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Cultural determinants of countries management efficiency: A random coefficients stochastic frontier approach

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Abstract

From a country's perspective, management refers to the organization of inputs, such as national capital or labor. In this paper, we investigate i) the mechanism in which countries management impacts national income, and ii) the cultural sources of different management levels among countries. We found that countries management mainly affects income due to its interaction with physical capital, rather than through its relation with labor or education. Furthermore, management levels are shown to be positively correlated to language and religious homogeneity, the existence of British-style institutions and the degree of individualism. Our methodology is twofold. First, using data of 62 countries from 1980 to 2004, we estimated a management input without the use of proxies. For this purpose, we employed a stochastic production frontier with random coefficients. Second, we regressed by OLS the estimated management input on cultural variables, for a sub-sample of 33 countries with available cultural data.

Key words: Random coefficients stochastic production frontier, countries management, language and religious diversity, British-style institutions, individualism, JEL CODE O43 - Institutions and Growth

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1. Introduction

Management refers to the planning, organization and monitoring of other inputs of production, such as physical capital, labor or human capital. The importance of controlling for management in the estimation of production or cost functions of firms, is well known. Since management is unobservable, earlier approaches to control for it include the use of proxy variables [Mefford, 1986; Dawson et al., 1985], covariance analysis or within transformations. However, since imposing strong assumptions may yield biased results, recent work has analyzed firms management by using a method that does not require the use of proxies [Barros et al., 2008; Alvarez et al. , 2004; Alvarez et al., 2003].

Although, at the micro-level, there are a number of studies regarding the role of managerial skills on cost performance, output and efficiency of firms, at the macro level there is a lack of research on the role of countries management on national outcome and productivity. Consequently, the first objective of this paper is to study the mechanisms through which management affects countries output and technical efficiency. We analyze, in particular, the interaction between management and other production inputs such as physical capital, labor and human capital.

For this first purpose, we employed a random coefficients stochastic production frontier model[Tsionas, 2002; Greene, 2005]. The stochastic production frontier includes a management input, without the need for proxy variables [Alvarez et al. , 2004]. The assumptions placed on management are that (i) it is a normally distributed random variable, (ii) it interacts with the rest of the production inputs (K,L,E) and (iii) it also appears in the model with a squared term. We estimated this model using data of 62 countries from 1980 to 2004, and we found that country-level management affects income mainly due to the interaction with physical capital, rather than through the relation with labor or education. Our results suggest that countries can boost their productivity if they dedicate special effort to improve the management of physical capital.

The second aim of this paper is to investigate the underlying cultural factors that determine different levels of management among countries. Although previous research has focused on the direct relationship between income differences and cultural or institutional variables such as ethnolinguistic fractionalization [Alesina et al. , 2005], governance[Huynh et al., 2009], market creating, stabilizing, regulating and legitimising institutions [Bhattacharyya , 2009] , British institutions, trade and geography, [Rodrik et al., 2004], private property (British) and extractive (Spanish) institutions [Acemoglu et al. , 2002, 2001], antidiversion policies [Hall et al., 1999]; or on the relationship between general values and economic systems [Pryor , 2008], or between individualism and British institutions, and governance [Licht et al. , 2007], to the best of our knowledge, this is the first study that attempts to unveil the relationship between cultural factors and country-level management differences. The overall motivation of this paper is that disentangling the relation between management and other inputs, as well as understanding the cultural determinants that affect national management can help countries issuing policies to increase their management level and therefore their productivity.

Concerning the second goal, our paper found that management efficiency is positively correlated to countries cultural variables such as language and religious homogeneity, as well as the existence of British-style institutions and the degree of individualism in the society. An OLS regression shows that the above cultural variables explain around 50% of the difference in management levels accross countries. Our results imply that the more linguistic and religious diversity, the larger the transaction costs to manage firms, create institutions or form social networks that contribute to a country's general output. In contrast, British-style institutions encourage a more productive use of physical capital mainly because it guarantees private property; and individualism implies a higher working motivation that leads to more efficient management of human capital. After controlling for cultural variables, geography had no significant impact on management. These results are similar to those of previous research studying the effect of geography on income after controlling for macroeconomic or institutional variables [Rodrik et al., 2004; Acemoglu et al. , 2001].

This paper is organized as follows. Section 2 summarizes the relevant literature on management and on the relationship between culture, institutions and income. Section 3 explains the random-coefficients stochastic production frontier with a fixed management parameter. Section 4 presents the employed database and the estimated empirical models. Section 5 analyzes the estimation results concerning management, technical inefficiency and its relationship with cultural variables. Finally, Section 6 gives the conclusions and final remarks.

2. Relevant Literature and Contributions

2.1. Fixed Management

Incorrect specification of a production function, such as a model excluding management levels, leads to *omitted-management-variable bias*. This bias occurs because management is, not only, a determinant of output, but also, is likely to be correlated to other inputs of production. However, a major issue is that management is unobserved and the use of assumptions or proxies brings inaccuracy and measurement error. Because of this additional error, there is a need to control for management in a different way. A novel econometric approach has been employed by recent studies to measure the impact of management on firms output or cost functions without using proxy variables. In this paper, we followed this method, known as random coefficients stochastic frontier approach [Tsionas, 2002; Greene, 2005] with a fixed management parameter [Alvarez et al. , 2004].

Using this methodology, the firm-related literature has reached the following conclusions about management. Barros et al. [2008] analyzed the impact of management on the cost function of 117 airports from 2001 to 2004 and showed that management contributes to cost control, as do regulatory procedures, such as the rate of return or incentive regulation. Alvarez et al. [2004] examined the effect of management on the production function of 247 farms in Spain from 1993 to 1998 and found that (i) management has a positive but decreasing effect on production, and (ii) not accounting for management leads to overestimation of firms technical inefficiency. Lastly, using data of 84 farms in Spain from 1987 to 1991, Alvarez et al. [2003] pointed out that an increase in farm size while holding managerial ability constant can be an important source of diseconomies of size, and can lead to a decrease in firms profits. Thus, these previous studies emphasize the importance of controlling for management and show empirical evidence of the impact of management on the productive activities of firms.

2.2. Culture and economic output

This paper postulates that culture impacts a country's income because it influences the management of physical capital, labor and human capital. Although previous literature shows that the prevalence of institutions and cultural values influences economic development [Licht et al. , 2007]; that sets of national values match the specific economic systems (institutions) of OECD countries [Pryor , 2008]; and that cultural factors affect economic performance through their impact on organization of firms, the attitudes towards consumption and work, and the creation of institutions and social networks [Fukuyama , 2001]; there are no studies that analyze empirically the specific role of culture on national management levels.

In particular, we make three hypotheses related to the cultural variables under study. First, we infer that religious and linguistic diversity affect economic growth by means of the national management input, because the more linguistic and religious heterogeneity, the larger the transaction costs. Related literature has found that increasing ethnolinguistic heterogeneity, as well as ethnic fractionalization, reduces the growth rate of countries [Alesina et al. , 2005], but it does not analyze the impact on national management.

Second, we hypothesize that British-style institutions impact countries management because they guarantee private property and this encourages a more productive use of physical capital. Related studies indicate that, in general, there is a positive effect of British rule on governance, economic performance and efficiency [Licht et al. , 2007], and specifically, on financial development [Dehejia et al., 2005] and favourable investment environment [Acemoglu et al. , 2002; Dehejia et al., 2005] which is vital to increase productivity, output growth and capital stock at the firm level [1] [Dollar et al. , 2005]. Nevertheless, there is no previous study on the relationship between British-style institutions and management.

Third, we expect individualism to affect countries management level, because it is likely to contribute to higher working motivation and to lead to more efficient administration of human capital [2]. This idea complements the study by Licht et al. [2007] which argues that autonomous individuals are important to achieve higher economic performance, because autonomy leads to democratic accountability and, in turn, democracy and rule of law exert a positive influence on economic development.

3. Stochastic production frontier approach

In order to estimate the national management input and per country technical efficiency, we employed a random coefficients stochastic production frontier model which includes a random management parameter. After the unobservable fixed management input was estimated, it was regressed by OLS on cultural variables such as language and religious diversity, British-style institutions and individualism.

The broad *stochastic frontier approach* (SFA) is a method for estimating frontier functions, in our case of production, and measuring productive or Technical Efficiency (TE). *Technical Efficiency* (TE) is the degree of success countries achieve in allocating resources, by obtaining maximum outputs from given inputs [Kumbhakar et al., 2000]. TE is defined in terms of distance to the production frontier. To measure TE using the SFA, we add to the production function a random error v_i and an additional non-negative random variable u_i that accounts for technical inefficiency.

A common assumption, in the SFA framework, has been that the inefficiency term u_i includes, among other things, differences in the level of management across countries. However, Alvarez et al. [2004] introduced an additional fixed input, m_i, to the model to capture *managerial ability*. This management input is assumed to be a random effect, distributed standard normal, and is part of the stochastic element of the production function. The unobservable maximum level of management m_i^* can be inserted as a random effect in a panel data model with a trans logarithmic function and multiple inputs in the following way:

$$\ln y_{it} = \alpha + \beta_m m_i^* + 0.5\beta_{mm} m_i^{*2} + \Sigma_{k=1}^K (\beta_k + \beta_{km} m_i^*) \ln x_{itk} + 0.5\Sigma_{k=1}^K \Sigma_{l=1}^K \beta_{kl} \ln x_{itk} \ln x_{itl} + v_{it} - u_{it} \tag{1}$$

where $\ln y_{it}$ is the natural log of the observed output for the ith country at the tth time period; α is a constant; m_i^* is the maximum level of management which appears (i) independently, (ii) multiplied by each of the other production inputs k and (iii) in a quadratic form, where a negative sign indicates that management has a positive but decreasing effect on production; $\ln x_{itk}$ is a $(1xK)$ vector of the natural log of the production inputs k of the ith country at the tth time period; β is a $(Kx1)$ vector of unknown scalar parameters to be estimated; and v_{it}, or random error, is distributed *i.i.d* $(0, \sigma_v^2)$. It encompasses measurement error and other random factors that affect the output $\ln y_{it}$ and accounts for the combined effects of unspecified input variables in the production function.

u_{it} is a non-negative variable, associated with technical inefficiency in the production process. It is the amount by which the sample countries fail to reach the frontier. For the ith country, the time-variant technical inefficiency effects, u_{it}, are independently $N^+(\mu, \sigma_u^2)$ distributed with truncation point at 0. In addition, u_{it} corresponds to the standard technical inefficiency definition in the SFA framework, so that $TE = \exp u_{it}$. We assume absence of correlation between u_{it} and the input levels (random-effects assumption).[3] Additional characteristics of the model are that (i) (β_{mm}) and first order terms (β_m) and $[\Sigma_{j=1}^K (\beta_k)]$ are random normally distributed; and (ii) the random component of each random parameter is the same, m_i^*. This means that each country has its own production function with parameters β_k that imply heterogeneity of countries in their technology and parameters(β_m), (β_{mm}) that reflect management variation among countries. This specification makes it feasible to separate technical inefficiency from technological differences and managerial heterogeneity across countries.

The marginal impact of management in this model is:

$$\frac{\partial \ln y_{it}}{\partial m_i^*} = \beta_m + \beta_{mm} m_i^* + \beta_{km} \ln x_{itk} > 0 \tag{2}$$

and the link between TE and management is:

$$\ln TE_{it} = \ln y_{it} - \ln y_{it}{}^{*} = (\beta_m + \beta_{km} \ln x_{itk})\,(m_i - m_i^*) + 0.5\beta_{mm}[(m_i)^2 - (m_i^*)^2] \qquad (3)$$

where $\ln y_{it}{}^{*}$ is maximum output for given x_{itk} achieved with the maximum level of managerial input m_i^*. As shown by the above equation, the Technical Efficiency (TE) is composed by (i) an individual time-invariant effect: $(\beta_m)\left(m_i - m_i^*\right) + 0.5\beta_{mm}[(m_i)^2 - \left(m_i^*\right)^2]$ and (ii) a time-varying component: $(\beta_{km} \ln x_{itk})\left(m_i - m_i^*\right)$. This specification implies that the change in managerial input necessary to increase TE, by a given amount, differs according to input use. Therefore, the effect of changes in management and input use on TE can be written as:

$$\frac{\partial \ln TE_{it}}{\partial m_i} = \beta_m + \beta_{km} \ln x_{itk} + \beta_{mm} m_i \qquad (4)$$

$$\frac{\partial \ln TE_{it}}{\partial \ln x_{itk}} = \beta_{km}\,(m_i - m_i^*) \qquad (5)$$

Since $\partial \ln TE_{it}/\partial m_i = \partial \ln y_{it}/\partial m_i$, an increase in management increases TE given the other inputs, if the production function is monotonic in managerial ability. Consequently, the model shows that (i) TE is not a fixed effect and can vary over time and (ii) the relationship between TE and management depends on the amount of the management input and the rest of the inputs.

The joint density for T observations on country i, or the contribution to the conditional likelihood for country i, $L_i|m{*}_i$, is defined as:

$$f(\epsilon_{i1}, ..., \epsilon_{iT}|m{*}_i) = \Pi_{t=1}^{T} f(\epsilon_{it}|m{*}_i) \qquad (6)$$

and the unconditional contribution to the likelihood function can be written as:

$$L_i = \int_{m_i^*} \Pi_{t=1}^{T} f\,(\epsilon_{it}|m_i^*)\, g\,(m_i^*)\, dm_i^* \qquad (7)$$

where $g\left(m_i^*\right)$ is the marginal density of m_i^*. The log likelihood is:

$$\log L\,(\delta) = \Sigma_{i=1}^{N} \log L_i\,(\delta) \qquad (8)$$

where δ denotes the full vector of parameters in the model

The maximum likelihood estimates of the parameters are obtained by maximizing equation 8 with respect to δ. Since the integral in equation 7 does not have a closed form, it is not possible to maximize equation 8 directly. Therefore, the maximum likelihood is simulated. In order to achieve a good approximation to the true likelihood function, a large number of random draws are required. The process can be accelerated by using intelligent draws, such as Halton sequences. In this paper we have used 300 Halton draws.

In order to estimate the efficiency of individual countries the best predictor for u_{it} is the conditional expectation of u_{it}, given the value of the compound error: $\epsilon_{it} = v_{it} - u_{it}$. The conditional expectation is used since u_{it} is unobservable. Even if the true value of the parameter vector β in the stochastic frontier model was known, only the difference, $\epsilon_{it} = v_{it} - u_{it}$, could be observed. For the particular distributional assumptions imposed on the technical inefficiency effects, the expected value of TE_{it} can be calculated by using the equation by Jondrow et al. (1982):

$$E\left[u_{it}|\epsilon_{it}, m_i^*\right] = \frac{\sigma\lambda}{(1+\lambda^2)}\left[\frac{\varphi\left(-\frac{(\epsilon_{it}|m_i^*)\lambda}{\sigma}\right)}{\phi\left(-\frac{(\epsilon_{it}|m_i^*)\lambda}{\sigma}\right)} - \frac{\left(\epsilon_{it}|m_i^*\right)\lambda}{\sigma}\right] \tag{9}$$

where $\varphi(\cdot)$ and $\phi(\cdot)$ denote the density and cumulative density function of the standard normal variable, respectively; and

$$\lambda = \frac{\sigma_u}{\sigma_v}; \sigma = \left(\sigma_u^2 + \sigma_v^2\right) \tag{10}$$

4. Models Specification and Panel Data

The main model in this paper is a random coefficients stochastic production frontier with a management parameter. For comparison we also show the results, using the same data, of a non random coefficients stochastic production frontier without the management input. The two models assume random-effects, or absence of correlation between u_{it} and the input levels, and estimate a trans logarithmic production function. The trans logarithmic is a flexible functional form, because it does not impose any assumptions about elasticities of production nor elasticities of substitution between production inputs. In addition to the inclusion of the management input, the random coefficient model relaxes the restrictive assumption imposed by the non random coefficients model that all countries share the same technological possibilities [Tsionas, 2002].

The estimated random coefficients model with four production inputs, physical capital stock K, labor force L, education E and management M, is of the form:

$$\begin{aligned}\ln y_{it} =&\alpha + \beta_K \ln K_{it} + \beta_L \ln L_{it} + \beta_E \ln E_{it} + \beta_{KL} \ln K_{it} \ln L_{it} + \\ &\beta_{KE} \ln K_{it} \ln E_{it} + \beta_{LE} \ln L_{it} \ln E_{it} + 0.5\beta_{KK} \ln K_{it}^2 + \\ &0.5\beta_{LL} \ln L_{it}^2 + 0.5\beta_{EE} \ln E_{it}^2 + \beta_{KM} \ln K_{it} m_i^* + \\ &\beta_{LM} \ln L_{it} m_i^* + \beta_{EM} \ln E_{it} m_i^* + \beta_M m_i^* + 0.5\beta_M m_i^{2*} + v_{it} - u_{it}\end{aligned} \tag{11}$$

The estimated non random coefficients model, with the three conventional inputs (K, L, E) and without management M, is of the form:

$$\begin{aligned}\ln y_{it} =&\beta_i + \beta_K \ln K_{it} + \beta_L \ln L_{it} + \beta_E \ln E_{it} + \beta_{KL} \ln K_{it} \ln L_{it} + \\ &\beta_{KE} \ln K_{it} \ln E_{it} + \beta_{LE} \ln L_{it} \ln E_{it} + 0.5\beta_{KK} \ln K_{it}^2 + \\ &0.5\beta_{LL} \ln L_{it}^2 + 0.5\beta_{EE} \ln E_{it}^2 + v_{it} - u_i\end{aligned} \tag{12}$$

In order to estimate the above models, we used a panel data set of 62 countries, from 1980 to 2004, with available data on output and inputs of production. The list of our sample countries is given in Table 1. The countries marked with (*) are a subsample of 33 countries with available data on the cultural variables used for the OLS regression of management.

INSERT TABLE 1 HERE

The output used, in the production frontier, is the real gross domestic product in constant 2000 US Dollars and was taken from the World Development Indicators [WDI , 2007]. The input data was obtained as follows. The physical capital stock in 2000 US Dollars, from 1980 to 2000, was calculated based on the physical capital to output ratio obtained from Klenow et al. [1997, p.78]; and, from 2001 to 2004, it was calculated based on the methodology described in Klenow et al. [1997, p.78] and using the annual gross capital formation data in 2000 US Dollars [WDI , 2007]. The total labor force, or economically active population, was extracted from the WDI [2007]. Finally, the human capital, defined as years of educational attainment for population aged between 15 and 64 was taken from the Barro et al. [2001] database. The data employed in the stochastic production function, both inputs and output, were normalized around the sample mean before applying the logarithmic transformation, in order to define the point of approximation to the trans logarithmic function[Chung , 1994].

After having estimated the random coefficients stochastic frontier and obtained the management input per country, the following OLS regression of management on cultural variables was performed for the sub-sample of 33 countries, with available cultural data, and marked with (*) in Table 1:

$$\hat{M}anagement = \beta_0 + \beta_{Language.Diversity} + \beta_{British.Style.Instit.} + \beta_{Religious.Diversity} + \beta_{Individualism} + \epsilon \quad (13)$$

The definitions and sources of the cultural variables used in the OLS regression are as follows. The muller index is defined as the probability from 0 to 1 that two randomly selected individuals in a country speak different languages [Muller, 1964]. British-style institutions is a dummy variable that takes the value of 1 if the country is Great Britain or was a British colony, and therefore has British-style institutions, and 0 otherwise (Rodrik et al. [2004] argues that colonial past is a valid instrument for current institutions). Religious fractionalization, ranging from 0 to 1, was calculated as $1 - \Sigma s_{ij}^2$ where s is the share of religious group i in country j. The data was taken from Alesina et al. [2005]. Individualism (100) versus collectivism (0) measures the degree to which individuals are integrated into, or define themselves apart from, groups such as extended families that provide protection in exchange for loyalty. It was taken from the Geert Hofstede Cultural Dimensions [Hofstede , 2009].

INSERT TABLE 2 HERE

An additional regression was estimated to test whether geographic conditions have a significant impact on countries management input level. The regression is:

$$\hat{M}anagement = \beta_0 + \beta_{Tropical.Dummy} + \beta_{Language.Diversity} + \beta_{British.Style.Instit.} + \beta_{Religious.Diversity} + \beta_{Emphasis.Technology} + \epsilon \quad (14)$$

The tropical dummy takes the value of 1 if the country has more than 50% of its land mass between the tropics of cancer and capricorn and 0 otherwise. The source is the 1986 list of the International Union of Conservation of Nature. Emphasis on technology, extracted from the 1981-2008 aggregate of the World Values Survey [2009], indicates the importance placed by a country's population on future technology development. All the models, including the random and non random coefficients stochastic frontier and the OLS regressions, were estimated using Limdep 9.0.

5. Estimation Results and Discussion

Except for their composed error term, the random and non random coefficients stochastic production frontier models are linear regression models. Therefore, the marginal effects in the production function are the β parameters. In both models, the estimated constant β_0 and the first-order coefficients -the parameters of physical capital β_K, labor force β_L and educational attainment β_E- have the expected positive signs and are statistically significant at the 1% level. All the second-order parameters are also statistically significant.

INSERT TABLE 3 HERE

Concerning the random coefficients model, the three interaction coefficients between the traditional inputs and the unobservable fixed management β_{MxK}, β_{MxL} and β_{MxE} are positive. This means that an increase in fixed management raises the contribution to output of the other three factors of production K, L and E. According to our results, an increase in management raises the contribution of physical capital (0.19) the most, followed by labor (0.08) and human capital (0.01). As the fixed management input augments, it exhibits a decreasing marginal contribution to output as shown by the negative coefficient of α_{mm} (-0.09).

In the non random coefficients model, the estimated parameter of the capital factor is underestimated (0.64) when compared to the random coefficients model result (0.72). In contrary, the estimated parameters of the remaining factors are overestimated by the non random coefficients model, labor (0.45) and human capital (0.23), in comparison with the results of the random coefficients model (0.29 and 0.11 respectively). The difference in the results of both models can be explained as follows. When the unobservable fourth production input or fixed management is not estimated and countries are assumed to have the same technology, the effect of management and technology is allocated to the labor and human capital factors. However, when estimated separately, the heterogeneity in management and technology lowers the contribution of labor and human capital and increases the one for capital.

INSERT TABLE 4 HERE

Table 4 shows a summary of basic statistics of TE per country estimated by the random and non random coefficients production frontiers, as well as the fixed management estimated by the random coefficients model. According to Table 4, the random coefficients model efficiency ranking ranges from 0.93 to 0.80, while the ranking of the non random coefficients model lies within a much wider range, between 0.98 and 0.18. These results suggest that when the management input is not taken into account and the assumption of homogeneous technology among countries is imposed, the estimated country inefficiency is overestimated. Therefore, we can interpret the inefficiency component in a stochastic frontier model as being composed by management and technology effects, as well as other unexplained factors.

INSERT TABLE 5 HERE

Finally, the 1980-2004 average marginal impact of fixed management on output per country $\partial \ln y_{it}/\partial m_i^*$ (See equation 2) is shown on Table 5. As expected from the model specification, countries with larger amounts of inputs of production, such as developed countries, obtain a higher marginal output from management.

Once the management input per country was estimated, we used an OLS regression on the cultural variables expected to impact national economic output through the organization of inputs of production. The results of the main OLS model are shown in Table 6. The coefficients of the cultural variables in the regression are statistically significant, have the expected signs and in total explain about 50% of the management input (the adjusted R-squared is 0.46).

INSERT TABLE 6 HERE

The negative coefficients of the Muller Index (-0.72) and Religion Franctionalization (-1.61) indicate that the more languages or religions that coexist in a single country, the less management a given country will have as a production input. The reason is that the more linguistic and religious diversity it exits, the larger the transaction costs to manage firms and institutions that contribute to a country's output. These results are consistent with the study by Alesina et al. [2005], which found that increased ethnolinguistic fractionalization reduces countries growth.

On the other hand, the estimated positive coefficient of the individualism index (0.009) confirms our hypothesis that individualism encourages a higher working motivation that leads to more management input directed to human capital. This result supports the findings of previous research showing that the place of individuals in the group as autonomous is important for economic development, because higher autonomy implies more democratic accountability [Licht et al. , 2007].

The positive parameter of the British-style institutions dummy variable (0.71) also supports our inference that British rule encourages a more productive use of physical capital and a higher management input because it guarantees private property. This results complements the findings of previous studies on the relation between British institutions and governance [Licht et al. , 2007], as well as British institutions and investment incentives and economic performance[4] [Acemoglu et al. , 2002, 2001].

After controlling for language and religious diversity, British-style institutions and the emphasis on technology of the society, geography (defined as a Tropical dummy variable) has no significant impact on management. The results of this additional model, shown in Table 7, are similar to those of previous research that state that there is no significant effect of geography on income after controlling for institutional variables [Rodrik et al., 2004; Acemoglu et al. , 2002].

INSERT TABLE 7 HERE

6. Conclusions

Since countries management is likely to be correlated with both output and other inputs, not accounting for it in the production function yields biased results. However, management cannot be included directly into the production function because it is unobservable, and the use of proxies causes measurement error. Moreover, although there are a number of studies on the role of management on cost performance, output and efficiency of firms, there is no previous research on management at the country level. For these reasons, this paper analyzed the impact of national management on countries output, as well as on physical capital, labor and human capital. By means of a novel econometric method, that does not require the use of proxies, we estimated a random coefficients stochastic production frontier with a fixed management input for 62 countries for the period 1980-2004.

Our results offer empirical evidence on the bias caused by the lack of control of country-level management and the restriction on technology heterogeneity of countries in the production function. For our sample data, the bias consisted on underestimation of the physical capital coefficient and overestimation of the labor and human capital parameters, as well as overvaluation of countries technical inefficiency. Additionally, we showed that country-level management affects national income mainly due to its interaction with physical capital, rather than through its relation with labor or education. Therefore, countries should particularly direct their policy efforts to improving the management of physical capital in order to increase their output.

The second goal of this paper was to shed light on the cultural determinants of varying management levels among countries. OLS analysis showed that management efficiency is positively correlated to cultural variables such as language and religious homogeneity, the existence of British-style institutions and the degree of individualism. Our results suggest that linguistic and religious diversity increase the transaction costs to manage firms, create institutions and form social networks that contribute to national output. In addition, individualism encourages higher working motivation, which leads to a more efficient management of human capital; and British-style institutions affect positively the management decisions in a given country, since it guarantees private property. Therefore, in order to improve their management efficiency, countries should issue policies to reduce the transaction costs derived from ethnolinguistic heterogeneity, promote the working motivation of its labor force by encouraging individual behaviour and guarantee private property to increase national investment projects.

Lastly, a number of issues are left for future research. In this paper, management was treated as an exogenous variable. However, a further analysis should attempt to handle management as an endogenous input in the production function. In addition, future research on this topic should study the impact on national management of historical facts such as countries independence, democratization, transition to market economy or membership of economic or political zones such as the European Union, among others. Finally, it would be interesting to test whether factors of production, such as physical capital and labor, move from countries with lower management levels, and therefore lower productivity, to countries with higher management levels.

Notes

[1]For instance, the lack of guarantee of private property in Colombia is shown to be one of the causes of low farms efficiency [Gonzalez et al., 2007].

[2]Lack of autonomy, or embededness, has been found to be negatively correlated to the Western European economic system [Pryor , 2008]

[3] The explicit definition of is u_{it} is:

$$u_{it} = \ln y^*_{it} - \ln y_{it} u_{it} = \beta_m + \Sigma_{k=1}^{K} \left(\beta_{km} \ln x_{itk}\right) \left(m^*_i - m_i\right) + 0.5\beta_{mm} \left[\left(m^*_i\right)^2 - (m_i)^2\right] \quad (15)$$

while $\ln x_{itk}$ does appear in u_{it} we assume that they do not influence $\left(m^*_i - m_i\right)$. Thus, u_{it} is of the form $a_i + k(m_i - m*_i)g(x_{kit}$, and each term $\left(m^*_i - m_i\right) g(x_{itk})$ will, by virtue of the presence of the freely varying $\left(m^*_i - m_i\right)$ be uncorrelated with x_{itk}. [Alvarez et al. , 2004]

[4]On the contrary, extractive institutions, such as those introduced by Spain in its colonies in Latin America, which concentrate power in the hands of a small elite and create a high risk of expropriation for the majority of the population, are likely to discourage investment and economic development [Acemoglu et al. , 2002, 2001].

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Table 1: List of Countries

62 Sample Countries[1]			
Algeria	Egypt (*)	Lesotho	Senegal
Argentina (*)	El Salvador (*)	Malawi	Spain (*)
Australia (*)	Finland (*)	Malaysia	Sweden (*)
Austria (*)	France (*)	Mali	Switzerland (*)
Bangladesh	Ghana	Mauritius	Syria
Belgium (*)	Greece (*)	Mexico (*)	Thailand
Benin	Iceland	Mozambique	Tunisia
Botswana	India (*)	Netherlands (*)	Turkey (*)
Cameroon	Indonesia (*)	New Zealand (*)	Uganda
Canada (*)	Iran (*)	Nicaragua	United Kingdom (*)
Chile (*)	Ireland (*)	Niger	United States (*)
China (*)	Italy (*)	Norway (*)	Venezuela (*)
Hong Kong	Japan (*)	Panama	Zambia
Denmark (*)	Jordan	Peru (*)	Zimbabwe
D. Republic	Kenya	Philippines (*)	
Ecuador	Korea,South	Portugal (*)	

[1] The countries marked with (*) are a subsample of 33 countries with available data on the cultural variables used for the OLS regression of management.

Table 2: Data Sources 1980-2004

Fixed-management random-coefficients stochastic production frontier		
Variable	Definition	Source
Y	Real Gross Domestic Product in 2000 US Dollars	WDI [2007]
K	Physical Capital Stock in 2000 US Dollars	Klenow et al. [1997] and WDI [2007] [2]
L	Total Labor force Economically Active Population	WDI [2007]
E	Human Capital Years of Educational Attainment population 15 and over	Barro et al. [2001]
Cultural variables used in OLS regression on management		
Variable	Definition	Source
Muller Index range 0-1	Probability of two randomly selected individuals speaking different languages	Muller [1964]
Britain and British Colony 0 or 1	Dummy variable for former British colonies and Britain	
Religious Fractionalization range 0-1	$1 - \Sigma s_{ij}^2$ where s is the share of religious group i in country j	Alesina et al. [2003]
Individualism range 0-100	Degree to which individuals are integrated into groups	Hofstede [2009]
Tropical dummy (0 or 1)	A country's tropical territory is more than 50% (list 1986)	IUCN [1998]
Emphasis on Technology	More emphasis in technology in the future is good	World Values Survey [2009]

[2] Physical capital from 1980-2000 was calculated from the physical capital to output ratio k/y obtained from Klenow et al. Physical capital from 2001-2004 was calculated based on the methodology described in Klenow et al. [1997, p.78] and using the WDI [2007] annual Gross Capital Formation in 2000 US Dollars

Table 3: Random-effects stochastic production function 1980-2004 - 62 Countries

Estimated parameters	Random coefficients	Non-random coefficients
	Non-random parameters	
$\beta_{CapitalxLabor}$	0.0188***[3]	-0.0179***
$\beta_{CapitalxEducation}$	-0.0311***	-0.0266***
$\beta_{LaborxEducation}$	-0.0335***	0.0176*
$\beta_{Capital^2}$	0.0308***	0.0460***
β_{Labor^2}	-0.0410***	0.0847***
$\beta_{Education^2}$	0.0903***	0.1127***
	Parameters with random means	Non-random parameters
β_0	0.1869***	0.4438***
$\beta_{Capital}$	0.7202***	0.6443***
β_{Labor}	0.2966***	0.4542***
$\beta_{Education}$	0.1100***	0.2331***
	Unobservable fixed management	
$\beta_{management}$	0.9478***	———-
$\beta_{managementxCapital}$	0.1932***	———-
$\beta_{managementxLabor}$	0.0845***	———-
$\beta_{managementxEducation}$	0.0142***	———-
$\alpha_{management^2}$	-0.0933***	———-
	Variance parameters for compound error	
λ	2.7636***	6.8877***
	Others	
Number of Observations	1550	1550
Log likelihood Function	1166.767	1283.755
AIC	-1.483	-1.6409
BIC	-1.424	-1.5995

[3]*** Indicates that the parameter is statistically significant at 1% level, ** at 5% level and * at 1% level.

Table 4: Summary of estimated technical efficiency and fixed management

Estimated technical efficiency (1980-2004)				
Model	Mean	Standard Deviation	Minimum	Maximum
Non random coefficients	0.649	0.219	0.179	0.980
Random coefficients	0.892	0.027	0.801	0.930
Estimated management (1980-2004)				
Maximum management m_i^*	Mean	Standard Deviation	Minimum	Maximum
Random coefficients	0.180	0.926	-2.340	2.952

Table 5: Marginal impact of fixed management on output per country $\partial \ln y_{it} / \partial m_i^*$ Average 1980-2004

$\partial \ln y_{it} / \partial m_i^*$ Average 1980-2004					
Rank	Country	Average	Rank	Country	Average
1	United States	1.634	32	Malaysia	0.434
2	Japan	1.550	33	Bangladesh	0.394
3	China	1.216	34	Algeria	0.375
4	France	1.178	35	New Zealand	0.337
5	United Kingdom	1.137	36	Ecuador	0.316
6	Italy	1.128	37	Chile	0.310
7	Canada	0.976	38	Zimbabwe	0.270
8	India	0.968	39	Egypt	0.179
9	Spain	0.965	40	Ireland	0.116
10	Mexico	0.934	41	Cameroon	0.096
11	Korea (south)	0.908	42	Niger	-0.015
12	Australia	0.822	43	Syria	-0.026
13	Netherlands	0.798	44	Dominican Republic	-0.068
14	Argentina	0.761	45	El Salvador	-0.078
15	Thailand	0.746	46	Tunisia	-0.105
16	Switzerland	0.730	47	Iceland	-0.149
17	Indonesia	0.711	48	Panama	-0.191
18	Sweden	0.680	49	Jordan	-0.207
19	Belgium	0.661	50	Kenya	-0.243
20	Turkey	0.639	51	Benin	-0.261
21	Austria	0.630	52	Lesotho	-0.376
22	Iran	0.609	53	Nicaragua	-0.416
23	Norway	0.590	54	Senegal	-0.417
24	Philippines	0.582	55	Ghana	-0.420
25	Greece	0.573	56	Botswana	-0.440
26	Denmark	0.558	57	Zambia	-0.468
27	Venezuela	0.534	58	Uganda	-0.488
28	Finland	0.516	59	Mauritius	-0.494
29	Peru	0.496	60	Mozambique	-0.501
30	Portugal	0.476	61	Mali	-0.525
31	Hong Kong	0.452	62	Malawi	-0.604

Table 6: OLS Regression of estimated Management on cultural variables

OLS Regression of Management on cultural variables	
Variable	Coefficient
β_0	0.36
$\beta_{Language.Diversity}$	-0.67**[3]
$\beta_{British.Institutions}$	0.71***
$\beta_{Religious.Diversity}$	-1.70***
$\beta_{Individualism}$	0.008**
Fit	
R-squared	0.53
Adjusted R-squared	0.46
Observations	33
Diagnostic	
Loglikelihood	-12.99
AIC	-1.75

[3]*** Indicates that the parameter is statistically significant at 1% level, ** at 5% level and * at 1% level.

Table 7: OLS Regression of estimated Management on cultural variables

OLS Regression of Management on cultural variables	
Variable	Coefficient
β_0	-0.62
$\beta_{Tropical.+50\%}$	-0.15[4]
$\beta_{Language.Diversity}$	-0.64**
$\beta_{British.Institutions}$	0.55***
$\beta_{Religious.Diversity}$	-0.75**
$\beta_{Emphasis.Technology}$	0.73**
Fit	
R-squared	0.35
Adjusted R-squared	0.25
Observations	40
Diagnostic	
Loglikelihood	-20.36
AIC	-1.51

[4]*** Indicates that the parameter is statistically significant at 1% level, ** at 5% level and * at 1% level.