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Entrepreneurship, Management Services and Economic Growth*

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Abstract

We set out to model the joint production of entrepreneurs and workers assuming that the former contribute to the output of the firm by making entrepreneurial decisions (with increasing returns), and managing the productive resources (with decreasing returns). The model explains the equilibrium output of the representative firm and the equilibrium share of entrepreneurs in the working population, as a function of the quality of the entrepreneur and of the elasticity of output to the entrepreneur's management services. The time dynamics of the solution imply that the contribution to labor productivity growth from increases in the quality of entrepreneurs over time is higher in countries with a larger starting share of entrepreneurs and higher in countries with lower starting labor productivity (convergence enhancing). The model predictions are tested with data from OECD countries for the period 1970-2002. We find that improvements in the quality of entrepreneurs can make a substantial contribution to economic growth by means of more productive management services.

Key words: Entrepreneurial quality, productivity growth, OECD countries, Coasian entrepreneur.

JEL: O47, J24, L26, M13; M55

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Introduction.

The field of entrepreneurship is of great and constantly increasing interest for scholars, managers and policy makers. The main reason why it continues to receive so much attention is because it has been conceptually and empirically linked to a nation's competitive advantage (Zahra, 1999) and its economic growth (Audretsch, Keilbach, and Lehmann, 2006, Baumol, 1968, 2004, Carree and Thurik, 2006). Researchers in strategic management have also pointed out that entrepreneurial actions can be a source of competitive advantage for firms that ensures that such actions strengthen the strategic position of the firm in the market and increases the creation of wealth (McGrath and MacMillan, 2000; Hitt et al, 2001). Research that contributes to explaining the relationship between the competitive advantages of firms and the competitive advantages of countries through the common link of entrepreneurial resources (as we try to do in this paper) can develop our understanding on how the profit motive of entrepreneurs and firms can be an engine for higher economic and social welfare.

This paper views the entrepreneur as the person that contributes to the output of the firm by performing two functions, whose effects on output are weighted by the *quality* of the services of the entrepreneur's input: i) making *entrepreneurial and strategic decisions* (those decisions that have to do with creation and innovation that also increase wealth and strengthen the competitive position of the firm in the market); and ii) providing *management services* (the direct involvement of the entrepreneur in coordination and supervision of the internal resource allocation process in the firm). The research question posed in this paper considers how differences in the quality of entrepreneurs across countries and within a country over time will affect the welfare of those countries, measured in terms of labor productivity and growth. The resolution of this question involves determining the equilibrium share of entrepreneurs in a country, as a function of the quality of the representative entrepreneur and of the relative contribution of management services to the output of the representative firm through the joint production of entrepreneurs and workers. To address these issues the paper postulates a stylized model for a representative firm in a country. This takes inspiration from the work of Lucas (1978) and Rosen (1982), whose initial interest was to explain the distribution of the sizes and profits of firms resulting from an efficient allocation of the talent of entrepreneurs in a given country.

Using the most popular vision of the Schumpeterian entrepreneur, as the person responsible for "creative destruction" through the introduction of radical innovations, the literature on Entrepreneurship has mainly focused on the entrepreneur as the input of the firm responsible for discovering "new combinations" of resources and activities (Cooper, 1986; Baumol, 1990; Wennekers & Thurik, 1999; Audretsch, 2002) that, in some cases, will also strengthen the strategic positioning of the firm and create greater economic wealth (Shane and Venkataraman, 2000; McGrath and MacMillan, 2000; Hitt et al., 2001). The model of the representative firm introduced in the paper allows for the entrepreneur influencing output through the quality of his/her entrepreneurial/strategic decisions, thus accounting for the Schumpeterian vision of the entrepreneur. However, the main innovation of the paper is to explore, both theoretically and empirically, the contribution to output and growth of the inputs from the "Coasian" view of the entrepreneur, i.e. "the person or persons who, in a competitive system, takes the place of the price mechanism in the direction of resources" (Coase, 1937, page 388).

The economic function of the Coasian entrepreneur differs from that of Knight's (1921) risk bearing role, Schumpeter's (1934, 1947a) creative response followed by creative destruction, Leibenstein's (1968) destruction of pockets of inefficiency in the system and Kirzner's (1979) arbitrageur. According to Coase (1937), the entrepreneur takes the place of the market in directing resources (coordination) because the price mechanism is costly to use (it incurs marketing costs). On the other hand, a single entrepreneur does not take over the whole price system because the management services of the entrepreneur are also costly and the management function is subject to "diminishing returns" so that, "the higher is the amount of transactions inside a firm the more likely it is that the entrepreneur will fail to place the factors of production in the uses where their value is greatest" (page 395). The diminishing returns of the management function contrasts with the scale economies that affect the entrepreneurial activities, in the sense that the higher quality of the entrepreneur's decisions on what to create or how to position the firm in the market will increase the productivity of all the people working in the firm. The incentive to increase the amount of resources under the entrepreneur with the highest quality will have to be weighted against the diminishing returns affecting the management function and the limits to its effective delegation because of agency and loss of control costs (Williamson, 1967).

In addition, a closer examination of Schumpeter's writings makes it clear that he had a broader view of the functions of the entrepreneur, a view that integrates both the entrepreneurial and managerial functions. Schumpeter (1947a) explicitly recognizes the dual function of enterprise and management when he writes: "evidently it is one thing to set up a concern embodying a new idea and another thing to head the administration of a going concern, however much the two may shade off into each other" (page 223).

Schumpeter (1949) also emphasizes that "the real life never presents the (entrepreneurial) function in and by itself" (and that the) "entrepreneurial element may be present to a very small extent even in very humble cases" (page 259), agreeing here, with A. H. Cole in the need to consider business activity as a whole (entrepreneurial and administration). Finally, in his analysis of the theoretical problems of economic growth, Schumpeter (1947b) recognizes the impossibility of foreseeing the "creative response" to economic change and, for this reason, acknowledges the difficulty of establishing a link between the creative response and economic growth. From here, he argues that since the creative response is the function that better defines the entrepreneur as an economic agent, one way to make creative response part of the list of factors of economic growth is through "its links with «the quality of the human material» and in particular with «the quality of leading personnel»" (page 239)[1].

This paper adopts a comprehensive view of the entrepreneur and establishes a precise link between the quality of the entrepreneurs' services and economic growth, as hinted at by Schumpeter. In this respect, we believe it makes relevant contributions to the literature on Entrepreneurship. The paper provides a formal model of economic growth that explicitly accounts for the function of the entrepreneur, therefore providing a theoretical explanation for the relationship between the quality of entrepreneurs' inputs and the economic development of nations[2]. This relationship has two components; one

[1] Although Coase (1937) focuses mainly on the coordination function of the entrepreneur, he also highlights the distinction between initiative or enterprise and management in the functions performed by businessmen. For Coase, the former has to do with forecasting and making new contracts (dynamics), while the later is a reaction to price changes (returning to static equilibrium).

[2] Acs and Storey (2004) provide an overview of recent empirical literature on entrepreneurship and economic development and raise several methodological issues on how research is performed. Their conclusion is that we are a long way from a theoretical framework which provides sound empirical analysis on entrepreneurship and economic growth. They make no reference to evidence which suggest that economic growth is related to the quality of the entrepreneur as director of the firm's internal resource allocation process.

is easy to reconcile with more conventional approaches to productivity growth, it based on the growth of total factor productivity as the result of *entrepreneurial activities*; the other, which has to do with the contribution from improvements in the quality of the *management services* (coordination, motivation) provided by entrepreneurs, is new in the literature. The way that management services enter the production function implies that the same rate of increase in the entrepreneur's quality has a higher effect on productivity growth in countries with a larger initial share of entrepreneurs. This is an unexplored explanation of cross country convergence in per capita income over time (Barro and Sala-i-Martin, 1991, 1992). The empirical evidence, using data from OECD countries in the period 1970-2002, indicates that at least 50% of average labor productivity growth is explained by increases in the quality of entrepreneurs that affect the quality of the management services they provide.

The paper also provides a new rationale for the use of the share of entrepreneurs in the working population as a measure of entrepreneurial activity of the countries. The share of entrepreneurs has been linked with economic activity and growth in both theoretical and empirical work. For example, Kihlstrom and Laffont (1979) endogenously determine the equilibrium share of entrepreneurs from differences in risk aversion in the working population and explain the size and output of firms. Schmitz (1989) formally demonstrates that the current share of entrepreneurs can be positively associated with future economic growth because there may be spillover effects resulting from the innovation decisions of entrepreneurs. In Audretsch, Keilbach, and Lehmann, (2006) the share of entrepreneurs affects productivity growth because it leverages the work of entrepreneurs as "knowledge filters". Other papers, going back as far as Kuznets (1971), highlight the empirical negative association observed between per capita income of countries and the share of entrepreneurs (self-employed, including business owners). Our model also determines the share of entrepreneurs as an endogenous variable, providing an explanation of the empirical regularity detected by Kuznets and others. In doing so, the model identifies factors that explain differences in the share of entrepreneurs and differences in per capita income across countries that are related to the quality of the entrepreneurs and the characteristics of the production technology and specialization. Additionally, the paper makes it clear that the share of entrepreneurs does not cause growth but it leverages the effect in productivity growth of a given rate of increase in the quality of entrepreneurs over time.

The country-level analysis performed in the paper (i.e. the modeling of the countries' representative firm and the countries' representative entrepreneur) excludes the possibility of accounting for the relationship between the dispersion of quality among entrepreneurs within each country and the resulting heterogeneity of firms. The extension of the paper to include intra-country heterogeneity of entrepreneurs will, on the one hand, advance the study of strategic entrepreneurship (as differences in entrepreneurial ability will explain the differences in size and profits among firms in the country) and on the other, advance the integration of strategic entrepreneurship and economic growth, since it will be possible to study how the heterogeneity in the distribution of firms across countries affects the countries' productivity growth over time.

The rest of this paper is therefore organized as follows: Section 2 presents the basic theoretical model of the neo-classical firm with entrepreneurial inputs in which entrepreneurs perform two functions: setting the strategy and managing the internal workings of the firm. Section 3 extends the model to explain productivity and productivity growth over time. Section 4 reviews some of the existing empirical literature on entrepreneurship and growth under the focus of the theoretical results of this paper. Section 5 presents our own empirical analysis that tests the main empirical prediction of the model and the section on conclusions provides a summary of the main results.

The model of joint production.

Consider the representative firm of an economy where output is the result of two inputs, those provided by the entrepreneur and the labor services provided by workers. The entrepreneur takes the entrepreneurial/strategic decisions (e.g. on the product mix, product and process innovation, market positioning), and also directs the internal resource allocation process (coordination and motivation of workers). Good or bad strategic decisions will affect the productivity of the whole organization, while the managing of the resource allocation process will consume the entrepreneur's time on a per worker basis and will lead to diminishing returns. The representative entrepreneur will have a particular quality which affects the two functions of entrepreneurial decisions and management. The model is adapted from Rosen (1982) keeping the assumption intact but solving it explicitly for a particular form of the production function (Cobb-Douglass). The new results of the paper refer to the solution of the model for the endogenous number of entrepreneurs and for the explanation of labor productivity growth over time, while Rosen's interests are to explain the cross section heterogeneity of firms and profits in a given country.

The quality of services provided by the representative entrepreneur relative to the quality of workers is given by *r*. It is assumed that *r* will be greater or equal to one since more able persons are more productive when directing the work of others. In the short term, the number of entrepreneurs of quality *r* is given and equal to *E*. The value of *r* may vary across economies (representative firms) and over time and will be interpreted as an aggregated measure of the entrepreneurial quality of the economy. The analysis ignores the possible cash flow and wealth constraints which may limit the creation of new firms in a world of asymmetric information and imperfect financial markets (Evans and Jovanovic, 1989), and assumes a world of certainty. Differences in risk aversion across the population which may affect the supply of entrepreneurs in a scenario of uncertainty are therefore not relevant for our model.

Let t_i be the entrepreneur's management time dedicated to complement the effort/time a_i of a worker *i*. The output l_i, jointly produced by both the worker *i* and the entrepreneur that s/he is working with, is given by

$$l_i = g(r) f(rt_i; a_i) \qquad \text{for all } i$$

Where *f( )* is assumed to be a linear homogeneous, increasing and concave function of inputs rt_i and a_i, and *g(r)* is increasing in *r*. To simplify the exposition and provide a closed solution to the problem we assume that

$$f(rt_i; a_i) = (rt_i)^{\beta} a_i^{1-\beta}$$

Where β is a parameter of the production technology that measures the elasticity (between zero and one) of output with respect to the entrepreneur's input in the management of the worker. A higher value of β implies a relatively higher contribution of entrepreneur's input in the output of the job position and lower relative importance of the input from the worker.

Higher quality strategic/entrepreneurial decisions improve the productivity of all team members, and of any other assets of the organization, in an indivisible way (scale economies). This effect is captured by the function *g(r),* which is increasing in the quality of the entrepreneur *r*. Initially, the model is formulated in static terms and ignores changes in *r* and the external effects (for example spillovers from innovations) which may result from the entrepreneurial decisions of a given quality. One of the variables commonly used to value the quality of the entrepreneurial decisions (in agreement with Schumpeter's view on the functions of the entrepreneur), is the degree of innovation incorporated in such decisions[3]. Other effects that function *g(r)* could also measure are the differences in the absorbing capacity of existing knowledge[4].

The term $f(rt_i;a_i)=(rt_i)^{\beta}a_i^{1-\beta}$ gives the joint output from the input a_i supplied by the worker and the input rt_i (time corrected for quality) supplied by the entrepreneur in managing the worker *i*. The marginal productivity of each input is positive but

[3] The effects of technological spillovers and the diffusion of innovation on economic growth have been widely stressed in economic literature: Rosemberg (1982) pointed out that during the industrial revolution there were some important innovations in specific sectors that later spread to a large number of industries; Griliches (1979), Jaffe (1986), Audretsch and Feldman (1996) quantified the effect on economic growth of R&D expenditure in the US economy; In Romer's (1986), growth model firms decide how much to invest in knowledge creation and the knowledge produced spreads without cost to other firms in the economy.

[4] Schmitz (1989) explicitly introduces the entrepreneur as an economic agent which decides to use existing knowledge to produce goods or services sold to the market. In this process, the entrepreneur

decreasing with the amount of input, $0<\beta<1$, to be consistent with the hypothesis of diminishing returns (Coase, 1937) and with the existence of loss of control which increases the marginal cost of delegating the management function to lower hierarchical positions by the entrepreneur (Williamson, 1967).

For all workers, the total labor services in the economy is given by

$$\sum l_i = \sum g(r) f(rt_i; a_i)$$

The total time available from entrepreneurs is T. We assume that there are E entrepreneurs and each provides one unit of time so $T=E$. For efficiency reasons we want to assign this time so that the total output is maximized,

$$\underset{t_i}{Max} Q = \sum g(r) f(rt_i; a_i)$$

Subject to $\sum t_i \leq T$

Let λ be the Lagrange multiplier of the constraint. This multiplier gives the marginal increase in output that can be obtained with an additional unit of entrepreneurs' time T. It is relatively easy to show that in the optimal solution, the ratio between management time t_i and worker effort a_i, t_i / a_i, must be the same for all workers and this is given by

$$t_i / a_i = \left[\lambda / g(r) r^{\beta} \beta\right]^{\frac{1}{\beta-1}}$$

contributes to the creation of new knowledge which spills over to the rest of the economy – the existing knowledge increases and has a positive impact on growth.

Since the restriction is binding in the optimal solution, $\Sigma\, t_i = T$; defining $A = \Sigma\, a_i$ and substituting in the binding constraint, we have

$$t_i / a_i = T / A = \left[\lambda / g(r) r^{\beta} \beta\right]^{\frac{1}{\beta-1}}$$

Solving for λ, the marginal productivity of entrepreneurs' time at the optimal solution is given by

$$\lambda = g(r) r^{\beta} \beta \cdot T_e^{\beta-1}$$

where $Te = T/A$ is the ratio between the entrepreneurs' and workers' time.

Substituting the optimal solution $t_i/a_i = T/A$ in the function *f( )* and taking into account that the function is linear and homogeneous we obtain

$$Q = \sum l_i = \sum a_i \cdot g(r) f(rt_i / a_i, 1) = A \cdot g(r) f(rt_i / a_i, 1)$$

If output Q is sold in the market at price p and direct labor is purchased at market price w, the profit maximizing solution for A is obtained from the problem

$$\underset{A}{Max}\, B = p \cdot A g(r) \cdot f(r\, T / A, 1) - wA$$

For the Cobb-Douglass production function proposed above, the solution to this problem is the following:

$$A^{*} = T\left[p(1-\beta)\cdot g(r)\cdot r^{\beta}/w\right]^{\frac{1}{\beta}} \qquad [1]$$

$$B^{*} = \left[p \cdot g(r)\right]^{\frac{1}{\beta}} \cdot rT\beta \cdot \left[(1-\beta)/w\right]^{\frac{1-\beta}{\beta}} \qquad [2]$$

In the optimal solution, based on the assumptions of the model, average and marginal profit per entrepreneur are the same and equal to B^{*}/T. In equilibrium, according to Rosen's model, differences in quality or ability of entrepreneurs relative to workers will imply different compensations for entrepreneurs in proportion to their relative ability. If *w* is the wage of workers, profit per entrepreneur will then be equal to *rw*. The equilibrium wage of workers, w^{*}, will be determined by the condition that profit per entrepreneur is equal to rw^{*}: $rw^{*} = B^{*}(w^{*})/T$. Solving this equation we obtain

$$w^{*} = p \cdot g(r) \cdot \beta^{\beta} \cdot (1-\beta)^{1-\beta}$$

and substituting the above

$$B^{*}(w^{*})/T = r \cdot p \cdot g(r) \cdot \beta^{\beta} \cdot (1-\beta)^{1-\beta}$$

Both the equilibrium salary of workers and equilibrium profit per entrepreneur increase with the quality of the entrepreneur *r,* although the elasticity of the entrepreneurs' profits with respect to the quality of entrepreneurial services is *1+ e(r)* and the elasticity of salaries is only *e(r),* where *e(r)* is the elasticity of *g(r)* with respect to *r*.

Substituting the expression of w^* in [1] implies a ratio of entrepreneurs over workers, *Te*, in the equilibrium solution, equals to

$$T_e^* = T \ / A^* \left(w^*\right) = \beta / (1-\beta) r$$

The inverse of the ratio T_e gives the average *span of control* for the representative firm, that is to say, the number of workers per entrepreneur. In the equilibrium solution, the span of control will be higher in economies with a higher quality of entrepreneur's services *r* and, on the contrary, it will be lower in economies with a higher elasticity parameter β.

On the other hand, the ratio of entrepreneurs over the total working population *Se* is given by

$$S_e^* = T \ / \left(T \ + A^*\right) = \beta / (\beta + r(1-\beta)) \qquad [3]$$

The equilibrium share of entrepreneurs in the total labor force of the economy (S^*_e) is a decreasing function of the quality of entrepreneur's services (*r)* and it increases with the elasticity parameter β. The inverse of this ratio provides an approximation to the average *size of the representative firm* of the economy and consequently the model predicts that the average size of the representative firm will be higher in economies with a higher quality of entrepreneur's services (*r)* [5]

[5] Predictions that relate *span of control* and size of the firm with parameter *r* are basically the same as those obtained by Rosen in his original model. Other papers that derive equilibrium values for the number of entrepreneurs in the economy are Schmitz (1989), assuming imitation and knowledge spillovers, and Kihlstrom and Laffont (1979), based on risk aversion.

From the optimal solution [1] and the equilibrium share of entrepreneurs, the total output Q^* can be written as

$$Q^* = A^* g(r)\left(rT \ / A^*\right)^{\beta} = A^* g(r)\left[\beta/(1-\beta)\right]^{\beta} = Tg(r)r\left[(1-\beta)/\beta\right]^{1-\beta}$$

Therefore, the output per occupied person in the economy (labor productivity), will be equal to

$$Q^*/\left(A^* + T\right) = \left[T/\left(A^* + T\right)\right] \cdot r \cdot g(r) \cdot \left[(1-\beta)/\beta\right]^{1-\beta}$$

Given that $T \ /\left(T \ + A^*\right) = \beta /(\beta + r(1-\beta))$, productivity can be written as

$$Q^*/\left(A^* + T\right) = r \cdot g(r) \cdot \beta^{\beta} \cdot (1-\beta)^{1-\beta} / \left[\beta + r(1-\beta)\right] \qquad [4]$$

Output per working individual is a function of the management technology parameter β and of the quality parameter r. It is immediate to show that labor productivity is increasing with the quality parameter r: *ceteris paribus*, economies with higher entrepreneurial quality r will have higher labor productivity than economies with lower quality. Productivity differences come from the effect of quality on management activities and from its effect on strategic decisions, $g(r)$.

In the equilibrium solution, the share of entrepreneurial income over total output w^*rT/pQ^* is equal to the elasticity β. The empirical relationship between labor productivity and the share of entrepreneurial income across countries can be explored by looking at variations of labor productivity as a function of changes in the elasticity parameter β. The derivative of $Q^{*}/(A^{*}+T)$ with respect to β gives

$$\frac{\partial\left[Q^{*}/\left(A^{*}+T\right)\right]}{\partial\beta}=\beta^{\beta}\left(1-\beta\right)^{1-\beta}r\cdot g\left(r\right)\left[\frac{Ln\left[\beta/\left(1-\beta\right)\right]}{\beta+r\left(1-\beta\right)}+\frac{r-1}{\left[\beta+r\left(1-\beta\right)\right]^{2}}\right]$$

The sign of $Ln\ \beta/(1-\beta)$ in this equation is positive for $\beta > ½$ and zero or negative otherwise. Therefore, in countries where the share of entrepreneurs' income is higher than the share of workers' income, we expect that the higher share of the entrepreneurs' income is associated with higher labor productivity, since $r-1$ is non negative by assumption. On the other hand, when comparisons are made within countries where the share of entrepreneurs' income is lower than that of the workers and, at the same time, the parameter r is relatively low (close to 1), then labor productivity can be expected to decrease in line with the share of entrepreneurial rents. If r is sufficiently higher than 1, however, the sign of the association can reverse. Therefore, the expected empirical relationship between the share of entrepreneurs' earnings and labor productivity is sensitive to the value of the quality of entrepreneurs across countries.

Productivity growth over time

The quality of the representative entrepreneur can change over time. The effect of these changes in labor productivity growth can be evaluated from equation [4] by computing the rate of growth of the output per working individual as a function of the rate of growth in the quality parameter r. Defining $N = T+A^{*}$ as equal to the total number of entrepreneurs and workers (total of occupied people), then the log of labor productivity from [4] is equal to

$$Ln(Q^*/N) = Lng(r) + Lnr + \beta Ln\beta + (1-\beta)Ln(1-\beta) - Ln[\beta + r(1-\beta)]$$

If the parameter β remains stable over time, labor productivity growth depends on time improvements in the quality of the entrepreneur's services. The derivative of the log of productivity with respect of time is given by

$$q_t = \gamma_t + \rho_t - [r(1-\beta)/(\beta + r(1-\beta))]\rho_t$$

Where q_t is the rate of growth in labor productivity over time, γ_t is the rate of growth over time in total factor productivity function *g(r)* and ρ_t is the growth rate of the quality of entrepreneur's input *r*. Since $(r(1-\beta)/(\beta + r(1-\beta)) = 1 - S_e$, productivity growth can be written as

$$q_t = \gamma_t + S_e\rho_t \qquad [5]$$

The rate of growth in labor productivity over time has two terms; the growth rate in total factor productivity (including the possible effect of improvement in the quality of entrepreneur's services for example in terms of better innovation decisions) and the growth rate in the quality of entrepreneur's services ρ_t weighted by the share of entrepreneurs in the economy[6]. *Ceteris paribus*, the same rate of growth in quality will imply a higher rate of labor productivity growth in economies with a higher share of entrepreneurs[7].

Economies with a higher quality of entrepreneurial services at a given moment of time will have higher productivity and the representative firm will be larger – that is to say, they will have a lower S_e than economies with lower quality (see equation [3]). However, the same rate of increase in the quality of entrepreneur's services over time will imply higher productivity growth in economies with a smaller size of representative firm, in other words, in economies with a higher share of entrepreneurs. The model implies a *convergence effect* in labor productivity over time across economies that start with a different quality of entrepreneur's services but with a similar rate of increase in quality of these services over time.

In general, firms use labor together with capital (machinery, equipment) to produce goods and services. The above model could be extended to allow for the capital input and its growth over time. Maintaining the assumption on the Cobb-Douglas type of production function, the generalization would be straightforward so, if the elasticity of output to capital is α (a parameter between zero and one) and the rate of growth in the ratio of capital per occupied person (workers plus entrepreneurs) is given by κ_t, then equation [5] will now be,

[6] Notice that when $g(r)$ depends only in r then γ_t can be written as $e(r)\rho_t$ where $e(r)$ is the elasticity of $g(r)$ with respect of r.

[7] The growth model proposed by Schmitz (1989) also predicts that the growth rate of output and consumption per capita will be higher in economies with a larger share of entrepreneurs, although for reasons related to the diffusion of knowledge.

$$q_t = \gamma_t + S_e \rho_t + \alpha \kappa_t \qquad [6]$$

The results from this theoretical section are summarized in the following proposition about the relationship between entrepreneurship variables, economic development and growth (allowing for other factors such as capital intensity per occupied person and/or growth of this intensity over time):

Proposition: *a) In a cross section of countries, the average size of the representative firm (share of entrepreneurs) will be higher (lower) in countries with a higher quality of entrepreneur's services(r), relative to direct labor services.*

b) In a cross section of countries, labor productivity will be higher in countries with a higher quality of entrepreneur's services(r).

c) Elasticity (β) and quality (r) parameters determine equilibrium values of both the share of entrepreneurs and labor productivity. In a cross section of countries, correlations can be found between labor productivity and the average size of the representative firm (share of entrepreneurs) that must be interpreted as the result of differences in parameters β and r across countries.

d) Time improvements in the quality of entrepreneur's services ($\rho_t > 0$) will imply positive growth rates in labor productivity over time. For the same rate of increase in the quality of entrepreneur's services (ρ_t), labor productivity increases at a higher rate in economies with a higher starting share of entrepreneurs.

Statement a) is derived from $S_e^* = T / (T + A^*) = \beta / (\beta + r(1-\beta))$; statement b) is directly derived from equation [4]. Statement c) is the direct implication of a) and b) since both the variables (size of the firm and productivity) are endogenous and a function of *r and β*. Statement d) is taken from [5]. The association between labor productivity and share of entrepreneurs pointed out in statement c) can in no way be interpreted as a causality relationship. The exogenous parameters of the model are only the quality of entrepreneurs (*r)*, its rate of change over time *(ρ_r)*, and the elasticity of output to management services supplied by the entrepreneur (*β).*

Review of the empirical literature.

The literature on entrepreneurship and economic growth concentrates on the strength and sign of the association between indicators of economic performance and measures of entrepreneurial activity of countries. In our model, performance measures include labor productivity *Y/(A+T)* and productivity growth *y*. Entrepreneurial related factors are the share of entrepreneurs S_e, and the quality of entrepreneur's services *r*. The share of entrepreneurs, a variable used in many empirical analyses as a measure of entrepreneurial activity, is endogenous. It must be explained in terms of the characteristics of managerial technology, input quality and from the equilibrium between the relative compensation of entrepreneurs with respect to that of workers.

The accumulation of human capital by workers and entrepreneurs, through education and learning by doing, together with changes in the management technology, can affect labor productivity growth over time. The quality of the entrepreneurs' services has sometimes been related to other institutional conditions (e.g. social mobility), and to indicators of innovation capacity such as patenting or the rate of the creation of new firms in high technology sectors.

A cross-section comparison of the share of entrepreneurs and per capita income

Research on entrepreneurship has looked at the relationship between the per capita income of countries and the share of entrepreneurs in the population (Kuznets 1971, Acs et al 1994, Iyigun and Owen 1998, Carree et al 2002). The earlier studies find a negative cross section association between income per capita and the share of entrepreneurs (Kuznets 1971). Other works report an increase in this share over time which is parallel to the increase in per capita income (Acs et al 1994). This is interpreted as part of a broader trend, observed in developed countries, of the increasing relative importance of small businesses in the population of firms (Acs and Audretsch 1993, Wennekers and Thurik 1999). Based on this evidence, Carree et al (2002) postulate “an equilibrium relationship between the rate of business ownership and per capita income that is U shaped (…), so there is a level of economic development with a minimum ownership rate” (p. 275). Countries will be penalized with lower economic growth if their business ownership rates are outside the equilibrium value corresponding to their current economic development.

Our model provides further insights into the expected cross section association between the share of entrepreneurs and productivity at a given moment in time. It is worth mentioning again that, according to the model, both variables (the share of entrepreneurs and the labor productivity), are endogenous and determined by the parameters of management technology and the quality of entrepreneur services.

Therefore, the relationship between the share of entrepreneurs and labor productivity must be interpreted in the light of this situation (proposition c). Figure 1 plots the simulated values of the share of entrepreneurs S_e and labor productivity Q/N, for different values of the parameters β and r. Each plot assumes a given value of r and varies the elasticity β in its range of values between zero and one. The simulated pair values of the two endogenous variables describe the U shape relationship between income per capita and the share of entrepreneurs as documented in the empirical research.

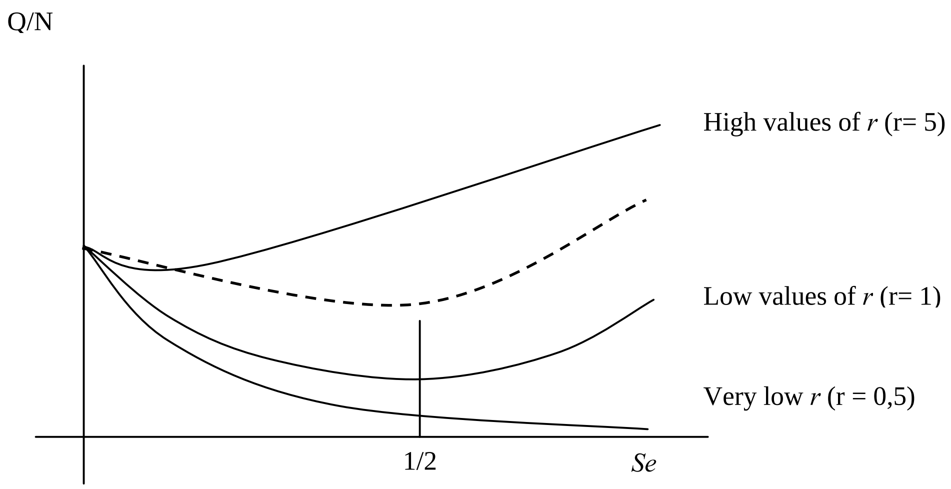

Figure 1. Share of entrepreneurs and labor productivity for different values of parameters of entrepreneurial quality, r, and elasticity of output to entrepreneur's direction services, β.

A number of important conclusions can be drawn from figure 1: First, we can see that comparisons between the share of entrepreneurs S_e and the per capita income (assuming similar occupation rates in all countries) only make sense on allowing for differences in the quality of the entrepreneur's input. Second, all the values along a given curve represent equilibrium values in economies with different management technology but with the same quality of entrepreneurial services. Third, a country can change its position over time due to changes in management technology, the quality of entrepreneur's services or both; and finally, it can be observed that a higher r in countries with a given β implies a higher per capita income. One issue not explicitly explored in the paper is how the technology parameter β varies across countries and over time. A reasonable assumption is that industries where jobs are well defined and tasks are easy to structure, will consume less management services than industries where jobs are undefined and tasks are unstructured. More labor intensive industries will also require more intensive supervision and coordination of workers than highly capital intensive or highly robotized ones. The empirical evidence suggests that the relative importance of service industries in a country can affect the equilibrium share of entrepreneurs (Carree et al, 2002). Our model would explain this evidence if service industries are more intensive in management services than manufacturing ones.

The empirical evidence shows that in countries with more than a minimum level of development, the share of entrepreneurs will be less than a ½ (less than half the total labor force are entrepreneurs). If the quality of entrepreneurs is not too different from 1, a negative association can be expected between the share of entrepreneurs and the per capita income. Countries with entrepreneurs of very low quality r could show a decreasing association between per capita income and share of entrepreneurs even in the range of share values lower than ½. If we select a set of countries with a very high value of r, then among these countries a positive association between the share of entrepreneurs and per capita income can be observed. When combining countries with very different values of r in the same sample, the empirically observed U shaped relationship between share of entrepreneurs and income per capita can just pick up the heterogeneity in the values of r across countries (the dotted line in Figure 1).

Total output and entrepreneurial capital

Audretsch and Keilbach (2004a,b) model a production function with three inputs instead of the more conventional two of labor and physical capital. They refer to this third input as “Entrepreneurship capital” and the neoclassical production function is formulated as $Y = \alpha L^{\eta} K^{\varphi} E^{\mu}$, where Y is the total output, L is the labor, K the physical capital, E is the entrepreneurial capital and α, η, φ, μ, are parameters of the production technology.

Audrestsch and Keilbach use the number of new firms per capita in a period of time and the number of new firms created in high tech sectors in a particular year, as proxy variables of the entrepreneurial capital of the German regions for which the model is estimated. No reference is made, however, to the issue of how entrepreneurs and workers are aggregated into the labor input L. Differences between the quality of services from entrepreneurs and from workers are also not made explicit. Our model could easily account for capital and labor inputs and would extend the production function to allow for differences in quality of entrepreneurs across regions. Moreover, within our framework a variable such as the number of new firms in high-tech sectors per capita would have to be considered a measure of entrepreneurial quality (r) in German regions, rather than a measure of quantity of entrepreneurial capital.

Growth

van Stel et al (2005) and Wong et al (2005) study the cross section association between growth rates (of GDP and productivity) and the Total Entrepreneurial Activity rate

(TEA) provided by the Global Entrepreneurship Monitor survey, allowing for other variables, in 36 countries. van Stel et al find that higher TEA values (the proportion of people in the country involved in the creation of new firms) only imply higher GDP growth in the group of rich countries. If we assume that the proportion of people involved in the creation of new firms is higher in countries with a higher share of entrepreneurs in the population, then the TEA would be positively correlated with S_e. The coefficient of the TEA in these empirical analyses would then be approximately equal to the average rate of change, across countries, in the quality of entrepreneur's services r over time. The fact that this coefficient is positive and significant only for developed countries and marginally negative in developing countries could indicate that the quality of the entrepreneur's input is improving over time but only in more developed countries.

Wong et al (2005) use alternative measures of entrepreneurial quality as determinants of differences in countries' economic growth rates, but they only find a positive association between productivity growth and the number of patents relative to the GDP, an explanatory variable that in our framework would more closely resemble the quality rather than the quantity of entrepreneurial input.

Audretsch, Keilbach, and Lehmann, (2006) also model and empirically estimate a relationship between productivity growth and the share of entrepreneurs across OECD countries. The model is formulated on the assumption that entrepreneurs contribute to economic growth by acting as "knowledge filters" and therefore help to convert complex technological developments into marketable products or services. Since new knowledge to be disseminated can be expected to be higher in countries that expend more in R&D activities, in the empirical model, the share of entrepreneurs is multiplied by R&D expending in the respective country. Our formal model does not account for the knowledge dissemination function of entrepreneurs and equation [5] provides a formal relationship between productivity growth and the share of entrepreneurs that does not depend on the level of R&D activity. In the empirical estimation of equation [5] we control for differences in growth of R&D expenditures per occupied person across countries in order to account for possible correlations between this variable (which can be considered as a measure of the quality of entrepreneurial activity) and the share of entrepreneurs

Empirical analysis.

This section presents the results of the empirical estimation of equation [5] which explains productivity growth over time as a function of the starting year value of the share of entrepreneurs and of the rate of change in the quality of the entrepreneurs' input. The estimation will use country level data provided by the OECD for the member states. The first term of equation [5] accounts for the growth in total factor productivity from improvements in quality of entrepreneurs' services. In general there will be other factors contributing to productivity growth not considered in the stylized model presented above, such as investment in physical and intangible capital (R&D, advertising, education, training, infrastructure), economic regulations (that may affect the entry and exit of firms, foreign investment) and institutional factors (quality of regulations, law and justice, work culture). Some of these variables can also explain cross country and time differences in the quality of entrepreneurial services (education of labor force, R&D expending, cultural and legal barriers to entrepreneurship). The econometric estimation of equation [5] will account for these growth factors through control variables.

The main empirical model to be estimated is the following:

$$y_{it} = b_0 + b_1 S_{e\,it-1} + b_2 (Y/N)_{i5t} + \sum d_i D_i + \sum d_j Time_j + \varepsilon_{it} \qquad [7]$$

The dependent variable y_{it} is the annual rate of labor productivity growth of country *i* in year *t*. The variable S_{eit-1} is the share of entrepreneurs in country *i* at the end of period *t-1; $(Y/N)_{i5t}$* is a five years average of labor productivity of country *i* in year t; D_i are countries dummies and $Time_j$ are time dummy variables. Average labor productivity is calculated for five years periods and therefore its value changes every five years (averages from 1970 to 1974, from 1975 to 1979 and so on). It is a control variable which accounts for differences in structural conditions across countries which may change over time but at a relatively low pace (e.g. differences in capital stock, industry specialization, level of economic development…). Country dummy variables will control for time invariant institutional factors which can also be correlated with the share of entrepreneurs (e.g. legal and regulatory barriers, credit availability, cultural values that influence risk taking behavior or preferences for independent work…). It also accounts for convergence effects due to differences in the start of the period level of productivity across countries. Finally, time dummy variables control for macroeconomic shocks common to all countries, including general trends in quality of entrepreneurs' services which affect total factor productivity growth.

The estimated value of parameter b_1 is the estimated time and the countries' average growth in the quality of entrepreneurs, ρ. A positive and significant value of estimated b_1 will support the prediction that improvement in quality of entrepreneurs has contributed to productivity growth and to productivity convergence within the sample of OECD countries. An estimated negative sign of parameter b_2 will indicate that there are other convergence factors not captured by the other control variables and by the lagged share of entrepreneurs that affects productivity growth over time.

For a limited set of countries, the OECD statistics provide additional country level variables that will be used to explain productivity growth in the robustness part of the analysis. These variables include the stock of physical capital, the number of patents, R&D spending per country and year and the number of people employed in R&D activities. Output per occupied person can grow over time because firms substitute physical capital (machines, for example) in place of labor. Equation [6], above, indicates that when such substitution is possible labor productivity growth will also be positively associated with the rate of growth in capital per occupied person, k_{it}. One form of capital that is especially important for productivity growth is that which results from innovation expenditures. For a limited number of countries and time periods, data are available on number of patents, R&D expenditures and the number of people employed in R&D, which allow for calculations of the intensity of innovation capital per occupied person and its growth over time. Model [7] will be expanded to include growth in physical and innovation capital per worker as additional explanatory variables of growth in labor productivity. Besides providing robustness tests of the basic model the expanded model will allow us to compare the contribution to productivity growth from growth in innovation activity and growth from better quality management services provided by the entrepreneur.

Data

Data on labor productivity, the share of entrepreneurs and the control variables are taken from official OECD statistics on member countries available in internet DSI. Labor productivity *Y/N* is calculated using data on GDP and Labor from OECD statistics:

$$Y/N = \frac{GDP\ (PPPs,\ price\ levels\ \&\ exchange\ rates\ 1995)}{Total\ Labor\ Force\text{-}\ Unemployment}$$

PPPs = Purchasing Power Parity.

The dependent variable annual rate of productivity growth of each country is equal to the annual rate of growth of the GDP per occupied person in the country. The growth rate in labor productivity between period 1 and period $1+m$ is calculated as $((Y/N)_{1+m} / (Y/N)_1)^{1/m}-1$. The explanatory variable S_e, the share of entrepreneurs, is also obtained from data on labor markets of the OECD countries:

$$S_e = \frac{Total\ Labor\ Force\text{-}\ Employees\ \text{–}Unemployment}{Total\ Labor\ Force\text{-}\ Unemployment}$$

Some countries differ in the way labor statistics are reported: Belgium, the Czech Republic, Denmark, Japan, Korea, New Zealand, Poland and the Slovak Republic report figures on the *Civilian Labor Force* instead of the *Total Labor Force*; Switzerland and USA publish *Employment Total Non Farm Private Isic B to P* instead of *Employees-Total*; and France and New Zealand report *Unemployment-Registered* instead of *Unemployment-Total*. Unfortunately, the population of entrepreneurs is not separated into the self employed with no hired employees and those with hired employees. Therefore we are forced to consider the total number of entrepreneurs in the country without allowing for differences in the composition of entrepreneur's services.

The descriptive statistics on productivity, productivity growth and entrepreneurs shares, are presented in Tables 1, 2, 3 respectively. The tables show averages, standard deviation and the coefficient of variation (standard deviation/average), for each variable across countries and for each time period. In the years 1970-1984 productivity data is available for 15 countries and after 1995 data are available for all 23 countries. For the complete sample, average annual labor productivity growth is around 2%. Average productivity growth is higher in the first half of the seventies and in the nineties and lower in the period 2000-03. No clear trend is observed in the coefficient of variation of productivity growth rates over time, which takes an especially high value (close to one) in the period 1990-94.

TABLE 1: Productivity Growth y_{it}. (1 year)

	70-74	**75-79**	**80-84**	**85-89**	**90-94**	**95-99**	**00-03**
No. of Countries	14	15	15	16	20	22	23
Average	0.0313	0.0176	0.0163	0.0174	0.0206	0.0204	0.0158
Standard Deviation	0.0136	0.0141	0.0085	0.0140	0.0206	0.0121	0.0113
Coefficient of Variation	0.4352	0.8032	0.5232	0.8094	0.9980	0.5922	0.7153

TABLE 2: Entrepreneurial shares *Se*

	70-74	75-79	80-84	85-89	90-94	95-99	00-03
No. of Countries	13	14	15	16	21	23	23
Average	0.1948	0.1751	0.1826	0.1969	0.1801	0.1703	0.1603
Standard Deviation	0.0919	0.0812	0.0847	0.0948	0.0861	0.0811	0.0768
Coefficient of Variation	0.4718	0.4641	0.4637	0.4816	0.4782	0.4759	0.4792

TABLE 3: Labor Productivity *Y/N*
(Dollars PPPs, prices levels and exchange rates 1995)

	70-74	75-79	80-84	85-89	90-94	95-99	00-03
No. of Countries	14	15	16	17	21	23	23
Average	33,244.7	37,057.5	38,765.2	40,777.6	39,319.1	43,982.1	46,869.4
Standard Deviation	5,612.7	5,789.5	6,827.2	8,817.9	11,921.0	12,377.2	12,083.3
Coefficient of Variation	0.1688	0.1562	0.1761	0.2162	0.3032	0.2814	0.2578

The average share of entrepreneurs in the working population for the whole sample is 18%. The average share increases over time until 1990 and from then on it slightly decreases to a lower average of 16% in the period 2000-03. The share of entrepreneurs varies across countries (average standard deviation of 8.5%) but the coefficient of variation is quite stable over time. Individual country data (not reported) show exceptionally low values for the share of entrepreneurs in the US in the second half of the period which is something which merits further analysis. Robustness tests in the model estimation attempt to account for possible inconsistencies in the data and for changes in measurement criteria of labor statistics over time. Absolute labor productivity shows an increasing time trend (the lower average productivity in the period 1990-94 compared with the previous five-year period is the result of changes in the number of countries in the sample - Table 3). Countries differ in average labor productivity and no evidence exists that productivity converges across countries (standard deviation of labor productivity increases over time). However, dispersion measures may be affected by differences in the number of countries for which data are available in the time period.

TABLE 4: Control variables ([1])
(Dollars PPPs, prices levels and exchange rates 1995)

	k_{it} ([2])	$GrwPAT/N_{it}$ ([3])	$GrwGERD/N_{it}$ ([4])	$GrwN\text{-}R\&D/N_{it}$ ([5])
	1970-1997	1977-1999	1981-2002	1981-2002
No. of Countries	9	22	21	19
No. of data	191	353	281	210
Average	0.0173	0.2173	0.0392	0.0182
Standard Deviation	0.0297	0.6716	0.0575	0.0422
Coefficient of Variation	1.7164	3.0907	1.4674	2.3121

([1]) Growth on: k_{it} = physical capital and in other kind of capital $GrwX/N_{it}$, where X stands for PAT= Triadic Patents Families; GERD=Gross Domestic Expenditure on R&D; N-R&D= Employees Full Time Equivalent on R&D.
([2]) 9 OCDE countries: AUS, CAN, FIN, FRA, DEU, ITA, NOR, GBR & USA
([3]) 22 OCDE countries: AUS, AUT, CAN, CZE, DNK, FIN, FRA, DEU, HUN, ITA, JPN, KOR, NZL, NOR, POL, PRT, SVK, ESP, SWE, CHE, GBR & USA
([4]) 21 OCDE countries: AUS, AUT, BEL, CAN, CZE, DNK, FIN, FRA, DEU, HUN, ITA, JPN, KOR, NZL, NOR, POL, PRT, SVK, ESP, GBR & USA
([5]) 19 OCDE countries: AUS, BEL, CAN, CZE, DNK, FIN, FRA, DEU, HUN, ITA, JPN, KOR, NZL, NOR, POL, PRT, SVK, ESP, & GBR

Finally, Table 4 presents descriptive statistics on additional control variables that can explain labor productivity growth and that will be included as additional explanatory variables in the estimation of model [7]. The first variable is the rate of growth in fixed capital per occupied person, k_{it}. Data on the stock of fixed capital are only available for nine countries and for the period 1970-1997. The raw data are transformed into PPP values for 1995 and the annual growth rate in fixed capital per occupied person is calculated. The other three variables in Table 4 refer to innovation capital. The annual expenditures in R&D and the R&D personnel (full time equivalent) are obtained from the OECD publication *Industry, Science and Technology Statistics,* and the number of patents (Triadic Patent Families) is obtained from the EUROSTAT publication *Science and Technology Statistics.* The R&D expenditures are transformed into PPP values for 1995. In the empirical model, the explanatory variables of innovation activity are expressed in annual growth rates of the ratios of the number of patents, R&D personnel (full time equivalent) and R&D expenditures per occupied person, respectively:

(*GrwPAT/N$_{it,}$*) (*GrwNR&D/N$_{it}$*) and (*GrwGERD/N$_{it}$*). The evidence from Table 4 indicates a high dispersion in these control variables across countries.

Results of the estimation

TABLE 5: Results of the estimation of the model. OCDE Countries ([1]).

$$y_{it} = b_0 + b_1 Se_{it-1} + b_2 (Y/N)_{i5t} + \sum d_i D_i + \sum d_j Time_j + \varepsilon_{it}$$

Coefficients & explanatory variables	1 year productivity growth					
	1970-2002				1980-2002	1990-2002
	1	2	3	4([2])	5	6
b_0 (Interception)	0.0357***	0.0123	0.0157	0.0061	-0.0269	0.0894
	(0.0066)	(0.0108)	(0.0204)	(0.0241)	(0.0257)	(0.0588)
b_1 (Se_{it-1})	0.0533***	0.1566***	0.1539***	0.1893***	0.1506***	0.1725
	(0.0109)	(0.0389)	(0.0414)	(0.0569)	(0.0548)	(0.1402)
b_2 ($[Y/N]_{i5t}$)	---	---	-9.38E-06	5.45E-08	2.41E-07	-2.52E-06**
			(4.62E-07)	(5.32E-07)	(5.77E-07)	(1.24E-06)
Country Dummies	NO	YES	YES	YES	YES	YES
Year Dummies	YES	YES	YES	YES	YES	YES
Adjusted R^2	0.1393	0.2365	0.2347	0.1890	0.2007	0.2239
F value	3.4338***	3.7232***	3.6469***	2.6737***	3.0651***	2.9118***
No. observations	467	467	467	318	371	233

Standard error in brackets. *, **, ***, significant at 10, 5 and 1%, respectively. Dummies of AUS and the first year of the period excluded.
(1)**1,2,3,5&6**: 23 COUNTRIES. AUS, AUT, BEL, CAN, CZE, DNK, FIN, FRA, DEU, HUN, ITA, JPN, KOR, NZL, NOR, POL, PRT, SVK, ESP, SWE, CHE, GBR & USA.
([2]) **4**: Only 13 Countries with homogeneous data. AUS, AUT, CAN FIN, DEU, HUN, ITA, NOR, POL, PRT, ESP SWE & GBR

The results of estimating the model [7] are presented in Table 5 for different specifications and for different time periods. In model 1 the only control variable is the time dummy variable. In model 2 we add the country dummies and in model 3 the explanatory variables are all the contemplated in empirical model [7], i. e. time and country dummies and five years average productivity. To account for possible bias due to simultaneous determination of the productivity and the lagged share of entrepreneurs, in all models the variable share of entrepreneurs has been instrumented by its lagged value (S_{et-2}). The model has been estimated using the Two-Stage Least-Squares Regression estimation procedure implemented by SPSS Inc.

When the lagged share of entrepreneurs is the only explanatory variable (model 1), we assume that this variable captures all converge factors affecting productivity growth. The estimated coefficient is 0.0533 (statistically significant at 1%). Therefore in this scenario the estimated growth in quality of entrepreneurial services would be around 5% per year on average. In model 2 when country specific effects are added to the regression, the estimated coefficient of the lagged share of entrepreneurs increases to 0.1566. Finally, including the five years average productivity as explanatory variable leaves the estimated value of the coefficient of the share of entrepreneurs practically unchanged, while the coefficient of the average productivity variable is not statistically significant (model 3).

The country specific effects explain productivity growth (adjusted R^2 almost doubles) but they are also (negatively) correlated with the share of entrepreneurs; excluding them from the regression biases downwards our estimate of the average growth in quality of entrepreneurial services. Controlling for this time invariant country specific effect there is no evidence of further convergence factors captured by the five years average productivity. However, estimating model 3 with no fixed effects and also excluding the share of entrepreneurs from the explanatory variables, in the two cases the estimated coefficient of average productivity is negative and statistically significant (not reported). The negative sign of the average productivity variable is consistent with convergence effects. Part of these effects are captured by the countries fixed effects and by the lagged share of entrepreneurs' variable so when these variables are included as explanatory of productivity growth then the coefficient of the average productivity variable is no longer statistically significant (the simple correlation between share of entrepreneurs and lagged average productivity is equal to -0.365, significantly different from zero).

Since labor statistics data are not homogeneous across countries equation [7] is estimated for the reduced sample of countries with homogeneous statistics, model 4. Models 5 and 6 refer to estimations of model [7] for subsets of selected time periods (1980-2002 and 1990-2002), to evaluate the stability over time of the estimated parameter of the lagged share of entrepreneurs variable. The estimated coefficients of parameter b_1 are statistically significant in all cases but in model 6 (p-value of 20%). The null hypotheses that the estimated values of the coefficients of models 4, 5 and 6 are equal to the estimated value of model 3 are not rejected confirming the consistence of the results.

Robustness analysis: Accounting for physical and innovation capital

The robustness analysis attempts to optimize the available data in order to expand the list of control variables to account for differences in physical capital and innovation activity across countries. The expanded formulation of model [7] to be estimated in this section is formulated as follows:

$$y_{it} = b_0 + b_1 Se_{it-1} + b_2 (Y/N)_{i5t} + b_3 k_{it} + b_4 GrwX/N_{it} + \sum d_i D_i + \sum d_j Time_j + \varepsilon_{it} \qquad [8]$$

where *GrwX/N* stands for the rate of growth of the Gross Domestic Expenditures on R&D (GERD), the Employees Full Time Equivalent on R&D activities and the Triadic Patent Families (EPO-USPTO-JPO), respectively. Coefficient b_3 represents the elasticity of output physical capital and also the elasticity of labor productivity growth to the rate growth rate in physical capital; the estimated value is expected to be close to the average share of gross profits in the GDP of the countries. Coefficient b_4 is also an elasticity that now refers to the respective measure of innovation capital. All these coefficients are expected non negative.

TABLE 6: Robustness of results of Table 5. OCDE Countries ([1]).

$$y_{it} = b_0 + b_1 Se_{it-1} + b_2 (Y/N)_{i5t} + b_3 k_{it} + b_4 GrwX/N_{it} + \sum d_i D_i + \sum d_j Time_j + \varepsilon_{it} \quad (^2)$$

Coefficients & explanatory variables	1977-99	1981-2002		1981-97
	1	2	3	4
b_0 (Interception)	-0.0281	-0.0466	-0.0456	-0.0800*
	(0.0299)	(0.0328)	(0.0470)	(0.0466)
b_1 (Se_{it-1})	0.1635***	0.1591**	0.1890**	0.2932*
	(0.0589)	(0.0710)	(0.0877)	(0.1637)
b_2 ($[Y/N]_{I5t}$)	2.17E-07	3.65E-07	1.27E-07	1.16E-06*
	(6.38E-07)	(6.71E-07)	(1.05E-06)	(6.1E-07)
b_3 (k_{it})	---	---	---	0.5280***
				(0.0769)
b_{4a} $GrwPAT/N_{it}$	0.0033	---	---	---
	(0.0024)			
b_{4b} $GrwGERD/N_{it}$	---	0.1152***	---	0.1526***
		(0.0223)		(0.0543)
b_{4c} $GrwN\text{-}R\&D/N_{it}$	---	---	0.0752*	---
			(0.0406)	
Country Dummies	YES	YES	YES	YES
Year Dummies	YES	YES	YES	NO
Adjusted R^2	0.1745	0.3047	0.2285	0.4889
F value	2.6016***	3.7724***	2.4591***	8.8104***
No. observations	342	273	203	99

Standard error in brackets. *, **, ***, significant at 10, 5 and 1%, respectively. Dummies AUS and the first year of the period excluded.
([1]) **1**: 22 COUNTRIES: AUS, AUT, CAN, CZE, DNK, FIN, FRA, DEU, HUN, ITA, JPN, KOR, NZL, NOR, POL, PRT, SVK, ESP, SWE, CHE, GBR & USA. **2**: 21 COUNTRIES: Those in (**1**) plus BEL, and minu SWE, CHE. **3**: 19 COUNTRIES: Those in (**1**) plus BEL, and minus AUT, SWE, CHE & USA**. 4**: 9 COUNTRIES: AUS, CAN, FIN, FRA, DEU, ITA, NOR, GBR & USA.
([2]) $GrwX/N_{it}$: PAT= Triadic Patents Families; GERD=Gross Domestic Expenditure on R&D; N-R&D= Employees Full Time Equivalent on R&D.

The results of estimating model [8], are presented in Table 6. The first three columns show estimates of the model each one with a different measure of innovation capital (recall that the data sets are different for each innovation variable). In the three estimations the coefficient of lagged share of entrepreneurs remains practically unchanged and at similar values to those shown in Table 5. The estimated coefficient of the innovation variable is positive in all three cases but only significant for the input variables, R&D expenditures and people employed in R&D activities. The estimated coefficient of $GrwGERD/N_{it}$ is 0.1152, statistically significant at 1%, which implies an elasticity of output to capital from R&D expenditures of 11.52%.

Column four of Table 6 shows the results of estimating model [8] with growth in physical capital per occupied person and growth in R&D expenditures per occupied person as explanatory variables. Data for these two variables is available only for a reduced number of countries and years (99 observations).[8] The estimated coefficient for the lagged share of entrepreneurs is now 0.2932, significant at the 7.7%. The coefficients of the growth rates in physical and R&D capital per occupied person are both statistically significant at the 1% level or less. The estimated values of these coefficients, 0.528 and 0.1526, measure the elasticity of output to the stock physical and R&D capital, respectively. Therefore, as expected, labor productivity growth over time increases with the deepening of physical and innovation capital per occupied person.

Sample differences make estimated values of the parameters of the model difficult to compare, but they all confirm a positive estimate of the coefficient of the lagged share of entrepreneurs in the working population. The estimated value of $b_1=0.1539$ in column three of Table 5 appears as a robust estimate of the average increase in quality of entrepreneurs services for the OECD countries in the time period 1970-2002. Since the parameter quality r is defined relative to quality of direct labor services the estimated value of b_1 implies that the relative quality of entrepreneurs' services increases at an annual rate 15.39% in OECD countries in the period 1970-2002. This rate of increase in relative quality of entrepreneurs' services contributes to productivity

[8] The time dummy variables are excluded from the regression to reduce the number of coefficients to be estimated. When they are included the estimated coefficient of the variable lagged share of entrepreneurs increases in value and statistical significance (0.3231, with p value < 1%).

growth through more productive management services (coordination and motivation functions of the Coasian entrepreneur) in a fraction equal to the share of entrepreneurs in the country, as model [5] indicates. On the other hand the positive and significant coefficient of the variable growth in R&D per occupied person indicates that entrepreneurial activity in the form of product and process innovation is an additional factor of productivity growth, this time in the more Schumpeterian view of the relationship between entrepreneurship and economic growth.

Discussion and Conclusion.

There is a lack of solid empirical evidence on entrepreneurship and economic growth and a lack of theoretical models that give a detailed explanation as to why and how entrepreneurial activity is often considered as synonymous with prosperity and growth. This paper provides theoretical predictions on the cross sectional relationship between per capita income and entrepreneurial inputs of the country (summarized in Figure 1) and on the relationship between changes in the average relative quality of entrepreneurs' services and labor productivity growth over time (equation [5]). One of the things that makes this work original is that these results come from integrating, in a single model, the Schumpeterian and the Coasian views of the entrepreneur. The quality of the entrepreneurial decisions, highlighted by Schumpeter, enter the production function as part of the total factor productivity component *g(r)*, while the quality and time of the entrepreneur in directing the resources, affecting output with positive but decreasing marginal returns is consistent with the diminishing returns of the directing function postulated by Coase.

The empirical analysis models labor productivity growth in OECD countries as a function of growth in the quality of entrepreneurs over time. We measure the contribution of this growth using the estimated coefficients of the empirical model from OECD data. The main explanatory variable, the share of entrepreneurs at the start of the period, measures the entrepreneurial base of the country that in turn approximates the intensity of management services provided by the entrepreneurs involved in directing the resources. According to the model, the effect of improvement in relative quality of the representative entrepreneurs in productivity growth is weighted by the intensity of management services measured by the equilibrium share of entrepreneurs at the start of the period. Therefore, the same rate of improvement in the quality of entrepreneurs will imply higher labor productivity growth in countries with a larger entrepreneurial base. But the model also predicts that the share of entrepreneurs in the equilibrium is inversely related to the quality of the representative entrepreneur, while the level of labor productivity is directly related to it. Consequently, countries with higher share of entrepreneurs are countries with lower initial productivity and this implies a negative correlation between the rate of productivity growth and the level of past productivity known in the growth literature as a *convergence effect*. Another explanatory variable used in the robustness analysis is the rate of growth in R&D expenditures per occupied person. This variable can be considered as a proxy of innovation activity and therefore capture, at least partly, the contribution to productivity growth of the growth in the intensity of innovation activity propelled by the Schumpeterian function of the entrepreneur.

The estimated coefficient of the share of the entrepreneurs' variable in the unconditioned growth model with a full sample of data is 5.33% (the first column of

Table 5); this rises to 12.41% in a fully conditioned growth model. For the entire sample of countries and years, average annual labor productivity growth is 1.99% and the mean value of the share of entrepreneurs *Se* is equal to 0.1801. From the unconditioned estimate of the average growth of the quality of entrepreneurs' services (column one of Table 5) the contribution of the improvements in the quality of entrepreneurs' services to productivity growth will be 0.0533x0.1801= 0.0096. This amounts to 48.24% (0.96/1.99%) of the average rate of productivity growth in the period. With the estimated average growth in the relative quality of entrepreneurs' services from the full model (column three of Table 5), the absolute contribution of improvements in the relative quality of entrepreneurial services to productivity growth is 2.77% (0.1539x0.1801). This contribution is significantly higher than that coming from deepening in innovation capital: The estimated coefficient of the variable growth rate in R&D expenditures per occupied person is 11.52% (column two of Table 6), while the average value of the growth rate over the whole period is 3.92% (Table 4); therefore the average contribution to productivity growth by growth in R&D expenditures is around 0.45% (0.1152x0.0392), less than a quarter of the contribution from more productive management services.

This study models the number of entrepreneurs of an economy as an equilibrium solution determined by technical conditions, such as the parameters of the production and managerial technology, the human capital (quality) of entrepreneurs relative to that of workers and by economic conditions (quality adjusted compensation in employment opportunities under the assumption of free entry conditions for becoming an entrepreneur). Carree et al (2002) discuss factors such as the expansion of the service sector that can explain differences in the share of entrepreneurs in countries and the changes in this share over time[9]. They do not however, mention possible differences in management technology. Moreover, their interpretation of the U shaped relationship between the share of entrepreneurs and the per capita income of a country is quite different from the explanation derived from our model. Our model explains the empirical regularity of a negative association between income per capita and the share of entrepreneurs by the fact that the two observable variables vary with the quality of entrepreneurial services in an opposite way; increasing, in the case of per capita income, and decreasing in the case of the share of entrepreneurs. Therefore, no casual relationship can be attributed to such an association.

The necessarily stylized model of the representative firm used to formalize the contribution of entrepreneurs to production and growth forces many simplifying assumptions. Some of the extensions of future research should go in the directions of generalizing the basic model and drawing implications for research in strategic entrepreneurship. A straightforward example of this is to allow for differences in ability of entrepreneurs within a country, a situation already contemplated by Rosen (1982). The heterogeneity of abilities will imply heterogeneity of firms in terms of size and profits. The Resource Based View of the firm acknowledges the importance of explaining the sources of heterogeneity in the resource endowments of firms which explain sustainable differences in profits across them. Research in the effect of family ownership and performance of firms finds that family firms outperform non family

[9] We have estimated a cross section model where the labor productivity of the countries in the sample has been regressed as a function of the share of entrepreneurs and its square (allowing for time and country effects), as suggested by Figure 1. The coefficients of the two explanatory variables are statistically significant and negative for S_e and positive for S_e^2. Therefore the predicted U-shape association between productivity and the share of entrepreneurs is also confirmed by our data. Our data also matches the result of Carree et al (2002) who observed that the share of entrepreneurs is a convex function of the labor productivity of countries.

ones, especially when the founder is actively involved in the governance of the firm (Anderson and Reeb, 2003; Villalonga and Amit, 2006). Other research finds that the succession of the founding entrepreneur by a family member in top management and governance position lowers the posterior performance of firms compared with the previous one, and the decline in performance is higher in those firms than in firms where the successor is a manager external to the family (Perez-Gonzalez, 2006). There is therefore evidence that the entrepreneurs' talent can be a source of sustainable competitive advantage, but much is still unknown as to how relative differences in ability affect relative differences in size and performance since the model presented in this paper predicts that relative differences in ability imply more than proportional differences in size and profits across firms.

Another interesting line of future research would be to provide an explanation of the cross firm differences and dynamics of management technology (parameter β of the model). The model summarizes this technology in the elasticity of output to time of entrepreneurs in directing the internal resources and the theoretical results indicate that this elasticity is relevant to explain the size of the representative firm. When in equilibrium, the higher the elasticity, the lower is the size of the representative firm (lower span of control of the representative entrepreneur). Very little is known about the factors that explain differences in management technology and in the intensity of entrepreneurs' time dedicated to directing the internal working of the firm. The starting point for a discussion on this issue would be the literature on efficient organizational design (coordination, supervision, incentives) and the observed flattening of organizational structures as a consequence of advances in information technologies. However, these advances affect both the efficient coordination of the market and the efficient coordination of the entrepreneur so, from the Coasian theory of the entrepreneur, an understanding of the net effect would require the investigation of the particular conditions of firms and industries.

Future research should also extend the results to situations where liquidity constraints can limit access to becoming an entrepreneur –where the entrepreneur is also the capitalist–. In this situation, entrepreneurs manage both direct labor and capital and the model of optimal allocation of entrepreneurial time would have to determine the allocation of this time in the two inputs. Unfortunately, data on the number and share of entrepreneurs in different countries is highly incomplete and compiled according to differing criteria in different countries. Moreover, we only have data on R&D and capital inputs for a limited time period and for a limited set of countries, so labor productivity growth has to be modeled without allowing for growth in the capital per employed person of the countries in the sample. Finally, our data does not distinguish between entrepreneurs with or without salaried employees. The fact that the main conclusions from the estimated models (in terms of the importance of improvements in quality of entrepreneurial services to productivity growth) are robust to longer or shorter time estimation periods and to estimations from the reduced sample with capital and R&D data, suggests that the rest of the control variables avoid potential biases in the estimated coefficients although further research with more refined data is clearly required.

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