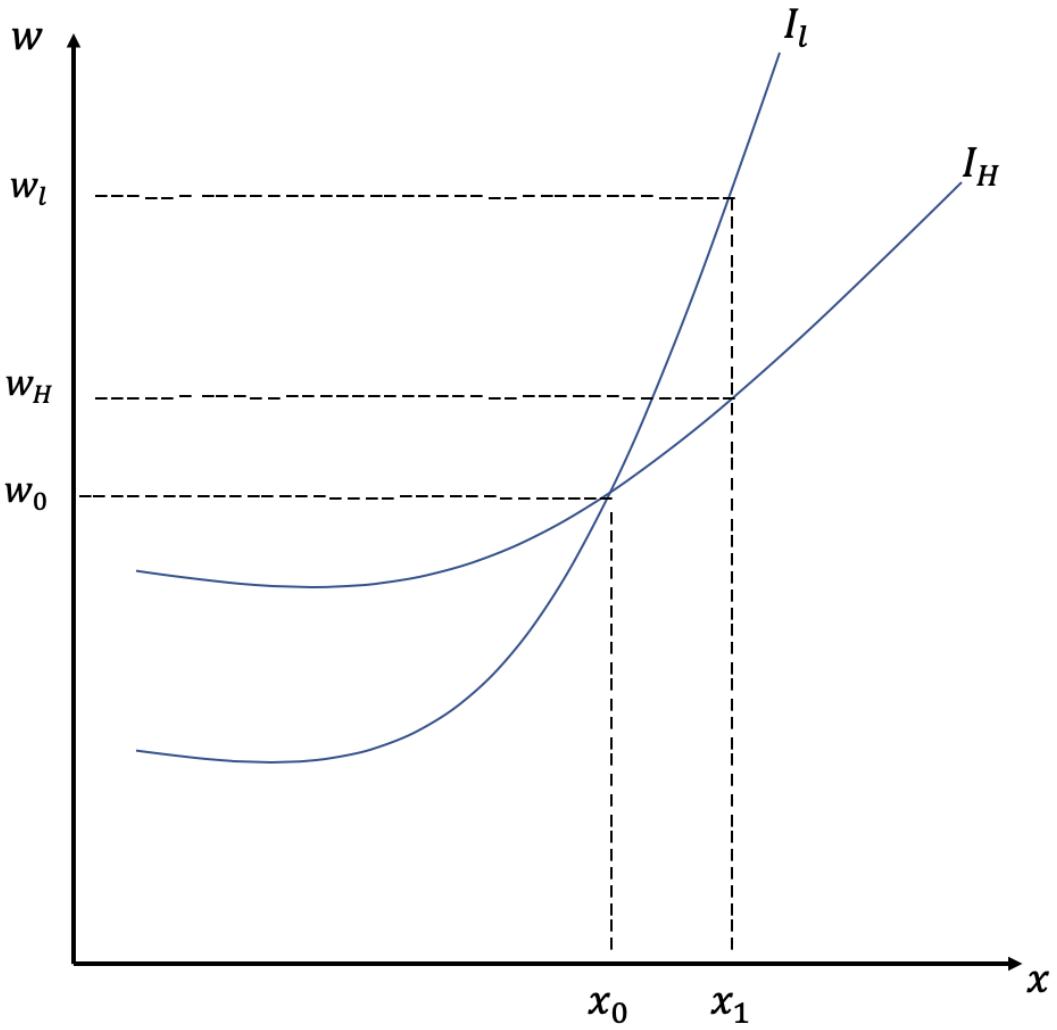

Figure 2: Indifference curves

Since $w_H < w_l$, a low skilled worker must be compensated with higher salary. Therefore, it is more costly for a worker with low productivity to acquire education.

The utility function is defined under a set of assumptions to include the government decision effect on workers utility. Also under the assumption that cost education is a function of government spending, the characterization is:

From equation 1 at page 22

$$U_i(w,x,\theta) = w_i(x) - C(\eta,x,\theta)$$

The characterization form will be:

$$U_i(w,x,\theta) \equiv \beta w - Ax^2 \tag{2}$$

Where $A(\cdot)$, is a function that will include the effect of government spending, as exposed before, the function will affect the cost curve and will be a function of the signal perceived from the government θ.

$$A(\theta) = A_i + f_i(\theta) \tag{3}$$

Basic assumptions of the government expenditure function.

$$f_i'(\theta) \leq 0$$
$$f_i''(\theta) < 0$$

A_i represents the minimum cost of education, since it can never be completely free, and $f_i(\theta)$ will be characterized as following:

$$A(\theta) = \overline{A}_i - log(\theta)$$

$$U_i = \beta w - [\overline{A}_i - log(\theta)]x^2 \tag{4}$$

From this characterization utility increases as government spending increases.

Formally,

$$\frac{dU}{d\theta} = \frac{1}{\theta}x^2$$

$$\frac{dU}{dx} = \beta w'(\cdot) - 2x\overline{A}_i + 2xlog(\theta) \tag{5}$$

Acquiring education is costly for many reasons since its time consuming and require effort according to the intrinsic ability. As education is acquired, utility may decrease. However through out my characterization, government spending helps compensate the cost to acquire education. An increase in *governmnet spending* θ will flatter the indifference curve showed on figure 2

From the prior disccusion, the effect of governemnt spending will be only perceived in the low skill sector, meanwhile the high skill group will be indifferent to the signal. Therefore

$$\text{for } i = \text{low skilled } f'(\theta) < 0$$
$$\text{for } i = \text{high skilled } f'(\theta) = 0$$

Equation 5 can be written as:

$$\frac{dU_i}{dx} = \left\{ \begin{array}{c} \beta w'(\cdot) - 2x\overline{A}_i + 2xlog(\theta) \; for \; i = l \\ \beta w'(\cdot) - 2x\overline{A}_i \; for \; i = H \end{array} \right\} \tag{6}$$

$\overline{A}_i$ represents the minimum intrinsic cost of education that is different for both type of workers due to ability differences.

$$\overline{A}_l > \overline{A}_H$$

3.4. Firm Setup

Murphy et al. (1991) discussed the incentives toward the job decision. In the paper "Allocation of talent", the authors discussed which firm decisions can attract the biggest number of workers. This research allows for the existence of two job market sectors, public and private. For further discussion, they would be defined as a rent seeker sector and a wealth productive sector according to the Murphy model.

Both will compete to attract the largest number of workers. In a competitive equilibrium, there would be proof that both sectors offer the same competitive wage; however, if we assume a public choice framework, we open the discussion towards a differential set of wages.

Firms are driven by the potential productivity they can earn from a worker; therefore, the payoff for each firm will be the difference between the production function and the wage paid. In a competitive market we will assume that the market follows the following problem:

The Market Payoff:

Spence Assume that competition among firms will drive expected profits to zero (Gibbons, 1992, p.193). Assuming a one player game, the combined payoff of the market will be:

$$\pi_m = -[y(\eta, x) - w]^2$$

The production function $y(\cdot)$ represent the output that a worker is able to provide to a firm. Assuming the common human capital literature, the product of a worker will be a function of its intrinsic abilities η and the abilities acquired through education x.

For each x_i in X, the firm's action wage, must maximize the receivers expected payoff, giving the belief about worker type from an observed x, $\mu(t_i|x_i)$. The firm aim to discover which type of worker would have sent x_i therefore, firm's action $w^*(x_i)$ solve.

$$\max_{w} \qquad \sum_{\eta} \mu(\eta|x_i)\ \pi_m(\eta, x_i, w)$$

If the market believe system will assume that only one type of signal perceived means high skill abilities then:

$$\mu(\eta|x_i) = \mu(\eta|x) = \mu(H|x^*)$$
$$\pi_m = -[y(H,x) - w]$$

In a problem with two possible types of workers, the firm's problem solve the expected payoff as following

$$\max_{w} \qquad \mu(H|x)\{-[y(H,x) - w]^2\} + [1 - \mu(H|x)]\{-[y(l,x) - w]^2\}$$

First order condition

$$\frac{d}{dw} = 2\mu(H|x)\{-[(y(H,x) - w](-1)\} + 2[1 - \mu(H|x)]\{-[y(l,x) - w](-1)\} = 0$$

$$2\mu(H|x)[y(H,x)-w]+2[1-\mu(H|x)][y(l,x)-w]=0$$

$$2\mu(H|x)y(H,x)-2\mu(H|x)w+2y(l,x)-2w-2\mu(H|x)y(l,x)+2\mu(H|x)w=0$$

$$2\mu(H|x)[y(H,x)]+2[y(l,x)]-2\mu(H|x)y(l,x)=2w$$

The best response function of firm will be:

$$w^*(x)=\mu(H|x)\ y(H,x)+[1-\mu(H|x)]\ y(l,x) \tag{7}$$

Assuming both firms will face the same beliefs. $x=x^*$ finding the "optimum" education that convey high skills.

The formal proof is explored in the Bertrand model (Gibbons, 1992), firms will pay the expected marginal product of workers.

3.4.1 First Case: Workers ability common knowledge

The mechanism behind the decision of education is the starting point of this analysis. The returns derived from the acquisition of education provide a framework of incentives towards the specialization decision of young adults. The inter-temporal decision to study in order to acquire a bachelor's degree will signal higher cognitive skills.

In the first simple case, we will assume that worker's ability is common knowledge. Through the mechanism of a competitive market, we will assume that the job

market will clear out. Educated and non-educated workers will become the supply of skilled workers who are going to be hired by firms. There will be two groups of workers, high skilled and low skilled workers that interact in the market signaling core model.

Previous calculated first order conditions in equation 6

$$w^*(x) = \mu(H|x)\ y(H,x) + [1-\mu(H|x)]\ y(l,x)$$

The set of beliefs of the firm will be:

$$\hat{x} \text{ implies High Skill}$$
$$\widetilde{x} \text{ implies low skilled}$$

Therefore.

$$w^*(\hat{x}) = y(H,\hat{x}) \qquad if \qquad \mu(H|\hat{x}) = 1$$
$$w^*(\widetilde{x}) = y(l,\widetilde{x}) \qquad if \qquad \mu(l|\widetilde{x}) = 1$$

In common knowledge the best response function of firm will be:

$$w^*(x_i) = y(\eta,x) \tag{8}$$

Firms will pay, the worker's marginal productivity since there is no uncertainty.

The problem of the worker, assuming $\theta = 0$

$$\max_x \qquad y(\eta,x) - C(\eta,x,\theta)$$

Since workers know the best response function of firm, presented in equation 8 then they will maximize utility when:

$$y'(\eta,x) = c'(\eta,x,\theta)$$

$$y'(\eta,x) = \left\{ \begin{array}{c} y'(l,x)\ for\ \eta = l \\ y'(H,x)\ for\ \eta = H \end{array} \right\}$$

Workers will choose (x) such that its marginal product equals the marginal cost to acquire education. Meaning:

$$y'(\eta,x) = c'(\eta,x,\theta)$$

The level of education they will acquire is: $x^*(\eta)$

Ergo:

$$w^*(\eta) = y(\eta,x^*(\eta),\theta)$$

Workers will choose an optimum educational level $x^*(\eta)$ according to their intrinsic ability. Then the salary received will be a function of the educational signal observed by the firm. Under common knowledge firms will pay the marginal product of labor of each type of worker.

Under the government signal model $\theta > 0$

Worker's problem:

$$\max_x \qquad \beta w - Ax^2$$

$$Where: A(\theta) = \overline{A_i} - log(\theta)$$

$$\max_{x} \qquad \beta w(x) - [\overline{A_i} - log(\theta)]x^2$$

$$\frac{d}{dx} = \beta w'(x) - 2x[\overline{A_i} - log(\theta)] = 0$$

$$\beta w'(x) = 2x[\overline{A_i} - log(\theta)]$$

The result is as before the marginal revenue equals marginal cost of acquiring education. For a low skill worker the cost to acquire education decreases making it more desirable to enroll into a third degree level program.

3.4.2 Second Case: Incomplete information, ability as private knowledge

The information of productivity is asymmetrical across the job market. The employers have a set of beliefs about an employee's productivity by observing a signal. It is important to consider that the cost of experimentation increases and requires a considerable amount of observations. It makes it possible a slow drift towards a pareto superior signaling equilibria (Riley, 1975).

Firms will have a set of beliefs about the message, "signal" received, where $\boldsymbol{q}$ will be the probability to hire a high skill worker.

Define:

$\hat{x}$: education that conveys High skills

$\tilde{x}$: education level that convey low skills

Best response function:

Since ability is private knowledge, from equation 7 firms will offer $w^*(x)$

Define education level: $x_p = [\hat{x}, \tilde{x}]$

$$w(x) = q\ y(H, x_p) + (1-q)\ y(L, x_p)$$

Beliefs of the firm:

$$\mu(H|\hat{x}) = 1$$

$$\mu(H|\tilde{x}) = 0$$

If it is too expensive for a low skilled worker to acquire high education then:

1. A high skill worker will end up acquiring and will perceive a salary of high skill worker $w^*(\hat{x})$

   If the signal works to screen out workers then:

2. $w^*(\hat{x})$ salary paid to a high skilled worker

3. $w^*(\tilde{x})$ salary paid to a low skilled worker

$$w^*(\hat{x}) \geq w^*(\tilde{x})$$

The implications found in equation 6 holds, an increase in θ government spending will decrease the marginal cost of education for the worker, making it easier and desirable to acquire more education.

Worker (η) will choose education x that satisfy.

$$\beta w'(x) = 2x(\overline{A}_i - log(\theta))$$

The educational decision will become a function, for a lower worker of his intrinsic ability and the government spending θ $x^*(l,\theta)$: for a low skilled worker

$x^*(h)$: for a high skilled worker

$w^*(\eta)$ will be the salary paid to worker, which will become a function of the productivity, since workers chose x based on ability η.

For High skilled worker

$$\beta w'(x) = 2x\overline{A}_H$$

$$Marginal\ revenue\ High\ skill = Marginal\ cost\ High\ skill$$

For the low skilled worker The equilibrium will hold if:

The Payoff of a low-skilled worker, getting education of low skill and earning a salary of low skill is higher than; the payoff of a low-skilled worker, getting education of high skill and earning a salary of high skill. Formally:

$$w^*(l) - C(l, x^*(l), \theta) > w^*(H) - C(l, x^*(H), \theta) \tag{9}$$

The prior equation 9 implies that for a low skilled worker getting the optimal level of education of a high skilled worker $\hat{x}^*(H)$ is too expensive. The same implication is shown in the figure 3.

3.4.3 Comparative

The effect of government spending will reduce the difference between the intrinsic costs of each workers group as follow:

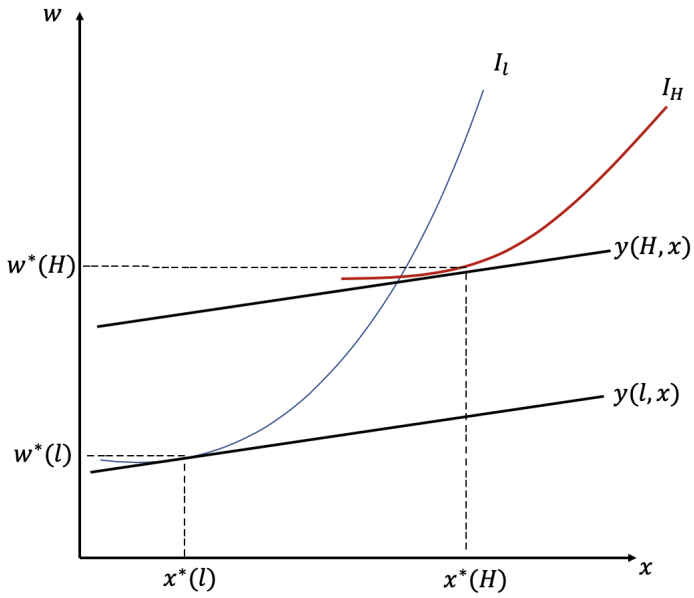

Figure 3: Indiference curves in equilibrium

High Skill Worker: The effect of government spending does not exist, as shown in equation 6 therefore the utility function of equation 4 is:

$$U_H = \beta w(x) - \overline{A}_H x^2$$

Low Skill Worker:

$$U_l = \beta w(x) - \overline{A}_l x^2 + x^2 log(\theta)$$

In order for log (θ), government spending, to have an effect on the utility curve of low skill worker.

$$\frac{dU_l}{dx} = \frac{dU_H}{dx}$$

$$\beta w'(x) - 2x\overline{A}_l + 2xlog\theta = \beta w'(x) - 2x\overline{A}_H$$
$$log\theta = \overline{A}_l - \overline{A}_H$$

The effect of government spending is towards the cost function, It will reduce the difference between the two cost functions making them look more similar. Figure 4 shows the effect on the indifference curve of a low skilled worker when θ increases. A flattering of the low skill worker indifference curve will allow the worker to acquire more education and demand a higher salary $w_2(l)$to compensate the acquisition of education. The increase in θ reduces the educational gap between workers.

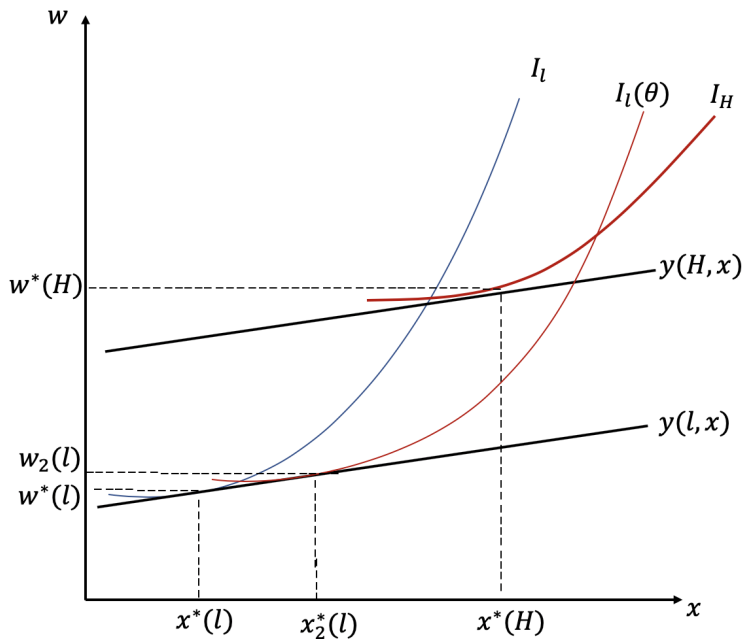

Figure 4: Indiference curves with a shock in θ

3.4.4 Pooling solution

The only solution explored in this research is the Pooling Solution, however Spence shows two other equilibrium solutions (Spence, 1973). Specifically the model assumes the existence of a Bayesian equilibrium under imperfect information. In order to determine the equilibrium, both sectors face the same set of beliefs about workers productivity. On the other hand workers, are fully aware of their intrinsic ability and face a set of beliefs about the expected salary in both working sectors. The job market asymmetry of information exists due to the wide variety of sources of information about workers ability. The main assumption of this model is that the only observable signal is the accomplishment of third-degree educational level.

Let's assume both high and low skilled workers will choose $\hat{x}$

Beliefs:

$$\mu(H|\hat{x}) = q$$

Best response of firm

$$w(\hat{x}) = q\, y(H,\hat{x}) + (1-q)\, y(l,\hat{x})$$

Firms believe and Solution:

Any other type of message that: $x \neq \hat{x}$

Will suggest:

$$\mu(H|x) = 0 \;\forall\; x \neq \hat{x}$$

$$\mu(H|\hat{x}) = 1$$

The new set of beliefs faced by the firm will be.

Firm belief:

$$\mu(H|x) = \begin{cases} 0 & x \neq \hat{x} \\ 1 & x = \hat{x} \end{cases}$$

$$w(x) = \begin{cases} y(l,x) & x \neq \hat{x} \\ w(\hat{x}) & x = \hat{x} \end{cases}$$

Workers: A worker of ability η will choose x to solve

$$\max_x \qquad w(x) - c(\eta, x, \theta)$$

Firms beliefs are well known by workers, therefore the best respond function of firm is known as before in equation 8:

$$w(x) = y(\eta, x)$$

$$\max_x \qquad y(\eta, x) - c(\eta, x, \theta)$$

$$\frac{dy(\eta,x)}{dx} = \frac{dC(\eta,x,\theta)}{dx}$$

1. **Worker** $\eta = H$ Testing the acquisition of a higher level of education, where, $\dot{x} > \hat{x}$

   For a High skill worker.

   $$\frac{dy(H,\dot{x})}{dx} = \frac{dC(H,\dot{x})}{dx}$$

   $$w(\dot{x}) = y(\eta, \dot{x})$$

   For a high skill worker acquiring a higher education than $\hat{x}$ is possible, since it

will be compensated by an equal increase in the salary. In equilibrium he will choose $x = \hat{x}$

2. **Low skill worker** $\eta = l$

$$\frac{dy(l,\dot{x})}{dx} \neq \frac{dC(l,\dot{x},\theta)}{dx}$$

Even if a low skilled worker receives a higher salary it will not compensate the increase in cost. For a low skilled worker acquiring a higher education is not optimal, since the equality does not hold. Higher education is only possible if there is an increase in θ. Otherwise he will choose the optimal level of education $x = x^*(l)$ A level of education that maximizes:

$$\max_x \qquad\qquad y(l,x) - C(l,x,\theta)$$

3.4.5 The case for Government

Starting from the basic assumptions of utility of both type of workers.

$$High\ skill = \beta w(x) - \overline{A}_H x^2$$
$$Low\ skill : \beta w(x) - \overline{A}_H x^2 + x^2 log\theta$$

The optimal level of education can be found by.

1. For a High skill worker.

$$\frac{dU_H}{dx} = \beta w'(x) = 2x\overline{A}_H$$

$$x_H^* = \frac{1}{2}\frac{\beta w'(x)}{A_H}$$

2. For a low skill worker.

$$\frac{dU_l}{dx} = \beta w'(x) - 2x\overline{A}_l + 2xlog\theta = 0$$

$$\frac{dU_l}{dx} = \beta w'(x) - 2x(\overline{A}_l - log\theta) = 0$$

$$\beta w'(x) = 2x(\overline{A}_l - log\theta)$$

The optimal level of education can be found by.

$$e_l^* = \frac{1}{2}\frac{\beta w'(x)}{A_l - log\theta}$$

High skilled worker will choose $\hat{x}$ while **low skilled** one will choose x_l^*

Since:

$$\overline{A}_H < \overline{A}_l$$

If $log\theta$ is large enough to:

$$\overline{A}_H = \overline{A}_l - log\theta$$

Then high and low skilled workers will choose $\hat{x}$ making it difficult for the firm to make inference from $\hat{x}$.

An increase in θ will damage the screening process.

$$\hat{x} \sim f(\eta, \theta)$$

If θ increases, the minimum educational signal required will increase as well. In other words, the increase in government expenditure makes it easier to acquire education therefore higher degree levels are demanded as proof of high skills.

3.5. Discussion

The investment educational decision is only wage driven, meaning that higher wages should encourage the acquisition of education. However, this is not true for all young adults that are about to take this decision. Since enrolling in a third level degree program is costly and carries an inter temporal decision; some of them would choose to jump into the job market immediately. If government expenditure helps reduce the cost of acquiring education, then a lot of low skilled workers will end up acquiring higher education. It is possible to believe that the overall outcome of the country will increase, since productivity increases. However, from a signaling perspective, the increase in education does not increase productivity therefore there is no benefit in the country's output.

The main implication of this model is that government expenditure in education is perceived as a signal that will damage the screening process in the market. At the end the private sector will begin to demand a higher level of education in order to find a better signal which is able to screen low skill workers. In a digital world the signal of a degree could end up being replaced (Eadicicco, 2019). Some firms like Apple and Google are hiring workers without a 4 year degree, but who can demonstrate certain abilities. This model can provide a general framework to analyze the mechanicism of the signal. If it is not possible to screen low skill workers from a 4 years degree, then the competitive market will switch to a better signal.

In Ecuador during the government of Rafael Correa, the country experienced a

wave of what Jorge Gomez call ”Titulitis” (Gòmez Tejada, 2018), workers going into the public sector only if they have a third level degree, and even with a fourth level degree. Since the overall wage and benefits in the public sector suddenly increased, the optimal choice of workers was towards acquiring a third-level degree regardless of its ability. In a country with a low institutional level, acquiring degrees does not involve a 4 year study. There were several cases of fake degree scandals or universities providing easy access to degrees. At the end the signal suffers, and the market will use a different set of beliefs to screen low skilled workers. It will be interesting to explore the idea of the market penalizing and having stigma toward those employees coming from the public sector.

4. Conclusions

The development of this work allows to set a framework of analysis to understand the dynamic behind the labor market, with some implications in Ecuador. It attempts to become a groundwork for further empirical research. The main implication of this work suggests the existence of large incentives towards worker specialization through acquiring education. However, it is necessary to build up a data set in order to prove this conclusion. It is important to point out some conclusions made by Uribe & Gachet (2019) who suggest that during the last 14 years in Ecuador, the public sector grew rapidly, demanding even more qualified workers, and putting high pressure in the job market. The Private wages became less competitive, specially since public sector wages didn't account for workers productivity. In Ecuador there is an important gap between public and private wages, that increased during the government of Rafael Correa. In "Vacas Flacas o Salarios Gordos" Uribe & Gachet (2019) shows that the labor market gap is not a coincidence; the higher wages in the public sector followed by regulation in the hours worked makes the labor productivity in public sector artificially higher than the private one.

In Uribe & Gachet (2019) the authors shows the implications on salary towards two educational groups. For low education workers the real salaries show a fast convergence after 2008; however, this is not the case for the high education workers, which shows a gap between the public and private sector. As exposed before government can influence the job market, through a signal. Both sectors will compete to attract a higher number of workers, through the dynamic of the model, higher wages will incentive workers to join a special sector. However, the screening process is not the same for both sectors, private companies will have incentives to hire high productivity workers mean-

while the public sector will have a different set of incentives. At the end if the market is not competitive and incorporates the signal of the government; the schooling signal will suffer, and the job market will converge to use a different signal which demonstrate high productivity.

An interesting empirical extension of this model will be towards the dynamic of the labor market and shows how the market has change its set of beliefs. An empirical analysis could demonstrate if the market changes the schooling signal to a more efficient one, as years of experience or ability certification. (Márquez Jijón, 2019) demonstrate that a second level degree in Ecuador called ”Bachillerato” became inefficient in order to screen workers. The signal that the job market uses will constantly change. It is also important to mention another extension, the market could built stigma towards those employed in the public sector; then job experience will become the signal. Bottom line, the signaling model developed shows the effect and the incentives towards specialization through acquiring education; it also implies the negative effect in terms of signaling that government decisions have on the labor market.

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