Returns to skills, incentives to study and students' performance

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Abstract. Students' learning effort is crucial in human capital accumulation. Since skills cannot be accurately observed by future employers, students may have incentives not to work hard if their labour market outcomes are based more on credentials and on the belonging to informal networks rather than on effective skills. In a principal-agent framework, we analyze the role of a policymaker who aims to maximize a social welfare function defining a minimum standard that students must meet to attain a certain educational degree. If the policy-maker takes into account the effective productivity of skills, in presence of highly distorted labour markets he will set a high standard to encourage individuals' learning effort and in maintaining high quality in the educational system. Nevertheless, we show that if standards are defined by subjects who consider exclusively individuals' returns to education (for example, heads of schools), there may be a perverse incentive to set low standard in badly functioning labour markets, furthering the tendency to reduce effective investments in human capital.

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1. Introduction

Some recent theoretical models have emphasized that relationships taking place during the process of human capital accumulation are replete with agency problems, involving students, their parents, schools, teachers, State and future employers in the labour markets. The complexity of these relationships makes it difficult to establish a direct relation between outcomes in terms of acquired skills by students and inputs used in the educational process (Bishop and Woessman, 2004). This conclusion finds support in a number of empirical analysis showing that variables representing the amount of resources devoted to education, such as the students/teachers ratio, the school size, the amount of expenses for each student, teaching materials, etc., are not related to the students' performances and to the future outcomes they obtain in the labour market (Hanushek, 1996).

In the same way as in labour relationships – in which the time individuals spend at work does not directly translates in output, since, as pointed out by agency models, the production is related to the effective effort provided – the time spent in school or the mere acquisition of a

certain educational degree does not directly lead to an increase of individuals' skills. Crucial inputs for human capital production are represented by the effective effort provided by students during learning activities and by the support and monitoring activities undertaken by their families, which are costly activities, in terms of disutility, money or opportunities lost.

As a consequence, the output of educational process is strongly influenced by the students' incentives to study. Resources devoted to schools do not influence students' performance – as in the simple educational production function approach – in the absence of adequate incentives for students to provide high effort in the learning processes and without the supporting and monitoring activities of their families, aimed at verifying the activities of teachers and schools. These aspects represent key factors in reaching high quality in education but have been rarely analyzed by the economic literature, who has substantially neglected agency problems in education.

The kind of agency problems in education that we analyze arise because skills and students' learning effort usually are not observable by future employers on the labour markets, as evidenced by a vast literature on adverse selection and signalling. If the observability of individuals' productivity is poor and the labour market does not reward adequately skills acquired in school, students and their families will have little incentive in providing learning effort and in monitoring school quality.

Schools who are "delegated" by society in evaluating students' effort and in signalling it to the labour market often lack adequate incentives in playing this role. In fact, even if teachers are in better position to evaluate students' effort, they may have interests to positively bias evaluation in order to attract more students and reduce their own effort, or they may find it difficult to set high performance standards without losing, at the students' eyes, their crucial role of advocates (Bishop, 1996). As a consequence, in this case, the role of the policy-maker in trying to correct these perverse incentives is particularly relevant. For example, as emphasized by many studies on the US educational system, the definition of national standards and external exams may play a crucial role in improving the quality of skills acquired through education.

Therefore, the human capital effectively acquired during the educational process is influenced by the incentives of student (and families) to work hard which, in turn, depends on a series of institutional factors, like the autonomy of schools, the degree of competition of the educational system, the students' proficiency evaluation methods, the selection of teachers and their wage incentives.

The objective of this paper is to analyses, in a principal-agent framework, the link existing between the characteristics of the labour market, the returns to skills acquired through education, and the students' (and their families') effort in the human capital investment process, taking into account the role of schools and the definition of standards as a policy instrument. While in Costrell (1994) and Betts (1998) students are uniquely interested in the attainment of

educational degree (since wages depends exclusively on the credential), and as a consequence, their effort depends only on the level of the standard, in the model we propose individuals' wages depend both on the attainment of a certain educational degree and, in addition, on a premium on effective skills acquired. The weight of each of these factors depends on the relevance of imperfect information problems and on other characteristics of the labour market: labour markets characterized by a higher degree of transparency especially reward effective skills and allow only a minor role to the signalling effect deriving from the acquisition of a credential; on the other hand, labour markets with relevant asymmetric information problems reward individuals mainly on credentials. In addition, highly distorted labour markets, with a strongly "compressed wage structure" (in the sense of Acemoglu and Pischke, 1999) due to union's wage bargaining, prevalence of minimum wages, etc., reduces the marginal returns to skills for workers, and creates a gap between productivity and wage.

The main idea we propose is that if skills are not adequately rewarded in the labour market (since wages and occupational prospects are weakly related to acquired skills), the incentive for students to provide learning effort is low with negative consequences on the quality of education. If either family or social networks are crucial in determining employment perspectives and wages, the learning effort could also be low. This may be the case when the labour market is characterized by imperfections that determine wages below productivity or in systems in which, due to the preponderance of a scarcely meritocratic public sector, competences are not adequately rewarded or in those cases in which firms use production technologies requiring low skills.

The policy maker can influence student's incentives through the definition of the minimum standard necessary to attain a certain educational degree. We examine the level of the optimal standard decided by a policy maker, who aims at maximizing a social welfare function taking into account the students' reaction function. We consider two different welfare function.

The first welfare function is based on the individuals' effective productivity of skills net of effort costs. We show that in this case the standard level that policy-maker chooses results higher when the skill premium is low, that is, in more distorted labour markets. The reason is simple: since effective skills are scarcely rewarded on the labour market, the policy maker takes into account the negative effects that this produces on students' effort by increasing the minimum standard (as a second best policy).

In an alternative setting, we consider a policy maker interested in maximizing the returns that individuals obtain in the labour market, rather than labour productivity. This assumption captures those situations in which schools authorities decide autonomously the standard, since it is reasonable to expect that their objective function includes returns students obtain from skills, instead of the effective productivity of skills. In this context, our model shows that the standard setter chooses a standard reflecting the degree of distortions

characterising the labour markets. As a consequence, the quality of education will be lower in those areas where skills are scarcely rewarded on the labour market.

Another important aspect we analyze in the paper is represented by the interaction of school standards and educational inputs, and by their joint effect on students' effort. Incentives to invest resources in increasing students' skills are also related to the characteristics of the labor market. If wages do not reflect individuals productivities increasing expenditure in education does not lead to any benefit for students. As a consequence, if the policy maker maximizes individuals' returns to education, in a distorted labour markets we will observe low standards and low public expenditure directed to schools. On the contrary, standards will be negatively related to the degree of labour market distortions when the policy maker maximizes the social welfare and this may also lead to a reduction of public expenditure in well functioning labour markets.

The relationship between labour markets characteristics, the incentives to study, the definition of standard and inputs devoted in the educational system might be relevant in explaining differences, among countries and regions, in students' performances and effective quality of human capital, recorded by international test scores.

The highly meritocratic systems of many East Asian countries (such as Japan[1], South Korea, Hong Kong) are associated with very good results in PISA student's test scores. Bishop (1996a, 1996b) claims that the low performance of US students in international tests is related to the low reward that the labour market associates to effort and achievement in high schools.

As far as Italy is concerned, a number of analysis show a large difference between the academic performances of students living in the Northern part of the country compared to those recorded by students in the South, with the latter performing much worse[2]. These differences are still important after controlling for a number of students' and schools' characteristics. In our view, an important role in explaining these differences may be due to the fact that effective skills are not adequately rewarded in the South because of many factors: for the importance that family background and social networks play on the local labour market (Fabbri and Rossi, 1997) as shown for example by the "Survey on graduates in the labor market" (ISTAT, 2001); for the relevance of the public sector which – as shown by many studies (see Alesina, Danninger and Rostagno, 2001) – is not based on meritocracy; for strong industrial specialization in traditional, technologically poor, sectors requiring low levels of skills.

In terms of policy these results imply that measures intended to improve the educational performances by increasing financial resources may be ineffective, in the absence of improvements in the working of labour markets.

[1] See, for example, Rosenbaum (1990).

[2] Northern regions perform at the level of best countries (South Korea, Finland, Hong Kong) while Southern regions achieve scores in line with less developed countries (Mexico, Thailandia, Turkey), see Checchi, 2004.

The paper is organized in the following way. Section 2 briefly discusses the economic literature on the relevance of student's effort in educational processes and on the definition of standards. In Section 3 we present a model analysing the student's choice of effort and the optimal standards defined by a policy maker maximizing two alternative welfare functions. Section 4 introduces educational expenses and examines the interaction between standards and educational inputs. Section 5 offers some concluding remarks.

2. Related literature

Given the nature of the educational process, in which students are active subjects, outcomes obtained in terms of accumulated human capital are strictly related to students' characteristics both in terms of abilities and effort provided in learning activities. The role played by students abilities in the educational system, for example in terms of choice between public or private schools (Epple and Romano, 1998) or in relation to class formation issues (Benabou, 1996; Fernandez, 1998; Fernandez and Gal, 1999; Hoxby, 2000), is well recognised in the economic literature, while only recently a number of contributions have focused on the importance of students' effort in shaping educational outcomes (Bishop, 1996a) and in influencing the choice of institutional setting and policy instruments, such as the definition of minimum standards (Costrell, 1994 and Betts, 1998).

Costrell (1994) and Betts (1998) analyse how the definition of the minimum standard necessary to achieve a given educational level influences the quality of education through the learning effort provided by students. Assuming that firms cannot observe workers' skills, but only their educational attainment, these authors discuss how the definition of a high standard by the policy-maker, on the one hand, increases quality of education acquired by students who attain the diploma, but, on the other hand, increases the number of individuals who decide to not acquire the credential, opting for zero effort. In their framework, the optimal standard depends on the objective function of the government and the policy maker aptitude toward equity considerations plays a crucial role in choosing standard levels.

In this paper we show that the objective function of the policy maker may play a crucial role also independently from equity issues. In all circumstances in which the productivity of skills acquired through education diverges from gains in terms of wages obtained by individuals, different standards will emerge depending on whether the policy maker is interested in maximizing social welfare or students' rewards from education. The relevance of future economic benefits for higher schooling achievement has been emphasized by Bishop (1996a), but models analyzing the interaction between labour markets and educational systems are scant. The influence of labour markets' characteristics and students' effort has been examined by Brunello and Ishikawa (1999), who show that, as the number of high-tech firms (paying higher

wages and employing individuals graduated in elite schools) increases, students increase their academic effort in order to obtain a job in these firms.

Students' choice in terms of effort is relevant also in defining other important aspects of the educational process. Bishop and Woessmann (2004) and De Fraja, Oliveira and Zanchi, (2004) analyse the interaction between students' effort and a number of institutional factors – such as the degree of school autonomy, teacher's quality, the amount of resources devoted to school, etc, showing that educational quality and educational inputs may be related in a complex way since each subject, in the agency relationship chain, can behave strategically. De Fraja and Landeras (2004), assuming that individuals choose their level of effort comparing costs and benefits, point out that resources devoted to improve teaching quality may not result in higher educational outcomes if there is a negative relationship between student's effort and school quality. In this paper, we consider the case of a complementariety relationship between students' effort and school quality with the aim of analysing the interaction between minimum standards and resources devoted to schools in different labour markets.

An increasing number of papers analyse whether academic standards should be set at the local or at national level. Costrell (1997) analyses the trade–off emerging from costs deriving from imposing a uniform standard across heterogeneous area and benefits in term of internalization of externalities emerging when only some areas define high standards. In our model defining a uniform standard may be sub-optimal if there are heterogeneous labour markets. However, if the delegation of standard setting implies also a change in the objectives pursued by standard setters, since local institutions such as schools are more likely to take into account student's welfare, then uniform standards may represent a better solution.

3. The model

In this Section we present a model analysing the interactions between students' effort choice in learning activities and labour market characteristics. We assume that schools evaluate individuals' achievement and decide whether to award an educational degree comparing the students' performance with a minimum standard: clearly, the student's effort will depend positively on the standard level, according to a student's reaction function. Given this function, we analyze the choice of the optimal standard by a policy maker who maximizes two alternative welfare functions: one based on the effective productivity of skills and the other based on returns individuals obtain in the labour market. We show that the relationship between local labour market conditions and the optimal standard changes according to whether the policy-maker maximizes students' wages or social gains.

3.1. Students' behaviour

We assume that all individuals participate in education without sustaining any monetary cost. However, to acquire skills it is necessary to provide effort in learning activities. For the sake of simplicity, we assume that skills acquired in the educational process are given by the amount of learning effort provided by students, denoted with *e*. The cost of effort is denoted with $c(e)/a$, where $c' > 0$ and $c'' > 0$, and we assume that this cost decreases with individuals' innate ability, *a*.

In order to obtain a certain educational degree or credential (for example, high-school diploma) individuals have to pass an exam. We assume that their performance *s* is measured with error and equal to $s = e - \varepsilon$, where ε (a negative shock) is a stochastic variable with distribution function $F(\varepsilon)$ and density function $f(\varepsilon)$. The individual will attain the credential only if his measured performance is higher than the minimum standard $\bar{s}$, $s > \bar{s}$, defined by a standard-setter, the school or a public authority. As a consequence, the probability *P* of acquiring the credential is given by $P = \Pr(e - \bar{s} \geq \varepsilon) = F(e - \bar{s})$.

We assume that individuals' skills are only imperfectly observable by employers on the labour markets. Therefore, individuals are rewarded in part in relation to the educational credential they have attained and *to some degree* on the basis of their effective skills. The relative weight of these factors depends on the characteristics of the labour market and on skills' observability. If skills are easily observed and the labour market is perfectly competitive, the wage is strictly related to individuals' effective skills; on the other hand, if skills are difficult to observe and markets are not perfectly competitive wages will not reflect individuals' effective skills[3]. Alternatively, one may assume that it requires time for the firm to find out the worker's effective abilities and, as a consequence, in the initial stage of the worker's career firms rely on the acquired credential and pay a wage based on the expected abilities of individuals who have obtained a given educational degree, while abilities will be recognized later in career and the wage will be more strictly related to them. Individuals who were not able to acquire the standard are rewarded only in relation to their effective skills.

Formally, an individual obtains the following returns to education:

$$W = F(e - \bar{s})B(\bar{s})(1 - \beta) + \omega e\beta \qquad [1]$$

where $F(e - \bar{s})$ represents the probability of acquiring the educational credential, given the student's effort in learning activities, *e*, and the minimum standard required to acquire the credential, indicated by $\bar{s}$; $B(\bar{s})$ is the reward deriving from the attainment of a certain

[3] The empirical evidence of whether the effects of investment in education in the labor market are best described by a human capital or a signalling model is mixed (see Weiss, 1995, Kroch and Sjoblom, 1994 and Lang and Kropp, 1986).

credential, which increases with the level of standard, $B'(\bar{s})>0$ $B''(\bar{s})<0$; ω represent the wage premium based on effective skills; β is the weight in wage determination played by effective skills relatively to the attainment of a formal degree. When $\beta=1$, the credential is irrelevant and the individual's remuneration is exclusively based on his effective skills, e, which, in turns, are compensated according to the parameter ω. On the other hand, if $\beta=0$, firms are not able to recognise individual's skills and remuneration is based only on the basis of the credential.[4] With β taking values between 0 and 1, wages are in part based on the signalling effect of the credential and in part related to effective skills.

We assume that *B* (the "diploma bonus") is an increasing function of the standard *s*: when the level of the standard is high, the value of a diploma is higher, since the expected abilities of workers who obtain the credential are higher and firms rationally pay higher wages, given that students had to provide high effort to obtain the credential. As it will be made clear below, workers have an effective productivity in firms equal to $y=\pi e$ and we will assume throughout the paper that $\pi e>W$. On the contrary, in perfectly competitive labour markets, $\beta=1$ and $\omega=\pi$.

Labour market characteristics are reflected therefore in two parameters: β and ω. The first captures the relative importance of effective skills compared to credentials, while the second ω measures how compressed the wage structure is.

The individual utility function takes the following simple form: $U=W-c(e)/a$. Substituting the wage returns (expression [1]) in the utility function, we get:

[2] $$U=F(e-\bar{s})B(\bar{s})(1-\beta)+\omega e\beta-\frac{c(e)}{a}$$

Students decide the level of effort maximizing their utility function, given the way in which the market rewards effort provided during the educational process and the standard required to acquire the credential. By maximizing *U* with respect to effort, we obtain the following first order condition:

[3] $$\frac{\partial U}{\partial e}=f(e-\bar{s})B(\bar{s})(1-\beta)+\omega\beta-\frac{c'(e)}{a}=0$$

The effort level solving [3] represents a maximum when the second order condition (SOC thereafter) $\frac{\partial^2 U}{\partial e^2}=f'(e-\bar{s})B(\bar{s})(1-\beta)-c''(e)/a<0$ is respected.

[4] In an alternative view, $(1-\beta)$ may represent the length of the period necessary to firms for understanding the effective abilities of workers, who, as a consequence, during the period β gain a wage reflecting their effective skills.

It is interesting to determine – in a comparative-static exercise – how the educational effort decided by students depends on exogenous variables. Let $H(e,\omega,s,B,a)=f(e-\bar{s})B(\bar{s})(1-\beta)+\omega\beta-c'(e)/a=0$ represent the implicit function of the FOC for the optimal effort.

Using the implicit-function theorem, it is possible to write:

[4] $$\frac{\partial e}{\partial \omega}=-\frac{\partial H/\partial \omega}{\partial H/\partial e}=\frac{\beta}{-\partial^2 U/\partial e^2}>0$$

when SOC for a maximum is respected.

Expression [4] shows that the educational effort increases with the wage premium to skills ω. *Ceteris paribus*, students tend to work harder when they know that on the labour market their skills will be better remunerated.

Similarly, the influence of minimum standard for student's performance is easily obtained from:

[5] $$\frac{\partial e}{\partial \bar{s}}=-\frac{\partial H/\partial \bar{s}}{\partial H/\partial e}=\frac{(1-\beta)\left[-f'(e-\bar{s})B(\bar{s})+f(e-\bar{s})B'(\bar{s})\right]}{-\partial^2 U/\partial e^2}$$

From [5], the optimal level of effort increases with the minimum standard $\bar{s}$, under the (sufficient) condition that the probability of attainment the educational degree increases at constant or at decreasing rate with effort $(\partial P/\partial e=f'\le 0)$. This would be the case if distribution probability of ε is uniform $(f'=0)$ (as we will assume in the next Sections) or if it is concave $(f'<0)$.

Under this assumption, effort increases with the standard both because the diploma bonus will be higher ($f(e-\bar{s})B'(\bar{s})$) and because it is necessary to provide higher effort to attain the diploma.[5]

Moreover, the effort level is increasing in the individual's innate abilities *a*, $\frac{\partial e}{\partial a}=-\frac{\partial H/\partial a}{\partial H/\partial e}=\frac{c'/a^2}{-\partial^2 U/\partial e^2}>0$, while the effect of an increase in β is ambiguous and depends on how the market rewards the effective skills relatively to the attainment of a credential, $\frac{\partial e}{\partial \beta}=-\frac{\partial H/\partial \beta}{\partial H/\partial e}=\frac{\omega-f(e-\bar{s})B(\bar{s})}{-\partial^2 U/\partial e^2}$.

[5] A positive relation between students' effort and the standard level finds support in the empirical literature. For example, Figlio and Lucas (2003) follow elementary school students over time and find that they learn more and behave better (measured respectively by improvements in mathematics and reading scores and by fewer serious disciplinary incidents) in years in which they have a teacher with high standards than in years in which they have a teacher with low standards. Similar results emerge from Betts and Grogger (2000) and from Bonesrønning (2004).

3.2. An explicit function for student's educational effort

It is useful for the following analysis to derive a closed-form solution for the student's effort, assuming a uniform probability distribution for measurement errors and an explicit function for the cost of effort. The stochastic variable ε is assumed uniformly distributed in the range $\{-z, +z\}$, from which $f(\varepsilon)=1/2z$. Therefore, it follows that the student's probability of obtaining the credential is simply given by:

[6] $$\Pr(e-\bar{s}\geq\varepsilon)=\int_{-z}^{(e-\bar{s})}\frac{1}{2z}d\varepsilon=\left[\frac{\varepsilon}{2z}\right]_{-z}^{(e-\bar{s})}=\frac{e-\bar{s}+z}{2z}$$

Secondly, we assume that:

[7] $$\frac{c(e)}{a}=\frac{\gamma e^2}{2a}.$$

Substituting the two explicit functions [6] and [7] in the student's utility [2], we obtain:

[8] $$U=\left[\frac{e-\bar{s}+z}{2z}\right]B(\bar{s})(1-\beta)+\omega e\beta-\frac{\gamma e^2}{2a}$$

The optimal level of the student's effort must respect the following first order condition:

$$\frac{\partial U}{\partial e}=\frac{B(\bar{s})(1-\beta)}{2z}+\omega\beta-\frac{\gamma e}{a}=0$$

from which the effort provided by student is equal to[6]:

[9] $$e^*=\left[\frac{B(\bar{s})(1-\beta)}{2z}+\omega\beta\right]\frac{a}{\gamma}$$

Similarly to the results in implicit form obtained above, effort is increasing in the remuneration of effective skills ω, in the individual skills, *a*, and in the minimum standard $\bar{s}$ (in this particular case just because the wage bonus *B* paid for the credential increases with *s*).

3.3. The setting of standard when the policy-maker maximizes social welfare

In this Section we analyse the choice of the optimal level of the standard, $\bar{s}$, when the policy-maker's objective is that of maximizing the total surplus generated by skills acquisition by individuals in the economy. We consider a sequential game in which, in the first stage, the

[6] This is a maximum, since $\partial^2 U/\partial e^2=-\gamma<0$.

policy-maker sets the standard and, in the second stage, students decide how hard to work at school.

The effective productivity of the skills acquired at school is given by πe. This productivity is assumed greater than the wage gains accruing to individuals in order to catch the idea that benefits of skills in terms of production can be high even if the economic benefits to the employees are modest. As discussed by Bishop (1996a), this divergence may be due to the fact that even if employers trust school performance as a good indicator of job performance it may be difficult to have this kind of information (in our model, the students' effort may be not completely observable). Even in case of perfect observability, Acemoglu and Pischke (1999) discuss a number of reasons, such as institutional factors and unions' preferences, that may lead to a compressed wage structure, in which wage increases less than productivity when skills improve. Moreover, employers and employees may prefer only modest adjustments of relative wages in response to perceived differences in productivities, due to the unreliability of productivity measures (Hashimoto and Yu 1980), to workers' risk aversion or to the desire to encourage cooperation among workers (Akerlof and Yellen, 1988).

We assume that there is a continuum of type of individuals, parameterized by *a*, $a \in [0,1]$ (individuals' abilities *a* are uniformly distributed).

The Social Welfare Function (SWF) considered by the policy-maker is:

[10] $$SWF = \int_0^1 [\pi e - c(e)]da$$

subject to the constraint of the student's reaction function [9].

Substituting [9] in the Social Welfare Function and solving the definite integral we obtain:

[11] $$SWF = \left\{ \pi \frac{B(\bar{s})(1-\beta) + 2\omega\beta z}{2\gamma z} - \frac{\gamma}{2}\left[\frac{B(\bar{s})(1-\beta) + 2\omega\beta z}{2\gamma z} \right]^2 \right\} \frac{1}{2}$$

The optimal level of the standard is obtained by deriving SWF with respect to $\bar{s}$, which gives rise to the following first order condition:

[12] $$\frac{\partial}{\partial \bar{s}} SWF = \frac{B'(\bar{s})(1-\beta)}{2\gamma z}\left\{ \pi - \frac{B(\bar{s})(1-\beta) + \omega\beta(2z)}{2z} \right\} = 0$$

The second order condition is:

$$\frac{\partial^2}{\partial \bar{s}^2} SWF = \frac{B''(\bar{s})(1-\beta)}{2\gamma z}\left[\pi - \frac{B(\bar{s})(1-\beta) + \omega\beta(2z)}{2z} \right] - \frac{[B'(\bar{s})(1-\beta)]^2}{\gamma(2z)^2} < 0$$

Since $B'(\bar{s}) > 0$ and $B''(\bar{s}) < 0$, SOC is satisfied when $\pi > \left[\frac{B(\bar{s})(1-\beta)}{2z} + \omega\beta \right]$.

We use again the implicit-function theorem to derive important comparative-static results. Let $K(.)=\frac{B'(\bar{s})(1-\beta)}{2\gamma z}\left\{\pi-\frac{B(\bar{s})(1-\beta)+\omega\beta(2z)}{2z}\right\}=0$ denote the implicit function of the FOC for the standard $\bar{s}$.

Firstly, we are interested in the policy adopted by the standard setter as regards to the productivity of skills. It is possible to see that the optimal standard is increased when the productivity of individual skills increases. From the implicit function theorem we obtain:

[13] $$\frac{\partial\bar{s}}{\partial\pi}=-\frac{\partial K/\partial\pi}{\partial K/\partial\bar{s}}=\frac{\frac{B'(\bar{s})(1-\beta)}{2\gamma z}}{-\partial^2 SWF/\partial\bar{s}^2}>0$$

Secondly, it is crucial the reaction of the policy-maker to the level of wage premium ω paid by markets to individuals for their skills. It is easy to obtain:

[14] $$\frac{\partial\bar{s}}{\partial\omega}=-\frac{\partial K/\partial\omega}{\partial K/\partial\bar{s}}=\frac{-\beta\left[\frac{B'(\bar{s})(1-\beta)}{2\gamma z}\right]}{-\partial^2 SWF/\partial\bar{s}^2}<0$$

Expression [14] shows that the social planner decreases the optimal standard when the premium individuals obtain on the labour marker for their effective skills increases. According to this result, in more distorted labour markets in which effective skills are poorly paid (low ω), it is optimal, from a social point of view, to set a high standard for academic performance in order to limit the negative effects deriving from the distortions in the labour market on individuals' incentive to acquire skills. On the other hand, in well-functioning labour markets there is less need to establish a high standard to induce individuals to effectively acquire human capital.

The effect of an increase in the degree of transparency of the labour market, denoted with β, is less straightforward and depends on the comparison between ω and the premium associated to the credential, $B(\bar{s})$, since $\frac{\partial\bar{s}}{\partial\beta}=-\frac{2z\omega-B(\bar{s})}{(1-\beta)B'(\bar{s})}$. If the reward associated to effective skills is higher compared to the reward deriving from the signalling effect, an increase in β produces a negative effect on the level of the optimal standard. In case of perfect observability of individuals' productivity, educational degrees are useless and as a consequence standards can be defined at a very low level.

3.4. The optimal standard for students' welfare

Conclusions reached in the previous section, emphasizing a negative relation between the degree of labour market imperfections and the level of optimal standards, are reversed if policy

maker maximizes – instead of a welfare function based on the effective productivity of skills π – the future returns that individuals obtain in the labour market, which depends on ω.[7] This assumption is meant to capture the case in which schools decide autonomously the standard. In fact, schools are more likely to be interested in maximizing gains students obtain from skills acquired through education rather than the social benefits of education. For the sake of simplicity, we assume that the social planner does not care of costs deriving from students' learning effort. This assumption is typical in the literature analysing standards (see for example Costrell, 1994, 1997; De Fraja and Landeras, 2004).

In this framework, the standard setter will take into account the following objective function:

[15] $$\widetilde{SWF} = \int_0^1 \left\{ \left[\frac{z + e - \bar{s}}{2z} \right] B(\bar{s})(1-\beta) + \omega e \beta \right\} da$$

From the student's reaction function [9], let $\Gamma = \frac{B(\bar{s})(1-\beta) + \omega\beta 2z}{2z\gamma}$. The optimal effort chosen by students can then be written as: $e^* = \Gamma a$. Substituting this expression in [15] and rearranging we obtain:

[16] $$\widetilde{SWF} = \int_0^1 \left\{ \Gamma^2 \gamma a + \left[\frac{z - \bar{s}}{2z} \right] B(\bar{s})(1-\beta) \right\} da$$

from which:

[17] $$\widetilde{SWF} = \left[\frac{z - \bar{s}}{2z} \right] B(\bar{s})(1-\beta) + \frac{\Gamma^2 \gamma}{2}$$

The optimal level of the standard satisfies the following first order condition:

[18] $$\frac{\partial \widetilde{SWF}}{\partial \bar{s}} = \frac{(1-\beta)\left[B'(\bar{s})(z-\bar{s}) - B(\bar{s})\right]}{2z} + \Gamma\left(\frac{(1-\beta)B'(\bar{s})}{2z} \right) = 0$$

We assume that Second Order Condition is satisfied, that is: $\frac{\partial^2 W}{\partial \bar{s}^2} < 0$.

Let $V(.) = \frac{(1-\beta)\left[B'(\bar{s})(z-\bar{s}) - B(\bar{s})\right]}{2z} + \Gamma\left(\frac{(1-\beta)B'(\bar{s})}{2z} \right) = 0$ indicate the implicit function defining the optimal level of the standard.

Using the implicit-function theorem it is possible to determine the impact of ω on the standard setter's decision:

[19] $$\frac{\partial \bar{s}}{\partial \omega} = -\frac{\partial V / \partial \omega}{\partial V / \partial \bar{s}} = \frac{\frac{\beta}{\gamma}\frac{(1-\beta)B'(\bar{s})}{2z}}{-\partial^2 SWF / \partial \bar{s}^2} > 0$$

[7] This kind of welfare function is considered in Costrell (1994) and in Betts (1998), however in these studies social and private returns coincide.

Expression [19] shows importantly that the standard set by school authorities increases in the wage premium ω that individuals receive for their effective skills. In markets in which the wage premium is low, this leads to the setting of lower standard. In fact, the standard setter – being interested only on students' wages – does not try to resolve the negative effects generated by distortions on the labour market. Therefore, the harmful effect produced by the low skills' rewards on the students' educational effort is strengthened by the low standard defined by public authority.[8]

3.5. Centralized or decentralized standards

Policy instruments that affect the way degrees are awarded, for example through the introduction of state or national level exit exams, have recently received considerable attention in the economics literature. Costrell (1997) analyzes the trade-offs arising from this choice.

In order to consider this issue in our framework, let us suppose that there are two different areas, 1 and 2, characterized by differences in the wage premia associated to effective skills, with $\omega_1 < \omega_2$ and identical skills' productivities.

Under a decentralized system, with policy makers maximizing a welfare function based on the effective productivity of skills, from equation [14] it is known that from a social point of view it would be optimal to define $s_1 > s_2$, that is, a high standard in area 1 helps in compensating for the negative effect produced by a low ω, while in area 2, since the labour market is able to encourage students' effort it is convenient to impose a lower standard.

In case of a centralized system that defines a uniform standard for both areas we will observe an inefficient solution, in that the uniform standard $\bar{s}$ will be below s_1 and above s_2, reducing welfare in both areas. An inefficient result would clearly emerge also when the two areas are characterized both by different labour market conditions and by different productivities of skills.

However, the superiority of decentralized system would be undermined if local policy makers are more likely to maximizes students' gains from education or if the definition of standards is decentralized at the school level. As shown in Section 3, in this case, the "local" policy maker tends to define higher standards in areas characterized by a higher ω, and as a consequence we would have $s_1 < s_2$ with negative effects on welfare.

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[8] If we assume that abilities takes values in the range $[\bar{a}, \underline{a}]$, it is possible to show that the optimal standard increases when abilities characterizing abler individuals increase. $\frac{\partial \bar{s}}{\partial \bar{a}} = -\frac{\partial H / \partial \bar{a}}{\partial H / \partial s} > 0$ where

$$\frac{\partial H}{\partial \bar{a}} = \left[\frac{\partial \Gamma}{\partial \bar{s}} \left[B(s)(1-\beta) + \omega\beta 2z \right] + \Gamma B'(s)(1-\beta) \right] \frac{1}{2} > 0$$

4. An additional instrument to improve education: Teaching quality

In the previous Sections schools had a unique function: their task was to verify each student's performance and signal to the labour market whether standards were met. Obviously, schools do much more than simply testing students' achievement. They actively contribute to the acquisition of skills by students through the effort of teachers and their quality, the decisions on the students/teacher ratio, the time spent in class, the expenses in books and other educational materials, and so on.

These activities by schools are costly, but raises the quality of schooling and produces two effects on students' outcomes: firstly, teaching quality increases the effective skills acquired by students, secondly, it increases the student's probability to obtain the credential.

In this Section, we consider a more articulated educational process in which schools or the policy-maker has to decide – in addition to the standard *s* – the amount of resources devoted to improve teaching quality, which we denote with g. We will show that the features characterizing the working of labour markets are likely to influence also resources devoted to the educational system.

Formally, we adopt the following new assumptions: a) students' skills are given by eg, under the assumption that g takes values higher than 1 (as a consequence, productivity becomes equal to πeg and the earnings related to skills ωeg); b) the probability of passing the final exam leading to the achievement of the credential is $P = \left[\frac{e+g-\bar{s}+z}{2z}\right]$; c) $C(g)$ represents the cost of teaching quality, where $C' > 0$ and $C'' > 0$.

Under these new assumptions, the student's utility function takes the form:

[19] $$U = \left[\frac{e+g-\bar{s}+z}{2z}\right] B(\bar{s})(1-\beta) + \omega eg\beta - \frac{\gamma e^2}{2a}$$

From the student's point of view, the optimal level of effort satisfies the following First Order Condition:

[20] $$\frac{\partial}{\partial e} U = \left[\frac{1}{2z}\right] B(\bar{s})(1-\beta) + \omega g\beta - \frac{\gamma e}{a} = 0$$

from which the optimal student's effort is obtained:

[21] $$e^* = \left[\frac{B(\bar{s})(1-\beta)}{2z} + \beta\omega g\right]\frac{a}{\gamma}$$

It is important to note that this result shows a complementariety relationship between school's quality and students' effort. Since school quality increases the effective labour productivity (g raises the marginal benefit of the student's effort), students are encouraged to invest more in education when more resources are devoted to school.

De Fraya and Landeras (2004) point out also the possibility of a relationship of substituibility between school expenses and student's effort. In our set-up this would emerge with a different density function, through which students would provide less effort since acquiring the credential is easier with an high expenditure devoted to school quality.

However, we neglect this possibility, since we are interested at examining the interaction between standards, school public expenditure and labour market characteristics, when educational outcomes are positively influenced by resources devoted to education.

In this new setting, the policy-maker decides jointly the level of the standard and the teaching quality *g*, taking into account the student's reaction function. If the welfare function is represented by the total surplus realized in the economic system, then the social planner will maximize:

[22] $$\underset{s,g}{MAX}\ \widetilde{SWF} = \int_0^1 [\pi e g - c(e)]da - C(g)$$

where $C(g)$ represents the cost of teaching quality.

Let us indicate the optimal level of effort chosen by students as $e = \Gamma a$, where $\Gamma = \frac{B(\bar{s})(1-\beta) + \beta\omega g(2z)}{2z\gamma}$. Substituting the student's reaction function in the welfare function we obtain:

[23] $$\widetilde{SWF} = \int_0^1 \left[\pi g \Gamma a - \frac{\gamma}{2a}(\Gamma a)^2 \right] da - C(g) = \frac{\Gamma}{2}\left[\pi g - \frac{\gamma}{2}\Gamma \right] - C(g)$$

The First Order Conditions of the policy-maker's maximization problem are:

[24] $$F_1 = \frac{\partial}{\partial s} W = \frac{B'(\bar{s})(1-\beta)}{4z\gamma}\left[\pi g - \frac{B(\bar{s})(1-\beta) + \beta\omega g(2z)}{2z} \right] = 0$$

[25] $$F_2 = \frac{\partial}{\partial g} W = \frac{\beta\omega}{2\gamma}\left[\pi g - \frac{B(\bar{s})(1-\beta) + \beta\omega g(2z)}{2z} \right] + \pi \frac{B(\bar{s})(1-\beta) + \beta\omega g 2z}{4z\gamma} - C'(g) = 0$$

where F_1 and F_2 indicate the relative implicit functions.

We assume that second-order sufficient conditions for a maximum are satisfied and then that the determinant of the Hessian (composed by the second derivatives) is positive. Given this assumption, the Jacobian J (which coincides with the Hessian) of this system with respect to

the endogenous variables *g* and *s* does not vanish at the optimal values and this allows us to study the comparative static of this problem.

Taking the total differentials of [24] and [25] and allowing to vary the endogenous variables, s and g, and only ω among the exogenous variable, we obtain:

$$\begin{aligned} &F_{1s}ds + F_{1g}dg + F_{1\omega}d\omega = 0 \\ &F_{2s}ds + F_{2g}dg + F_{2w}d\omega = 0 \end{aligned} \qquad [26]$$

where the partial derivatives of the implicit functions take the following values and signs:

$$F_{1s} = \frac{B''(\bar{s})(1-\beta)}{4\gamma z}\left[\pi g - \frac{B(\bar{s})(1-\beta)+\beta\omega g(2z)}{2z}\right] - \frac{[B'(\bar{s})(1-\beta)]^2}{8\gamma z^2} < 0 \qquad \text{since } B'' < 0$$

$$F_{1g} = -\frac{B'(\bar{s})(1-\beta)}{4z\gamma}[\pi - \beta\omega] < 0$$

$$F_{1\omega} = -\beta g\frac{B'(\bar{s})(1-\beta)}{4z\gamma} < 0$$

$$F_{2s} = \frac{\beta\omega}{2\gamma}\left[-\frac{B'(\bar{s})(1-\beta)}{2z}\right] + \pi\frac{B'(\bar{s})(1-\beta)}{4z\gamma} = (\pi - \beta\omega)\left[\frac{B'(\bar{s})(1-\beta)}{4z\gamma}\right] > 0$$

$$F_{2g} = \frac{\beta\omega}{2\gamma}(2\pi - \beta\omega) - C''(g) < 0 \qquad \text{by assumption}$$

$$F_{2\varpi} = \frac{\beta}{2\gamma}\left[\pi g - \frac{B(\bar{s})(1-\beta)+\beta\omega g(2z)}{2z}\right] + (\pi - \beta\omega)\frac{\beta g}{2\gamma} > 0 \qquad \text{(under the assumption that } \pi g - \frac{B(\bar{s})(1-\beta)+\beta\omega g 2z}{2z} > 0 \text{ (that we maintain throughout the paper), implying that the marginal social benefit of educational expenditure (} F_{2\omega} \text{) increases when } \omega \text{ increases).}$$

The equation system in [26] can be written in matricial form as:

$$\begin{vmatrix} F_{1s} & F_{1g} \\ F_{2s} & F_{2g} \end{vmatrix} \begin{vmatrix} ds \\ dg \end{vmatrix} = \begin{vmatrix} -F_{1\omega}d\omega \\ -F_{2\omega}d\omega \end{vmatrix} \qquad [27]$$

Using Cramer's rule to obtain ds, and then dividing the two sides by $d\omega$, we get the key comparative static results:

$$\frac{\partial s}{\partial \omega} = \frac{\bar{F}_{1g}\overset{+}{F}_{2\omega} - \bar{F}_{1\omega}\bar{F}_{2g}}{\overset{+}{|J|}} < 0 \qquad [28]$$

This result shows that the policymaker tends to increase standard when the returns to skills are lower. This confirms the result obtained previously in the one-instrument set-up.

On the other hand, from [27], using again Cramer's rule it is possible to obtain $\partial g/\partial \omega$:

[29] $$\frac{\partial g}{\partial \omega} = \frac{\overset{+}{F}_{2s}\overset{-}{F}_{1\omega} - \overset{-}{F}_{1s}\overset{+}{F}_{2\omega}}{\overset{+}{|J|}} ?$$

The sign of this derivatives is ambiguous. It could be that the policy-maker decides to devote more expenses to education in more competitive labour markets (if $F_{2\omega}$ or F_{1s} tend to be higher in absolute value than F_{2s} or $F_{1\omega}$) and viceversa. On the one hand, when ω increases, the social marginal benefit of g increases ($F_{2\omega}$ is high) and it would be convenient to increase public expenditure; on the other hand, an increase in ω produces a reduction in the marginal benefits of high standards and since lower standards reduces the social benefits of g, it would be appropriate to reduce public expenditure. The final result depends on which of these two effects prevails.

4.1. Standard setter interested in welfare's student and educational expenses

Results obtained in the previous Section change if we consider a policy-maker interested only in the future returns that individuals will obtain in the labour market. In this case the Social Welfare Function will be:

[30] $$\widetilde{SWF} = \int_0^1 \left\{ \left[\frac{e + g - \bar{s} + z}{2z} \right] B(\bar{s})(1-\beta) + \beta\omega eg \right\} da - C(g)$$

Substituting in [30] the student's reaction function $e = \Gamma a$, we obtain:

[31] $$\widetilde{SWF} = \left[\frac{g + z - \bar{s}}{2z} \right] B(\bar{s})(1-\beta) + \Gamma^2 \frac{\gamma}{2} - C(g)$$

from which we determine the First Order Conditions:

[32] $$\widetilde{F}_1 = \frac{\partial}{\partial s} W = \left[\frac{-B(\bar{s})(1-\beta)}{2z} \right] + B'(\bar{s})(1-\beta) \left[\frac{g + z - \bar{s}}{2z} + \frac{B(\bar{s})(1-\beta) + \beta\omega g 2z}{4z^2\gamma} \right] = 0$$

[33] $$\widetilde{F}_2 = \partial \frac{W}{\partial g} = \left[\frac{B(\bar{s})(1-\beta)}{2z} \right] + \beta\omega \frac{\left[B(\bar{s})(1-\beta) + \beta\omega g 2z \right]}{2z\gamma} - C'(g) = 0$$

Assuming that second-order sufficient conditions for a maximum are satisfied (which implies also the assumptions that $\widetilde{F}_{1s} < 0$ and $\widetilde{F}_{2g} < 0$) we apply the procedure followed in the previous Section in order to obtain the following results:

[34] $$\frac{\partial s}{\partial \omega} = \frac{\overset{+}{F}_{1g}\overset{+}{F}_{2\omega} - \overset{+}{F}_{1\omega}\overset{-}{F}_{2g}}{\overset{+}{|J|}} > 0$$

[35] $$\frac{\partial g}{\partial \omega} = \frac{\overset{+}{F}_{2s}\overset{+}{F}_{1\omega} - \overset{-}{F}_{1s}\overset{+}{F}_{2\omega}}{\overset{+}{|J|}} > 0$$

since it is easy to ascertain that: $F_{1g} > 0$; $F_{2s} > 0$; $F_{1\omega} > 0$; $F_{2\omega} > 0$.

It follows that when in the policy-maker welfare function enter the effective individuals' return, then the decisions taken on s and g go hand in hand: in distorted labour markets (low ω) the policy-maker will choose a low standard and a low public expense in education.

5. Concluding remarks

In this paper we analyse, in a principal-agent framework, the relationship between student's effort in learning activities and the setting of optimal standards by a policy maker who maximizes two alternative welfare functions: one focusing on the effective productivity of skills acquired through education and the other taking into account future wage returns accruing to students.

While in perfectly competitive labour markets workers' obtain all the gains from human capital investments and wages coincide with productivity, inducing individuals to accumulate skills even if no standard is imposed, in imperfectly competitive labour markets, wages may increase less that productivity in relation to investments in human capital and standards becomes necessary to stimulates individuals to work hard at school. However, different standard will be defined according to the objective of standard setter.

In our framework students' incentives to provide effort depend both on the expected wage premium on effective skills and on the level of the standard necessary to acquire a certain educational level. Since in distorted labour markets incentive to provide effort by students are low, defining high standards would result a particularly useful political instrument. According to our analysis in countries or regions where, for a series of factors, labour markets do not reward adequately human capital, it would be optimal, from a social point of view, to set a high standard for the attainment of an educational degree. Nevertheless, we show that standards will be defined in order to contrast distorted incentives deriving from the structure of the labour market only if the policy maker aims at maximizing a welfare function that includes the effective productivity of skills net of effort costs. On the contrary, when the standard setter is more incline to consider students' welfare (as when the same schools define standards), these distorted incentives will result reinforced by the definition of low standard in response of

scarcely rewarded skills. As a consequence, the quality of education will be lower in those areas where skills are scarcely rewarded on the labour market.

If we believe that local standard setters tend to be more prone to students' interest and then more likely to take into account students' returns, instead of social returns, it may be optimal to define centralized standards. In heterogeneous areas uniform standards represent a second-best solution, but they may still correspond to an improvement compared to standards defined only in relation to students' benefits.

In addition, we show that labour market distortions may influence also incentives to invest resources in the school system. If the policy maker maximizes students' returns to education, we will observe low public expenditure in labour markets characterized by low skill wage premia.

This analysis is relevant in interpreting the large differences, among countries and regions, recorded in students' performances in international test scores. For example, the impressive differences among the performance in the OECD international test scores (PISA) of students living in the South an in the Northern part of Italy, may be related to differences in labour markets.

Many studies find that southern regions show a badly functioning labour market, where employment chances, wages and careers depends mainly on family and social background rather than on acquired skills. In our analytical framework, these regions show a low ω. As a consequence, a rational policy-maker should impose in these regions a high standard to encourage effective investments in human capital. However, if the standard is only formally national, because schools in practice have the possibility to discretionarily evaluate students, low standards will prevail especially in those regions where labour markets are more distorted.

References

Acemoglu D. and Pischke S., (1999), "The structure of wages and investment in general training", *Journal of Political Economy*, vol. 107, pp. 539-72.

Akerlof, G., Yellen, J., (1988), "Fairness and unemployment", American Economic Review, 78 (2), pp. 44–49.

Alesina, A., Danninger, S., Rostagno, M. (1999), "Redistribution through public employment. The case of Italy", NBER Working Paper N. 7387.

Epple and Romano

Benabou, R. (1996), "Heterogeneity, stratification and growth: Macroeconomic implications of the community structure and school finance", *American Economic Review* 86/3, pp. 584-609.

Bertola, G., Checchi, D., (2003), "Education financing and student achievement", *Revue suisse des sciences de l'éducation*, 25 (3), pp. 200-300.

Betts, J. R. (1998), "The Impact of Educational Standards on the Level and Distribution of Earnings", *American Economic Review*, 88, pp. 266-275.

Betts, J. and Grogger J. (2000), "The Impact of Grading Standards on Student Achievement, Educational Attainment, and Entry-Level Earnings", NBER Working Paper No. 7875 (September).

Bishop, J. (1996a), "The Impact of Curriculum-Based External Examinations on School Priorities and Student Learning", *International Journal of Education Research*, 23 (8), pp. 653–752.

Bishop, J. (1996b), "Incentives to Study and the Organization of Secondary Instruction", in "Assessing Educational Practices", Becker, W. and Baumol W. ed., the MIT Press.

Bishop J., Woessmann (2004), "Institutional Effects in a Simple Model of Educational Production, *Education Economics*, pp. .

Bonesrønning H. (2004), "Do the teachers' grading practices affect student achievement?" Education Economics, August 2004, vol. 12, no. 2, pp. 151-167(17)

Brunello, G., Ishikawa, T., (1999), "Elite schools, high tech jobs and economic welfare", Journal of Public Economics, 72 (1999) 395–419.

Checchi D. (2004), "Da vengono vengono le competenze scolastiche?", *Stato e Mercato*, n. 72, pp. 415-453.

Costrell, R. (1994), "A Simple Model of Educational Standards." *American Economic Review*, 84 (4), pp. 956–71.

Costrell R. (1997), Can Centralized standards raise welfare, *Journal of Public Economics*, 65, pp. 271-293.

De Fraja G. and Landeras P. (2004), "Could Do Better: The Effectiveness of Incentives and Competition in Schools", CEIS working paper, n. 48.

De Fraja, G., Oliveira, T., Zanchi, L. (2004), "Must try harder. Evaluating the role of effort on examination result", mimeo.

Epple, D. and Romano, R., (1998), Competition between private and public schools, vouchers and peer group effects, *American Economic Review*, 33/62.

Fabbri F. and Rossi N. (1997), Caste, non classi. Una società immobile. Il Mulino, 1, pp. 110-116.

Fernandez, R. (1998), "Education and borrowing constraints: test vs. prices. CEPR discussion paper n.1913.

Fernandez, R. e Gali J. (1999), "To each according to … ? Markets, tournaments and the matching problem with borrowing constraints", *Review of Economic Studies* 66: 799-824.

Figlio, D. and Lucas. M. (2003), "Do High Grading Standards Affect Student Performance?", *Journal of Public Economics, pp.* .

ISTAT, (2001), I laureati e il mercato del lavoro, *Inserimento professionale dei laureati*.

Hanushek, E. (1996). Measuring investment in education, *Journal of Economic Perspectives* 10(4), pp. 9-21.

Hashimoto B. and Yu T. (1980), "Specific Capital, Employment Contracts and Wage Rigidity", *Bell Journal of Economics*, n, 2, pp. 536-349.

Hoxby, C. (2000), “Peer effect in the classroom: learning from gender and race variation”, NBER wp.7867.
Kroch, E. A. and K. Sjoblom (1994), “Schooling as human capital of signalling”, Journal of Human Resources 19, pp. 156–180.
Lang, K. and D. Kropp (1986), “Human capital versus sorting”, American Economic Review, 84, pp. 353–358.
Weiss A. (1995), Human capital vs signalling. Explanations of wages, Journal of Economics Perspectives, vol. 9, n.5, pp. 133-154.