UNIVERSIDAD CARLOS III DE MADRID working papers

Working Paper 08-19
Economic Series (11)
June 2008

Departamento de Economía
Universidad Carlos III de Madrid
Calle Madrid, 126
28903 Getafe (Spain)
Fax (34) 916249875

Robust Methodology for Investment Climate Assessment on Productivity: Application to Investment Climate Surveys from Central America[1]

Alvaro Escribano* J. Luis Guasch**

Abstract

Developing countries are increasingly concerned about improving country competitiveness and productivity, as they face the increasing pressures of globalization and attempt to improve economic growth and reduce poverty. Among such countries, Investment Climate Assessments (ICA) surveys at the firm level, have become the standard way for the World Bank to identify key obstacles to country competitiveness, in order to prioritize policy reforms for enhancing competitiveness. Given the surveys objectives and the nature and limitations of the data collected, this paper discusses the advantages and disadvantages of using different productivity measures. The main objective is to develop a methodology to estimate, in a consistent manner, the productivity impact of the investment climate variables. The paper applies it to the data collected for ICAs in four countries: Costa Rica, Guatemala, Honduras and Nicaragua. Observations on logarithms (logs) of the variables are pooled across three countries (Guatemala, Honduras and Nicaragua). Endogeneity of the production function inputs and of the investment climate variables is addressed by using a variant of the control function approach, based on individual firm information, and by aggregating investment climate variables by industry and region. It is shown that it is possible to get robust results for 10 different productivity measures. The estimates for the four countries show how relevant the investment climate variables are to explain the average level of productivity. IC variables in several categories (red tape, corruption and crime, infrastructure and, quality and innovation) account for over 30 percent of average productivity. The policy implications are clear: investment climate matters and the relative impact of the various investment climate variables indicate where reform efforts should be directed in each country. It is argued that this methodology can be used as a benchmark to assess productivity effects in other ICA surveys. This is important because ICA surveys are available now for more than 65 developing countries.

JEL Clasification: D24, L60, O54, C01.

Keywords: Total factor productivity, investment climate, competitiveness, firm level determinats of productivity, robust productivity impacts.

---

[1] We are indebted to Jorge Pena, Heisnam Singh and Rodolfo Stucchi for their excellent research assistance. This paper is an extension of Escribano and Guasch(2005). We have benefited from the suggestions and questions from Paulo Correa, Juan Miguel Crivelli, Pablo Fajnzylber, Luke Haggarty, Danny Leipziger, Eduardo Ley, Marialisa Motta, Jose Guillherme Reis, Isabel Sánchez and Stefka Slavova, and from participants at a World Bank seminars, CORE (UCL) seminar and the American Association meetings in Chicago, January 2006.
* Telefónica-UC3M Chair on Economics of Telecommunications. Departamento de Economía, Universidad Carlos III de Madrid, Madrid 126, 28903 Getafe, Spain. Email: alvaroe@eco.uc3m.es. http://www.eco.uc3m.es/
** World Bank and University of California, San Diego.

CONTENTS

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

As developing countries face the pressures and impacts of globalization, they are seeking ways to stimulate growth and employment within this context of increased openness. With most of these countries having secured a reasonable level of macroeconomic stability, they are now focusing on issues of competitiveness and productivity through microeconomic reform programs. From South East Asia to Latin America, countries are reformulating their strategies and making increased competitiveness a key priority of government programs.

A significant component of country competitiveness is having a good investment climate or business environment. The investment climate, as defined in the World Development Report (2005), is “the set of location-specific factors shaping the opportunities and incentives for firms to invest productively, create jobs and expand.” It is now well accepted and documented, conceptually and empirically, that the scope and nature of regulations on economic activity and factor markets - the so-called investment climate and business environment - can significantly and adversely impact productivity, growth and economic activity (see Bosworth and Collins, 2003; Dollar et al., 2004; Rodrik and Subramanian, 2004; Loayza, Oviedo and Serven, 2004; McMillan, 1998 and 2004; OECD, 2001; Wilkinson, 2001; Alexander et al., 2004; Djankov et al., 2002; Haltiwanger, 2002; He et al., 2003; World Bank, 2003; and World Bank, 2004 a,b). Prescott (1998) and Parente and Prescott (2002) argue that to understand large international income differences, it is necessary to explain differences in productivity (TFP). His main candidate to explain those gaps is the resistance to the adoption of new technologies and to the efficient use of current operating technologies, which in turn are conditioned by the institutional and policy arrangements a society employs (investment climate variables). Recently, Cole et al. (2004) also have argued that Latin America has not replicated Western economic success due to the productivity (TFP) gap. They point to competitive barriers (investment climate variables in our analysis) as the promising channels for understanding the low productivity observed in Latin American countries.

Figures 1a to 1c plot the evolution of the GDP-per capita, of labor productivity and labor force participation in Costa Rica, Guatemala, Honduras and Nicaragua, relative to the values of the US. Since the relative labor force participation of each country is stable since 1975, the decline in GDP per capita is mainly due to the observed decline in labor productivity, indicating that the gap in both series, relative to the US, is increasing through time (divergence). Therefore, it is clear that these countries have a serious productivity problem. In this paper we want to study the elements related to the investment climate of those three Caribbean countries in order to identify the bottlenecks for productivity growth in the areas of; infrastructure, red tape and corruption and crime, finance and corporate governance and, quality, innovation and labor skills.

Government policies and behavior exert a strong influence on the investment climate through their impact on costs, risks and barriers to competition. Key factors affecting the investment climate through their impact on costs are: corruption, taxes, the regulatory burden and extent of red tape in general, input markets regulation (labor and capital), the quality of infrastructure, technological and innovation support, and the availability and cost of finance.

For example, Kasper (2002) shows that poorly understood “state paternalism” has usually created unjustified barriers to entrepreneurial activity, resulting in poor growth and a stifling environment. Kerr (2002), shows that a quagmire of regulation which is all too common, is a massive deterrent to investment and economic growth. As a case in point, McMillan (1988) argues that obtrusive government regulation before 1984 was the key issue in New Zealand’s slide in the world per-capita income rankings. Hernando de Soto (2002) describes one key adverse effect of significant business regulation and weak property rights: with costly firm regulations, fewer firms choose to register and more become informal. Also, if there are high transaction costs involved in registering property, assets are less likely to be officially recorded, and therefore cannot be used as collateral to obtain loans, thereby becoming “dead” capital.

Likewise, poor infrastructure and limited transport and trade services increase logistics costs, rendering otherwise competitive products uncompetitive, as well as limiting rural production and people’s access to markets, which adversely affects poverty and economic activity (Guasch, 2004).

The pursuit of greater competitiveness and a better investment climate is leading countries -often assisted by multilaterals such as the World Bank - to undertake their own studies to identify the principal bottlenecks in terms of competitiveness and the investment climate, and to evaluate the impact these have, to set priorities for intervention and reform. The most common instrument used has been firm-level surveys, known as Investment Climate surveys (ICs), from which both subjective evaluations of obstacles and objective hard-data numbers with direct links to costs and productivity are elicited and imputed. Such surveys collect data at firm level on the following themes: infrastructure, bureaucracy and corruption, technology and quality, human capital, corporate governance, crime and security, and financial services.

While the ICs are quite useful in identifying major issues and bottlenecks as perceived by firms, the data collected is also meant to provide a quantitative assessment of the impact or contribution of the investment climate (IC) variables on productivity. In turn, that quantified impact is used in the advocacy for, and design of, investment-climate reform. Yet providing reliable and robust estimates of productivity estimates of the IC variables from the surveys is not a straightforward task. First, ICs do not provide balance panel-type data on all the variables. Second, the production function is not observed; and third, there is an identification issue separating Total Factor Productivity (TFP) from the production function inputs. When any of the production function inputs is influenced by common causes affecting productivity, like IC variables or other plant characteristics, there is a simultaneous equation problem. In general, one should expect the productivity to be correlated with the production function inputs and, therefore, inputs should be treated as endogenous regressors when estimating production functions. This demands special care in the econometric specification for estimating those productivity effects and in the choice of the most appropriate way of measuring productivity.

There is an extensive literature discussing the advantages and disadvantages of using different statistical estimation techniques and/or growth accounting (index number) techniques to estimate productivity or Total Factor Productivity in levels (TFP) or in rates of growth (TFPG). For overviews of different productivity concepts and aggregation alternatives see, for example, Solow (1957), Jorgenson, Gollop and Fraumeni (1987), Hall (1990), Olley and Pakes (1996), Foster, Haltiwanger and Krizan (1998), Batelsman and Doms (2000), Hulten (2001), Diewert and Nakamura (2002), Jorgenson (2003), Barro and Sala-i-Martin (2004) and Van Biesebroeck (2007).

In this paper we discuss the applicability of some of these techniques to the problem at hand and present adaptations and adjustments that provide a best fit for the described objective: estimating robust productivity impact of IC variables collected through firm-level surveys across countries; investment climate surveys.

The development of a consistent econometric methodology to be used in most developing countries as a benchmark for evaluating the impact of IC variables on productivity at the firm level is the main objective of this paper. To illustrate its applicability and usefulness, the methodology is used to assess the productivity impact in four different countries, Costa Rica, Guatemala, Honduras, and Nicaragua, with the ICs data collected for 2001 and 2002 (Guatemala, Honduras, and Nicaragua) and 2002, 2003 and 2004 (Costa Rica).

Using a common productivity methodology is essential for benchmarking and for cross country comparisons of the empirical results. This methodology is intended to give robust empirical results and aims at explaining the reasons why different research groups addressing common issues might reach opposite conclusions, even sharing the same data set. At the same time, in support of diversity and cross fertilization, having alternative econometric approaches should help identifying limitations, advantages or disadvantages of each approach. Those productivity results that are robust to different approaches should play a key role in the formulation of clear policy recommendations for developing countries. This robust econometric approach can be justified using the statistical sensitivity analysis discussed in Magnus and Vasnev (2007).

This paper is structured as follows. Section 2 introduces the concepts of productivity and discusses general productivity measures based on levels versus differences. We conclude that, given the fixed effect nature of IC variables obtained form ICs, it is better to analyze productivity in levels (or log-levels) rather than rates of growth of productivity. This section also introduces a consistent econometric methodology for the selection of IC and firm explanatory variables for different productivity measures. This econometric strategy is applied to study the investment climate determinants of productivity in Costa Rica, Guatemala, Honduras and Nicaragua. Section 3, describes in detail the estimation issues and presents the results. This section also suggests evaluating the country specific contribution of IC variables to average productivity, if we have estimated common elasticities by pooling the data from several countries. Section 4 compares our empirical results with the results form using other methods suggested in the literature to estimate production functions. Finally, section 5 presents a summary of the econometric methodology and of the main conclusions. All the figures and tables with the definitions of the variables used and with the panel data estimation results are included in the appendix.

1 Productivity and Total Factor Productivity Measures for the Analysis of the Productivity Impact of Investment Climate (IC) Variables

The econometric methodologies discussed in this paper are applied to study the productivity determinants of variables collected at the firm level. In particular, we consider the impact of investment climate (IC) variables and other firm control variables (C) on several productivity measures. We classify the IC variables into four broad categories: i) infrastructure, ii) red tape, corruption and crime, iii) finance and corporate governance and iv) quality, innovation and labor skills; see Tables 3a to 3d of the appendix.

Productivity (P), or multifactor productivity, refers to the effects of any variable different from the inputs --labor (L), intermediate materials (M) and capital services (K)--, affecting the production (sales) process. To be more specific, consider that the production function Q=F(L,M,K, α) and the productivity (P_{it}) equation of the firm (i) at period (t) are given by:

$$Y_{it} = F(L_{it}, M_{it}, K_{it}, \alpha_{F,it})\ P_{it} \tag{1a}$$

$$P_{it} = G(IC_{it}, C_{it}, \alpha_{IC.it}) \exp(u_{it}) \tag{1b}$$

where u_{it} is a random error term with properties that will be specified later on. The individual firms are indicated by the sub-index i = 1, 2, ..., N, where N is the total number of firms in the sample and by the sub-index time t = 1, 2, ..., T, where T is the total number of years in the sample. In the IC surveys, N is large and T is small.

When any of the input variables (L, M and K) is influenced by common causes affecting productivity, like IC variables or other firm characteristic variables (C), we have a simultaneous equation problem. (See Marschak and Andews, 1944, and Griliches and Mairesse, 1995). In general, we should expect productivity to be correlated with the inputs L, M and K, and therefore the inputs must be treated as endogenous regressors when estimating production functions. Blundell and Bond (2000) discuss a solution, System-GMM, to this endogenous regressors problem based on a generalized method of moments (GMM) approach, applied to persistent panel data. Olley and Pakes (1996), Levinsohn and Petrin (2003) and Akerberg, Caves and Frazer (2007) suggest structural approaches to estimate production functions.

A specific solution to this endogeneity problem of the inputs L, M and K in (1a) will be presented in section 2.2 when estimation issues of production functions are discussed. Taking logarithms in (1a) and (1b),

$$\log Y_{it} = \log Q_{it} + \log P_{it} \tag{2a}$$

$$\log P_{it} = \log G(IC_{it}, C_{it}) + u_{it} \tag{2b}$$

where log P is the "residual" from equation (2a) and log Q = log F(L,M,K). That is, the log of productivity (P) is the difference between the logarithm of output (Log Y) and the logarithm of aggregate input (log Q) formed by L, M and K. Differentiating (2a) and (2b) we get similar expressions for the rates of growth:

$$d \log Y_{it} = d \log Q_{it} + d \log P_{it} \tag{3a}$$

$$d\log P_{it} = d\log G(IC_{it}, C_{it}) + du_{it} \,. \tag{3b}$$

From equations (3a) and (3b) it is clear that we would like to be able to assign to $d\log P_{it}$ all those changes different than L_{it}, M_{it} and K_{it}, that shift the production function of firm i in period t, while associating the movements along the production function with changes in the aggregate input[2], $d\log Q_{it}$.

---

[2] Consider the extended production function $Y_{it} = F(L_{it}, M_{it}, K_{it}, P_{it})$, where P_{it} is an aggregate productivity index which incorporates technological changes, recent innovations, etc., in the production of Y_{it}. In this general specification, any improvement in P_{it} , perhaps due to improvements in IC conditions, represents a movement along the production function as well as a shift of the production function.

$$d\log Y_{it} = \frac{\partial \log F_{it}}{\partial L_{it}} dL_{it} + \frac{\partial \log F_{it}}{\partial M_{it}} dM_{it} + \frac{\partial \log F_{it}}{\partial K_{it}} dK_{it} + \frac{\partial \log F_{it}}{\partial P_{it}} dP_{it} \,.$$

If the "residual" or the weighted rate of growth of P_{it} , which is $\frac{\partial \log F_{it}}{\partial P_{it}} dP_{it} = \alpha_{P,it} d\log P_{it}$, has elasticity $\alpha_{P,it} = 1$ then $d\log P_{it} = d\log TFP_{it}$, where TFP refers to the Total Factor Productivity. However, when the separability conditions (Hicks neutral technical, etc.) are not satisfied, see Jorgenson, Gollop and Fraumeni (1987), what we are measuring by the "residual" is the rate of growth of productivity as a time varying weighted rate of growth of P_{it} and this might not be equal to the rate of growth of TFP. As we will see in the empirical section, those conditions are difficult to satisfy in most countries. So we call the "residual" productivity (P) and not TFP. Our productivity (P) concept is sometimes called *multifactor productivity*.

The next step is to discuss the advantages and disadvantages of using alternative measures of productivity for the evaluation of the impact of IC variables on productivity. From the above discussion is clear that we have two general approaches to measure productivity (P): a) based on the rate of growth of productivity or b) based on the level (or logs) of productivity.

From equations (3a) and (3b) and the comment of footnote 3 we can write (2a) and (2b) in term of their rates of growth[3] as:

$$d\log Y_{it} = \alpha_{L,it} d\log L_{it} + \alpha_{M,it} d\log M_{it} + \alpha_{K,it} d\log K_{it} + d\log P_{it} \tag{4a}$$

$$d\log P_{it} = \alpha_{IC,it} d\log IC_{it} + \alpha_{C,it} d\log C_{it} + du_{it} \tag{4b}$$

where the coefficients of equation[4] (4a) $\alpha_{j,it}$ are the heterogeneous and time varying j-input-elasticities of the aggregate input Q, j = L, M, and K, of firm (i) in period (t).

Which of the two approaches, a) or b), is more convenient to evaluate the impact of IC variables on productivity based on ICA surveys?

At first glance, the procedure based on productivity growth seems to be more general and more convenient because it does not require us to specify a particular functional form of the production function F(L,M,K). However, it has serious drawbacks arising from the quality of the data (measurement errors and missing firm observations from one year to the next). The common drawbacks of estimating equation in rates of growth are:

(i) Measurement errors are enhanced by taking first differences,

(ii) When the inputs are not strictly exogenous (or “exogenous”) the standard simultaneous equation problems imply and least square estimators are inconsistent and biased. The most common solution requires the use of GMM estimators or instrumental variable (IV) estimators. However, equations with variables in differences suffer from the weak instruments problem which produces very poor parameter estimates (Chamberlain, 1982; Griliches and Mairesse, 1995). Recently, Blundell and Bond (2000) have

[3] Notice that we are assuming that IC and C variables are scalar and not vectors. At this point this is done to simplify the notation. Later on and also in the empirical application we will consider both as vectors.

[4] The coefficients of (4b) are also elasticities and are defined in a similar way.

proposed an alternative GMM estimator for variables that are slow mean reverting (persistent).

(iii) We only have information on IC variables for a single year. Therfore, if we compute rates of growth we lose all the unobservable fixed effects but also all the IC variables.

In order to estimate productivity growth based on equation (4a) we have to take two important decisions:

First. We have to approximate the continuous transformation of the variables, say $d\log(Y_{it})$, by a discrete approximation based on first differences, say $\Delta\log(Y_{it}) = \log(Y_{i,t})-\log(Y_{i,t-1})$. This last approximation requires transforming (4a,) using the Tornqvist[5] (1936) index:

$$\Delta \log Y_{it} = \bar{\alpha}_{L,it} \Delta \log L_{it} + \bar{\alpha}_{M,it} \Delta \log M_{it} + \bar{\alpha}_{K,it} \Delta \log K_{it} + \Delta \log P_{it} \tag{5}$$

where $\bar{\alpha}_{j,i,t} = \frac{1}{2}(\alpha_{j,i,t} + \alpha_{j,i,t-1})$ is average input-output elasticity of input j of firm i during the last two years (t and t-1) where j = L_{it}, M_{it} and K_{it}.

Second. Since the heterogeneous and time varying input-output elasticities $\alpha_{j,it}$ are unknown they can be measured by nonparametric procedures, index number techniques (see Solow 1957, Diewert and Nakamura 2002) or estimated by regression techniques, assuming that the input-output elasticity parameters are constant in some sense. In this paper, we will consider two possibilities: constant input-output elasticities by industry pooling and not pooling across countries, and constant elasticity parameters at the aggregate level pooling and not pooling countries.

To understand why the characteristics of World Bank investment climate surveys (ICs) favor the productivity analysis done in levels, we describe now the main ICs properties of these four Central America countries.

---

[5] Jorgenson and Griliches (1967), among others, suggested to use *this Tornqvist* index as an approximation to the continuous *Divisia* index.

1.1 Description of the Data

The data base of each country is a short unbalanced panel with temporal observations of most variables for 2001 and 2002 (T=2) in Guatemala Honduras, and Nicaragua and 2002, 2003 and 2004 (T=3) in Costa Rica. However, for the IC variables, which are listed in Tables 3a to 3d of the appendix, we have observations only for the year 2002 in Guatemala, Honduras, and Nicaragua and for the year 2004 for Costa Rica.

This raises the first question: should we only use cross-section data (say only for 2002 for the pool of countries and 2004 for Costa Rica) or, should we also use the recall data from the previous one or two years, even if we do not have information on the IC variables for those years? We assume that, unless there is an important structural break in the preceding, the IC variables at the firm level should not change much from one year to the next. In fact, what can change from one year to the next is the reaction of the firm facing a certain investment climate, but it requires time for the firm to implement the corresponding adjustments. Therefore, for each plant we repeat the values observed of each IC variable for the three years (observable fixed effects).

We are interested in keeping as many observations as possible to benefit from the law of large numbers and the central limit theorems. Hence, we suggest pooling observations across Guatemala, Honduras, and Nicaragua while treating separately Costa Rica[6] This is important because our observations are very unevenly distributed through time and across firms, precluding us from doing separate country analyses of each industry or sector. (See Table 4 of the appendix.) For example, if we conduct an industry analysis country by country, we will end up having in the textile sector of Honduras only nine observations, while if we pool the observations across the three countries we have at least 38 observations, giving more reliable statistical results.

In 2001, after pooling the observations across the three countries, we only have 440 observations while for 2002 we have 1,020 observations. Therefore, if we measure productivity in rates of growth we will end up with at most 440 firms, which is a very small sample size to study differences by industry and by country. However, doing the

[6] Some other World Bank studies, see for example Haltiwanger and Schweiger (2005) take an alternative approach. They selected a very large pool of countries (say 30 countries) and estimate only a cross section. However, by doing that cross country analysis at the firm level, we generally loose a lot of firms from the sample because we do not have a large common set of IC variables for very different countries. This approach suffer important sample representation issues or sample selection biases. We believe that selecting a small group of countries with similar number of responses to the questions of the ICA surveys, increases the representativeness of the sample and the number of observations.

analysis in levels or logs we get 1,460 observations in total. From Table 4 of the appendix it is clear that the three countries have similar number of observations for the two-year period: Guatemala has 468 firms, Honduras 472 and Nicaragua 521.

In all the regressions we use several productivity measures, 11 dummy variables (D_r , r = 1, 2, ..., 11) and a constant term (intercept). That is, we control for a constant industry effect of the nine industries (apparel, beverages, chemicals/rubber, food/tobacco, furniture/wood, leather/shoes, nonmetallic minerals, textiles, metal), by including only eight dummy variables, leaving out apparel to avoid having perfect multicolinearity with the constant term. Similarly, we add only one yearly dummy variable leaving out the corresponding dummy for the year 2001. Finally when we pool countries, to control for a constant country effect, we include two dummies, one for Honduras and the other for Nicaragua, with Guatemala omitted. In the case of Costa Rica we have enough observations to avoid pooling the ICs with the other three Caribbean countries but we also use 9 dummy variables (seven industry dummies and two dummies of year).

1.2 The level of firms' productivity

To estimate productivity in levels we have to specify a functional form of the production function. If the functional form F(L,M,K) is Cobb-Douglas, estimating productivity in levels requires estimation of the following well known equation,

$$\log Y_{it} = \alpha_L \log L_{it} + \alpha_M \log M_{it} + \alpha_K \log K_{it} + \alpha_p + \log P_{it} . \tag{6}$$

When the parametric functional form of the production function is Translog, the equation becomes:

$$\begin{aligned}\log Y_{it} &= \alpha_L \log L_{it} + \alpha_M \log M_{it} + \alpha_K \log K_{it} + \\ &+ \frac{1}{2}\alpha_{LL}(\log L_{it})^2 + \frac{1}{2}\alpha_{MM}(\log M_{it})^2 + \frac{1}{2}\alpha_{KK}(\log K_{it})^2 + \\ &+ \alpha_{LM}(\log L_{it})(\log M_{it}) + \alpha_{LK}(\log L_{it})(\log K_{it}) + \alpha_{MK}(\log M_{it})(\log K_{it}) + \\ &+ \alpha_p + \log P_{it}.\end{aligned} \tag{7}$$

The third alternative considered in this paper is to use a nonparametric or index number approach based on cost-shares from Hall (1990) to obtain the Solow´s residual in levels (logs)

$$\log \hat{P}_{it} = \log Y_{it} - \overline{s}_L \log L_{it} - \overline{s}_M \log M_{it} - \overline{s}_K \log K_{it} \tag{8}$$

where $\overline{s}_j$ is the aggregate *average cost shares* from the last two years[7] given by $\overline{s}_j = \frac{1}{2}(s_{j,t} + s_{j,t-1})$ for j = L, M and K. The advantage of the Solow residuals, Solow(1957), is that it does not require the inputs (L, M, K) to be exogenous nor the input-output elasticities to be constant nor heterogeneous. The drawback is that it requires to have constant returns to scale (CRS) and at least competitive input markets. Measuring productivity in levels (or in logs) it is less demanding in terms of:

(i) data quality (since it allows to treat unbalanced panel without loosing many observations),

(ii) measurement errors, and

(iii) allowing constant firm specific fixed IC variables (observable fixed effects).

This productivity approach in levels is in line with Hall and Jones (1999) when they say that "to explain differences in levels of long-run economic success across countries, one is forced to focus on more basic determinants: infrastructure, persistent barriers (why is technology and capital not moving fast across borders) ..." and continue saying that "Long-run determinants of economic success are factors that are changing slowly over time". Those determinants are associated in this paper with firm specific investment climate (IC) fixed effects.

Therefore, the estimation strategy suggested for productivity levels, can be justified from the following simplified *structural simultaneous equations model* which includes the following equations: a production function, a productivity equation, determinants of the unobserved firm specific time-fixed effects and the inputs demands of L, M and K (for simplicity we only write the equation for L in (9.d)). That is,

[7] When there is only firm information about a single year we take the average cost share of the firms of that year.

$$\log Y_{it} = \alpha_L \log L_{it} + \alpha_M \log M_{it} + \alpha_K \log K_{it} + \log P_{it} \quad (9.a)$$

$$\log P_{j,it} = a_i + \alpha'_{Ds} D_j + \alpha'_{DT} D_t + \alpha_P + w_{it} \quad (9.b)$$

$$a_i = \alpha'_{IC} IC_{P,i} + \alpha'_C C_{P,i} \;\; + \varepsilon_i \quad (9.c)$$

$$\text{LogL}_{it} = \delta'_{IC,L}\; IC_{L,i} + \delta_{Lw} \log(\text{wages})_{it} + v_{Lit}\,. \quad (9.d)$$

where, Y is firms' output (sales), L is employment, M denotes intermediate materials, K is the capital stock, IC and C are time-fixed effect vectors of investment climate and control variables, and D_j and D_t are the vectors of industry and year dummies.

The usually unobserved time fixed effects (a_i) of the TFP equation (9.b) are here proxy by the set of observed time fixed components IC, and C variables of (9.c) and a remaining unobserved random effects (ε_i). The two random error terms of the system, ε_i and w_{it}, are assumed to be conditionally uncorrelated with the explanatory L, M, K, INF, IC and C variables[8] of equation (10),

$$\log Y_{it} = \alpha_L \log L_{it} + \alpha_M \log M_{it} + \alpha_K \log K_{it} + \alpha'_{IC} IC_{P,i} + \alpha'_C C_{P,i} \;\; + \alpha'_{Ds} D_j + \alpha'_{DT} D_t + \alpha_P + u_{it} \quad (10)$$

Therefore, the regression equation (10) is representing the *conditional expectation* plus a composite random-effect error term equal to $u_{it} = \varepsilon_i + w_{it}$ and should satisfy *standard assumptions* of random effects (RE) conditional models. That is,

$$E\left[w_{it} / \log L_{it}, \log M_{it}, \log K_{it}, IC_{P,i}, C_{P,i}, D_j, D_t, \varepsilon_i \right] = 0$$
$$E\left[\varepsilon_i / \log L_{it}, \log M_{it}, \log K_{it}, IC_{P,i}, C_{P,i}, D_j, D_t \right] = 0$$
$$\textit{and} \quad Var\left[\varepsilon_i / \log L_{it}, \log M_{it}, \log K_{it}, IC_{P,i}, C_{P,i}, D_j, D_t \right] = \sigma_\varepsilon^{\,2}\,.$$

Notice that we need to condition on the observable fixed effects (IC) to get the orthogonally condition of the inputs L, M and K. That is $E\left[w_{it} / \log L_{it}, \log M_{it}, \log K_{it}, D_j, D_t \right] \neq 0$ and also $E\left[a_i / \log L_{it}, \log M_{it}, \log K_{it}, D_j, D_t \right] \neq 0$ and therefore the correlation between the unobserved effects and the inputs come the time fixed IC variables. As will become clear later on, the fact that this conditional expectation of a_i is not equal to cero, invalidates one of the main assumptions of

[8] Under this formulation (and other standard conditions) the OLS estimator of the productivity equation (4.2) with robust standard errors is consistent, although a more efficient estimator (GLS) is given by the random effects (RE) estimator that takes into consideration the particular covariance structure of the error term, $\varepsilon_i + w_{it}$, which introduces certain type of heteroskedasticity in the regression errors of (4.2).

section 4.4 where we discuss Wooldridge (2005) procedure of estimating Ackerberg et al (2007).

Equation (9.a) is the familiar Cobb-Douglas production function, but it is obvious that the argument applies to other functional forms, like the Translog. The second equation (9.b) is the usual firm level productivity equation of firm i in year t. Productivity depends on the unobserved firm specific effects, a_i, a vector of firm control variables (C_{it}), industry, country and year dummies (D_r) and the productivity shocks (w_{it}) which are assumed to be uncorrelated with the inputs (L, M and K).

Many of the usually unobserved firm specific fixed effects (a_i) are now observed at the micro level (firm level), due to the detailed firm specific information obtained from the ICA´s surveys. In equation (9.c) we add an extra random firm specific fixed effect term (ε_i) which is the part of the unobserved time fixed effects not correlated with the IC variables (IC_i). Notice, that since the number of available firm specific IC_i variables is very large (in our data base we used more than 50 time fixed effect terms) it is reasonable to assume that ε_i's are uncorrelated with the inputs after conditioning in IC information. The last equation is the input demand equation derived from a competitive labor market[9]. In particular, the demand for labor depends on wages but also on certain investment climate (IC) fixed effects that affects also the productivity equation.

From this simple structural simultaneous equation model, it is clear that a 2-step estimation approach, where we first estimate the single equation (9.a) to get a measure of productivity and second we use this estimated productivity measure to evaluate the impact of IC variables, will render inconsistent least squares estimations. The measurement error problem of the dependent variable ($LogP_{it}$) of equation (9.b) is transmitted to rest of the parameters of the productivity equation. The reason is clear, the measurement error term of the dependent variable of equation (9b) includes the inputs (labor, etc.) which from (9.d) are correlated with the IC explanatory variables.

From this simple simultaneous equation model it is clear that direct applications of the production function estimation procedures proposed by of Olley and Pakes (1996), Levinsohn and Petrin (2003) and Akerberg, Caves and Frazer (2007) might generate inconsistent parameter estimates in their first step, derived from the correlation of the inputs with IC variables. Furthermore, these sophisticated estimation procedures require

[9] For simplicity we omit the input demand equations of the other two inputs, intermediate materials (M) and capital (K). However, it is clear that IC variables will affect as well those input demands and the same argument applied to the estimation of those inputs-output elasticities.

at least two years of firm level data, and, as we pointed out before, we would loose many observations if we have to track the same firm for more than one year because usually panels based on IC surveys are usually very unbalanced.

The solution we propose to address the endogeneity of the inputs is to estimate an *extended production function* that incorporates the IC variables driving endogeneity. By joint estimation of the input-output elasticities and the rest of the parameters of the system (IC and C variables), the IC variables are used as *proxies* for the unobserved firm specific effects (a_i) and we are therefore controlling for the common cause of endogeneity.

Using similar arguments, we could consistently estimate by least squares, the following Translog extended production function,

$$\begin{aligned}\log Y_{it} &= \alpha_{L,j}\log L_{it} + \alpha_{M,j}\log M_{it} + \alpha_{K,j}\log K_{it} + \\ &+ \frac{1}{2}\alpha_{LL,j}(\log L_{it})^2 + \frac{1}{2}\alpha_{MM,j}(\log M_{it})^2 + \frac{1}{2}\alpha_{KK,j}(\log K_{it})^2 + \\ &+ \alpha_{LM,j}(\log L_{it})(\log M_{it}) + \alpha_{LK,j}(\log L_{it})(\log K_{it}) + \alpha_{MK,j}(\log M_{it})(\log K_{it}) + \\ &+ \sum_{r=1}^{q_{IC}}\alpha_{IC}\log IC_{r,it} + \sum_{r=1}^{q_C}\alpha_{C}\log C_{r,it} + \sum_{r=1}^{q_D}\alpha_{D,r}D_r + \alpha_P + u_{it}\ .\end{aligned} \tag{11}$$

This general local functional approximation, allows us to check whether the technology (at the aggregate level or at the industry level) is Cobb-Douglas. Furthermore, with both parametric specifications of the production function we can test the constant returns to scale[10] (CRS) condition behind Solow´s residuals ($\log P_{it}$), see equation (8). From equation (12) we can estimate the IC elasticities and semi-elasticities,

$$\log P_{it} = \sum_{r=1}^{q_{IC}}\alpha_{IC,r}\log IC_{r,i} + \sum_{r=1}^{q_C}\alpha_{C,r}\log C_{r,it} + \sum_{r=1}^{q_D}\alpha_{D,r}D_r + \alpha_P + u_{it}. \tag{12}$$

Since there is no single salient measure of productivity (P_{it}), any empirical evaluation on the productivity impact of IC variables might critically depend on the way productivity is measured. Therefore, to get reliable empirical results for policy analysis, we suggest

[10] For example, if the coefficients of the inputs (L, M, and K) in the Cobb-Douglas specification of the production function add up to one. Similar but more complicated coefficient restrictions apply for a CRS Translog production function. Tables 8, 9 and 10 show the results for the pool of countries and for Costa Rica.

to look for robust empirical results using several productivity measures. This is the approach we will follow in the rest of the paper.

For this purpose, we use the 10 productivity measures (see section 3) that best fit with the characteristics of our data set: two levels of aggregation (countries and industries), with two parametric production functions (Cobb-Douglas and the Translog) and the Solow residuals for each level of aggregation.

Controlling for the largest set of IC variables and firm characteristics in equations (10) and (11) we can get, under standard regularity conditions, *consistent and unbiased* least squares estimators of the parameters of the production function and of the productivity equation. That is, we can run OLS from a one-step regression[11] based on the extended production function (10). In the empirical section we allow the errors (u_{it}) from (10) and (11) to be heteroskedastic and therefore we will be using pooling OLS with robust standard errors and also random effects (RE) estimators (GLS).

1.3 Endogeneity of the IC Variables

Another econometric problem that we have to face in estimating (10), (11) and (12) is the possible *endogeneity* of IC variables and some C variables. The traditional instrumental variable (IV) approach is difficult to implement in this context, given that we only have IC variables for one year and therefore we cannot use the natural instruments like those provided by their on lags, and that it is difficult to find good and convincing instruments for them.

To control for the endogeneity of the IC variables, we use the *region-industry average* of the plant level investment climate variables ($\overline{IC}$) instead of the crude IC variables. This is a common solution in panel data studies at the firm level. In the pool of countries we have, in total, 13 regions for the three countries and 9 industries for each country (See Table 1 for details). In Costa Rica, we have 7 regions and 8 industries (See Table 2). Taking region and industry averages instead of the individual IC variables, is also useful to mitigate the effect of missing individual IC observations. This is an important issue in most of the IC surveys.

[11] Alternatively, we could have used an equivalent two-step control function approach procedure where we first estimate by OLS a regression of each of the inputs on all the IC and C variables (partialling out) and then include the residuals of each estimated input equation, instead of the observed inputs, in the production function.

1.4 Strategy for IC Variables' Selection

The econometric methodology applied for the selection of the variables (IC, C and PE) goes from the general to the specific. The *omitted variables* problem that we encounter, starting from a too simple model generates biased and inconsistent parameter estimates. On the contrary, adding *irrelevant variables* (meaning starting from a very general model with some variables that are irrelevant) gives unbiased and consistent, but inefficient, estimates. Therefore, we start from a general model, such as equations (10) and (11) with all the variables of Tables 3a to 3d included at once, and we reduce this general model to a simpler one with relevant (significant) variables[12]. Note that the final estimated model is efficiently estimated once we have deleted insignificant or irrelevant variables.

In the reduction process we should not delete all insignificant variables at once. Due to multicolinearity, if we drop one variable that is highly correlated with others, some of the insignificant variables might become significant. An informative statistic for this purpose is the variation of the R^2 of the regression (or the standard error of the regression). The R^2 of the simplified model with only significant or relevant variables, see Table 11 for Guatemala, Honduras and Nicaragua and Table 12 for Costa Rica, is smaller but close to the initial R^2 of the most general regression model. We applied this iterative procedure, eliminating the less significant variables leaving, for interpretive purposes, at least one IC variable from each broad category (infrastructure, bureaucracy/corruption, crime, technology and quality, human capital, corporate governance, etc.). The estimated explanatory variables of the regression models of Tables 11 and 12 of the appendix were selected in this way. We include in those tables the set of IC variables that were significant in at least one of the 12 specifications (pooling OLS or random effects). These regression results are consistent (with equal signs and a reasonable range of parameter values). The detailed empirical results are explained in the next section.

[12] Sometimes, in the final regression model, we leave IC variables that are not individually significant but are relevant for the model (jointly significant, affect the significance of other variables, etc.). When this happens it could be due to the presence of multicolinearity among some of the explanatory variables.

2 Robustness of the Estimated Productivity-IC Elasticities and Semi-elasticities

As we said before, for policy implications we would like the estimated *elasticities, or semi-elasticities* of IC variables to be robust among: 1) different functional forms of the production functions; 2) different consistent estimation procedures; 3) different productivity measures; and 4) different levels of aggregation (industry, country, pooling across countries, etc).

Summary of Productivity Measures and Estimated Investment Climate (IC) Elasticities				
			1.1.a OLS	
1. Solow´s Residual	**Two Step**	**1.1 Restricted Coef**	**1.1.b RE**	**2 (P_{it}) measures**
	Estimation		**1.2.a OLS**	**4 (IC) elasticities**
		1.2 Unrestricted Coef	**1.2.b RE**	
			2.1.a OLS	
2. Cobb-Douglas	**Single**	**2.1 Restricted Coef**	**2.1.b RE**	**4 (P_{it}) measures**
	Estimation		**2.2.a OLS**	**4 (IC) elasticities**
		2.2 Unrestricted Coef	**2.2.b RE**	
			3.1.a OLS	
3. Translog	**Single Step**	**3.1 Restricted Coef**	**3.1.b RE**	**4 (P_{it}) measures**
	Estimation		**3.2.a OLS**	**4 (IC) elasticities**
		3.2 Unrestricted Coef	**3.2.b RE**	
				10 (P_{it}) measures
			Total	**12 (IC) elasticities**

Restricted Coef.= Equal input-output elasticities in all industries of the three countries
Unrestricted Coef.= Different input output elasticities by industry of the three countries
OLS = Pooling Ordinary Least Squares estimation (with robust standard errors)
RE = Random Effects estimation

As mentioned in section 2, to reduce the simultaneous equation bias and the risk of getting reverse causality problems if the IC_i variables are endogenous, we use their region-industry average ($\overline{IC}_j$). The coefficients of investment climate ($\overline{IC}_i$) variables and other plant-specific control (C_{it}) variables are maintained constant for all the firms in Costa Rica and for all the firms in the pool of countries. However, we allow the production function elasticities, and therefore the productivity measures, to change for each functional form (Cobb-Douglas and Translog), and for each different aggregation levels (industry and countries). We consider two levels of aggregation: (i) Restricted estimation (equal input-output elasticities among industries for the three countries) and (ii) unrestricted estimation (different input-output elasticities for each industry). Moreover, we consider two different estimators (pooling OLS and random effects, RE) for each productivity measure. The following table summarizes the productivity measures and the corresponding IC elasticities that we estimate.

Thus we obtain 10 different productivity measures (P_{it}) and we evaluate the impact of IC variables on each of them based on two estimation procedures pooling OLS and RE. If the sign of the impact of certain IC variables on productivity changes, contingent on the productivity measure used, we would not have a robust or solid empirical result for policy implementation. However, as we will see later, it is possible to obtain robust and consistent results even when the correlations between the alternative measures of productivity differ dramatically. Tables 6 and 7 report the correlations between the log productivity measures obtained from the four single-step production function estimates and from the two Solow residuals. The correlations between the Solow residuals and the productivity measures that result from estimating restricted production functions are high, ranging from 0.87 to 0.98. However, when we allow for different input elasticities across industries (unrestricted production functions) the correlations are lower, ranging from 0.69 in the Cobb-Douglas case to 0.11 in the Translog case.

Figure 2, shows the kernel density of the 1o productivity measures. We observe that that are very different and therefore we might expect the IC elasticities on productivity to change depending on which one we are using. However, as we will se later on, it is possible to get very robust results with any of them. Therefore, it is no so important which one to use in practice if the goal is to estimate the IC elasticities, see section 3.3.

2.1 Restricted Coefficient Estimates (equal input-output elasticities)

2.1.1 Solow´s Residual (Two-step restricted estimation)

We first obtain the Solow residuals (P_{it}) as in equation (8) and then estimate the impact of IC variables on P_{it} through regression techniques. This two-step approach overcomes the endogeneity problem for the inputs.

Table 8 shows that the cost share of labor is 0.36 in the pool of countries and 0.33 in Costa Rica. The cost shares of intermediate materials are 0.53 and 0.56, respectively, and that of capital 0.11 and 0.11. The cost shares add up to one because we are imposing constant returns to scale (CRS).

The empirical results of estimating equation (12) by pooling the observations from the three countries and running OLS and random effects (RE) are in Table 11. Table 12 shows the same estimates for Costa Rica. We comment these results in section 3.3.

2.1.2 Cobb-Douglas and Translog Productivities (Single-step restricted estimation)

In this case, we consider that the coefficients of the three inputs (L,M,K) of the Cobb-Douglas (10) and Translog (11) production functions are constant for the whole manufacturing sector. Each of the two equations is estimated in a single step, meaning that the parameters of the production function are estimated jointly with the parameters of the IC, C and D variables. However, to make the empirical results more readable we present them in separate tables. Table 8 shows the elasticities of inputs and Tables 10 and 11 the elasticities and semi-elasticities of the IC variables.

In the pool of countries, the estimated labor elasticity of the Cobb-Douglas production function is 0.43 (OLS) and 0.48 (RE), the intermediate materials elasticity is 0.52 (OLS) and 0.45 (RE). Finally, the elasticity of capital is 0.07 for both OLS and RE. With both estimation procedures, we can not reject the constant returns to scale (CRS) hypothesis.

In the case of Costa Rica, the estimated input elasticities are as follows: (i) labor, 0.31 by OLS and 0.29 by RE, (ii) intermediate materials, 0.53 by OLS and 0.47 by RE, and (iii) capital, 0.12 by OLS and RE. In this case, the CRS hypothesis is rejected at any reasonable significance value in the case of RE and at 10% in the case of OLS (the p-value is 0.0649).

The empirical results obtained assuming a Translog production function are also in Table 8. The Translog specification allows to test whether the production function is Cobb-Douglas. The Cobb-Douglas specification is rejected with a p-value of 0 both for the pool of countries and for Costa Rica. The CRS is not rejected at any reasonable significance level for the pool of countries and rejected at any significance level for Costa Rica.

2.2 Unrestricted Production Function Coefficients (by Industry)

In this case, the coefficients of the inputs (L, M and K) in the production function vary by industry. Table 1 shows the definition of the industries for the pool of countries and Table 2 for Costa Rica.

2.2.1 Solow´s Residuals (Two-step unrestricted estimation)

First, the costs shares of each industry are reported in Table 9.a (pool of countries) and Table 9.b (Costa Rica). We can see that there is a certain homogeneity among the 9 sectors. Intermediate materials (M) always has the highest share, with almost 50%, followed by the cost share of labor, at nearly 40% and capital, around 10%.
Second, the empirical results from the OLS and the random effects estimates of equation (12) are included in Table 11 (pool of countries) and Table 12 (Costa Rica).

2.2.2 Cobb-Douglas and Translog Productivities (Single-step unrestricted estimation by industry)

In this case, the production function specifications derived in equations (10) and (11) become the production functions for each industry j, j=1,2 ,...,9. Each equation is estimated by OLS and by random effects (RE). Once again, we separate the information on the production function elasticities from the information on the IC elasticities to make the tables more readable although all the parameters were jointly estimated.
Tables 9.a and 9.b show the Cobb-Douglas specification for the pool of countries and Costa Rica, respectively, and Tables 10.a and 10.b the Translog specification.
When estimating a Cobb-Douglas specification, in the pool of countries, the constant returns to scale (CRS) condition is non rejected in six of the nine sectors (Apparel, Food and Tobacco, Furniture and Wood, Nonmetallic minerals, Textiles and Metal Products). In the industry of Chemical and Rubber the hypothesis is strongly rejected and in the other sector the evidence is mixed.
For some sectors like leather/shoes, the estimated input-output elasticities are very different from the values obtained from the cost shares given by the two-step procedure with Solow residuals, meaning that the industries have certain heterogeneity in their input-output elasticities. Therefore, the corresponding productivity measures should differ in a significant way. Tables 6 and 7 and Figures 2 and 3 show that this is the case.

With the trasnlog specification the CRS hypothesis is only rejected in the Apparel sector. The evidence in the other industries is mixed in the sense that is rejected in the OLS and not rejected in the RE estimation.

In the case of Costa Rica the CRS hypothesis is not rejected when estimating a Cobb-Douglas specification in three out of eight industries and rejected two. (See Table 9.b.)

The empirical results of the Translog production function parameters are included in Table 10.a. The CRS hypothesis is rejected in 5 industries and not rejected in one. The Cobb-Douglas specification is rejected in six out of eight sectors it was rejected. The industries that failed to reject the Cobb-Douglas specification also failed to reject CRS.

2.3 Empirical Results: The impact of the IC variables on firms' productivity

The question of interest is whether these new productivity measures yield similar elasticity and semi-elasticity estimates for the IC effects on productivity.

Before discussing the effects of different IC variables on productivity, it is important to take into account that the economic interpretation of each investment climate coefficient is contingent on the units of measurement of each IC variable and on the transformations performed on them (logs, fractions, percentages, qualitative constructions, etc.). Since productivity variables are always in logs, when the IC variable is also expressed in logs, the estimated coefficient is a constant *productivity-IC elasticity*; and when the IC variable is not expressed in logs, the estimated coefficient is generally described as a *productivity-IC semi-elasticity*[13]. While the constant productivity-IC elasticity measures the percentage change in productivity induced by a percentage change in the IC variable, the semi-elasticity coefficient multiplied by 100, measures the percentage change in productivity induced by a unitary change in the IC variable. A detailed explanation of the units of measurement of each variable is given Tables 11 and 12 with the estimated elasticities and semi-elasticities for the 10

[13] While it is sometimes natural to express an IC variable in log form, for some types of IC variables it is more appropriate not to do so. For example, when an IC variables is a fraction or a percentage number with some data equal to 0 or close to 0. Notice however that expressing IC variables in fractions allow us to interpret also their coefficients as constant elasticities and not as semi-elasticities.

productivity measures. Table 11 shows the results for the pool of countries and Table 12 for Costa Rica.

As we mention before, Investment Climate (IC) variables were classified into five broad categories: (a) Red Tape, Corruption and Crime, (b) Infrastructure, (c) Quality, Innovation and Labor Skills, (d) Finance and Corporate Governance, and (e) Other control variables.

Within each group, all IC variables have the expected signs and the estimated elasticities or semi-elasticities are always within a reasonable range of values for the 10 productivity measures. In absolute terms, the highest elasticity values correspond to the Solow residual or to the Cobb-Douglas specification, while the lowest usually correspond to the Translog production function. Therefore, we observe a trade-off between the role played by inputs (labor, intermediate materials and capital) and the role played by the IC variables and other control variables. The *robustness* of these empirical results across productivity measures allows us to obtain *consistent evaluations* of the IC determinants of productivity.

The Translog results on the empirical estimates of the IC elasticities are the same in terms of signs but less number of parameters become significant now, see Table C5.2. The reason is clear: the Translog specification includes many nonlinear terms of the inputs variables of each sector and they compete with the explanatory power of IC variables or C characteristics. The important point is that all the signs of the coefficients of the IC and C variables are maintained[14]. Therefore, the results on the impact of IC variables on productivity are consistent and robust to different productivity measures, suggesting that we can use the signs and the range of estimated elasticities for policy analysis[15].

Finally, we also present the individual estimates of the elasticities or semi-elasticities of IC variables on productivity in Figures 4 and 5.

[14] We also considered the possibility of having nonlinear impacts of IC variables on productivity in equations (10), (11) and (12) by including linear terms as well as the square and cubic terms of the IC and C variables that appear in those equations. However, they were not significant.

[15] Those elasticity and semi-elasticity parameter were also estimated *for small and large* firms as well as for *young and old firms*. The results are reported in Escribano and Guasch (2005).

2.4 The contribution of the IC variables to average productivity

To complement the evaluation of the impact of IC variables on TFP we will evaluate the regressions estimates at their corresponding sample means. Since the 10 productivity measures of Figure 2 are very different we will fist find their demean counterpart to makes them more similar. The results are presented in Figure 3. To make this productivity methodology a valid benchmark for cross-country comparisons form now on we will always evaluate the IC impacts on average TFP coming from the restricted Solow's residuals of each country.

Replacing each one of IC elasticity by its estimate in equation (12) using as a measure of TFP the aggregate Solow residual, and averaging across firms of each country, it is possible to evaluate country by country, the contribution of each IC variable to the average log of productivity.

This mean evaluation has two advantages: (i) the contribution of each variable can be obtained as a percentage and percentage can be added by groups of IC variables, and (ii) even when we estimate equal coefficients for all the firms in the pool of countries (Guatemala, Honduras and Nicaragua), we can average by country and therefore we can have the contribution of each IC variable by country.

Figure 6 shows the contribution of each IC variable to the average log of productivity in each country of the pool of countries (Guatemala, Honduras and Nicaragua) and Figure 7 shows the same for Costa Rica.

In all the countries the group of IC variables with larger contribution is Red Tape, Corruption and Crime. This group represents 41.1%, 36.6%, 36.6%, and 37.8% of the whole contribution of IC variables and C variables in Guatemala, Honduras, Nicaragua, and Costa Rica, respectively. The second group of variables with large contribution to the average log productivity is Infrastructures in Guatemala (30.5%), Honduras (32.3%), and Nicaragua (32.3%) and Finance and Corporate Governance in Costa Rica (25.3). In Costa Rica Infrastructures also has a large contribution (19.2%).

These Figures also show the contribution of each IC variable. In the group of Red Tape, Corruption and Crime, the variable with the largest contribution is the number of days spent in inspections and regulation related activities in Guatemala, Honduras, and Nicaragua and the percentage of sales that is declared for tax purposes in Costa Rica.

In the group of infrastructures the most important variables in Guatemala, Honduras, and Nicaragua are the number of days that a firm needs to clear customs when it imports and whether the firm uses internet to communicate with its clients or suppliers. In Costa Rica, is the number of days that a firm has to wait after asking for electricity.

The group of other control variables explains around 16% of the impact of the IC variables in Honduras and Nicaragua, 13% in Guatemala and 11% in Costa Rica. The most important variable in this group is the age of the firm that explain around 8% in the Guatemala, Honduras and Nicaragua. In Costa Rica the most important variable is the number of competitors that explain 7.9% of the impact of IC variables on firms' productivity.

The last group in order of importance in the four countries is quality, innovation and labor skills. The contribution of this group of variables is around 10%. In Guatemala, Honduras and Nicaragua, the factor with the largest contribution is training provided beyond "on the job". In Costa Rica, in this group of variables, there are many variables that resulted significant but none of them has a contribution larger than 2%.

3 Further Robustness

In this section, we estimate the production function considering structural procedures based on Olley and Pakes (1996). In particular, we consider the procedures of Levinshon and Petrin (2003) and Ackerberg, Caves, and Frazer (2007).

3.1 Olley and Pakes (OP)

The Olley and Pakes (1996) estimation algorithm takes into account the attrition bias due to exiting firms, as well as the simultaneous equation problem already mentioned. Given that the IC surveys are not designed to address issues related to firms' survival we focus our attention on the simultaneous equation problem.

As we mention before, the production function can be written in logs as follows

$$y_{it} = \alpha_L l_{it} + \alpha_M m_{it} + \alpha_K k_{it} + p_{it} + \varepsilon_{it} \ , \tag{13}$$

where y is the logarithm of firm's i output, l is labor, m denotes intermediate inputs and k is capital stock, all in logs. The sequence $\{p_{it}: t=1, 2,\ldots, t\}$ is unobserved productivity and $\{\varepsilon_{it}: t=1, 2,\ldots, t\}$ is a sequence of *i.i.d* unanticipated shocks.

In their structural model the investment in fixed assets is function of firm's productivity and firm's the capital stock, i.e., $i_t = h_t(p_t, k_t)$. They show that i_{it} is strictly monotonous in p_{it} and therefore it is possible to invert it out obtaining $p_t = h_t^{-1}(i_t, k_t)$. Substituting this expression into (13) we have

$$y = \alpha_L l_{it} + \alpha_M m_{it} + \alpha_K k_{it} + h_t^{-1}(i_{it}, k_{it}) + \varepsilon_{it} \ . \tag{14}$$

This equation allows us to obtain estimates of the labor and materials coefficients, as well as, an estimation of the composite term, $\hat{\phi}_{it} = \alpha_K k_{it} + h_t^{-1}(i_{it}, k_{it}) + \varepsilon_{it}$.

The next step is related to the estimation of the capital coefficient in (13). Assuming that capital is a fixed input in the sense that it depends on the amount of capital in period t-1 and on the investment decisions taken also in period t-1, and assuming that productivity follows a first order Markov process, that is, $\rho(p_{it} \mid p_{it-1}, p_{it-2}, \ldots, p_{i0}) = \rho(p_{it} \mid p_{it-1})$, we have the moment condition that allow us to identify the capital coefficient. That is, $k_{it} = i_{it-1} + (1-\delta)k_{it-1}$ with $p_{it} = E[p_{it} \mid p_{it-1}] + \xi_{it}$ yields to $E[k_{it} \mid \xi_{it}] = 0$. The second step involves replacing the estimates of α_L, α_M and $\hat{\phi}_{it}$ in equation (14), i.e.,

$$y_{it} - \hat{\alpha}_L l_{it} - \hat{\alpha}_M m_{it} = \alpha_K k_{it} + g(\hat{\phi}_{i,t-1} - \alpha_K k_{it-1}) + \mu_{it} + \varepsilon_{it} . \tag{15}$$

To estimate this equation, g(.) is approximated by a third or fourth order series expansion on ϕ_t, and k_{it-1}.

3.2 Levinsohn and Petrin (LP)

One possible pitfall of OP procedure is that in many data sets the investment variable takes many zero values. Levinshon and Petrin (2003) addressed this problem by using the intermediate inputs demand instead of the investment equation. Let

$$m_{it} = f_t(p_{it}, k_{it}) \tag{16}$$

be the intermediate inputs demand. If monotonicity holds, then this expression can be inverted and replaced in equation (13). Then, the resulting production function is given by

$$y = \alpha_L l_{it} + \alpha_K k_{it} + \alpha_M m_{it} + f_t^{-1}(m_{it}, k_{it}) + \varepsilon_{it}\,. \tag{17}$$

As in the OP approach, it is possible to obtain an estimate of the composite term $\hat{\phi}_{it} = \alpha_K k_{it} + \alpha_M m_{it} + f_t^{-1}(m_{it}, k_{it}) + \varepsilon_{it}$.

The timing assumption regarding inputs is important. LP assumes that materials are chosen in the moment that the production takes place and therefore, it is influenced by productivity. Additionally, they assume that labor is chosen in same point after materials materials election. If this assumption does not hold, then l_{it} would affect the optimal choice of m_{it}. Hence, given these assumptions, in the last step there are two coefficients to estimate and identification is provided by the next two moment conditions: (i) $E[\xi_{it}(\alpha_K, \alpha_M) \mid k_{it}] = 0$, and (ii) $E[\xi_{it}(\alpha_K, \alpha_M) \mid m_{it-1}] = 0$.

3.3 Ackerberg, Caves, and Frazer (ACF)

Ackerberg, Caves, and Frazer (2007) point out that productivity also affect the demand of labor and therefore it coefficient can not be identified in the first step. If labor is a function of productivity and capital, $l_{it} = \gamma_t(p_{it}, k_{it})$, and intermediate inputs are used as proxy rather like in LP[16], then

$$l_{it} = \gamma_t(p_{it}, k_{it}) = \gamma_t(f_t^{-1}(k_{it}, m_{it}), k_{it}) = h_t(m_{it}, k_{it})\,.$$

Now, it is not possible to identify the labor coefficient in the first step and all the coefficients must be estimated in the second step.

In this case, the production function is given by $y_{it} = \phi_t\,(m_{it}, k_{it}) + \varepsilon_{it}$. ACF like OP and LP, also assume a first order Markov process for productivity and therefore the set of moment conditions that allows identification of the three parameters are: (i)

[16] The procedure can also be implemented using investment as proxy.

$E[\xi_{it}(\alpha_L,\alpha_K,\alpha_M)\,|\,k_{it}]=0$, (ii) $E[\xi_{it}(\alpha_L,\alpha_K,\alpha_M)\,|\,m_{it-1}]=0$, and (iii) $E[\xi_{it}(\alpha_L,\alpha_K,\alpha_M)\,|\,l_{it-1}]=0$.

If labor is a dynamic input, i.e., the current choice of labor may affect future choices, then the expressions of intermediate materials and labor demand become $m_{it}=f_t(p_{it},k_{it},l_{it-1})$ and $l_{it}=\gamma_t(p_{it},k_{it},l_{it-1})$, respectively. This yields to $y_{it}=\phi_t\,(m_{it},k_{it},l_{it-1})+\varepsilon_{it}$, with an additional moment condition provided by $E[\xi_{it}(\alpha_L,\alpha_K,\alpha_M)\,|\,l_{it-1},k_{it}]=0$.

When labor is not a variable input, i.e., it is chosen in the moment t-b between t and t-1, the intermediate inputs and labor demand become $m_{it}=f_t(p_{it},k_{it},l_{it})$ and $l_{it}=\gamma_t(p_{it-b},k_{it})$, respectively. In this case, the production function is of the form $y_{it}=\phi_t\,(m_{it},k_{it},l_{it})+\varepsilon_{it}$ and the additional moment condition is as in the previous case $E[\xi_{it}(\alpha_L,\alpha_K,\alpha_M)\,|\,l_{it-1},k_{it}]=0$.

3.4 GMM estimation

Wooldridge (2005) proposed a computational improvement that can be used in the OP, LP and ACF procedures. In particular he proposed a GMM procedure to estimate to estimate α_l, α_m and α_k.

Assuming that in (13), $E(\varepsilon_{it}\mid l_{it},m_{it},k_{it})=0$, the expected value of the production function is given by

$$\begin{aligned}E(y_{it}\mid l_{it},m_{it},k_{it}) &= \alpha_0+\alpha_l l_{it}+\alpha_m m_{it}+\alpha_k k_{it}+g(k_{it},m_{it})=\\ &=\alpha_0+\alpha_l l_{it}+h(k_{it},m_{it})\end{aligned}$$

for some unknown function $p_{it}=g(m_{it},k_{it})$ and $h(k_{it},m_{it})=\alpha_m m_{it}+\alpha_k k_{it}+g(k_{it},m_{it})$.

Note that this equation is the first step of the LP and ACF estimation algorithms.

The unanticipated productivity shocks follows a first order Markov process and its innovations are defined by $a_{it}=p_{it}-E(p_{it}\mid p_{it-1})$. The expected value of p_{it} conditional on p_{it-1} is a function *f(.)* of m_{it-1} and k_{it-1}, i.e., $E(p_{it}|p_{it-1})\equiv f[g(m_{it-1},k_{it-1})]$, then

$$v_{it} = f[g(m_{it-1},\ k_{it-1})] + a_{it} \tag{18}$$

Plugging (18) into (13) gives

$$y_{it} = \alpha_0 + \alpha_l l_{it} + \alpha_m m_{it} + \alpha_k k_{it} + f[g(k_{it-1}, m_{it-1})] + a_{it} + \varepsilon_{it}$$

If $u_{it} = a_{it} + e_{it}$ then,

$$y_{it} = \alpha_0 + \alpha_l l_{it} + \alpha_m m_{it} + \alpha_k k_{it} + f[g(k_{it-1}, m_{it-1})] + u_{it}\,. \tag{19}$$

Remember that the equation of the first step in OP, LP and ACF is given by

$$y_{it} = \alpha_0 + \alpha_l l_{it} + \alpha_m m_{it} + \alpha_k k_{it} + g(k_{it-1}, m_{it-1}) + \varepsilon_{it}\,. \tag{20}$$

The orthogonality condition for equations (19) and (20) are given by

$$E(u_{it} \mid m_{it},\ k_{it}, l_{it-1}, m_{it-1},\ k_{it-1}, ..., l_{i1}, m_{i1},\ k_{i1}) = 0\,, \tag{21}$$

$$E(\varepsilon_{it} \mid\ l_{it}, m_{it},\ k_{it}, l_{it-1}, m_{it-1},\ k_{it-1}, ..., l_{i1}, m_{i1},\ k_{i1}) = 0\,, \tag{22}$$

respectively.

The main concern in the estimation of α_l, α_m and α_k is that we have to deal with unknown functions *g*(.) and *f*(.). An approach that has been found to work well is to use high order polynomials. Thus we have

$$g(m_{it}, k_{it}) = \lambda_0 + \mathbf{c}(m_{it}, k_{it})\lambda\,, \tag{23}$$

for a 1XQ vector of functions **c**(.). Further assume that *f*(.) can be approximated by a polynomial of degree G in **c** such that (19) and (20) becomes

$$y_{it} = \alpha_0 + \alpha_l l_{it} + \alpha_m m_{it} + \alpha_k k_{it} + \mathbf{c}(k_{it}, m_{it})\lambda + \varepsilon_{it}\,, \tag{24}$$

and

$$y_{it} = \delta_0 + \alpha_l l_{it} + \alpha_m m_{it} + \alpha_k k_{it} + \rho_1(\lambda c_{i,t-1}) + ... + \rho_G(\lambda c_{i,t-1})^G + u_{it}\,. \tag{25}$$

Given the moment conditions (21) and (22) it is possible to use an instrumental variables procedure for (24) and (25). The most straightforward choice of instruments for (24) is simply

$$\mathbf{z}_{it1} = (1, l_{it}, k_{it},\ \mathbf{c}^{\mathbf{0}}_{\mathbf{it}})\,, \tag{26}$$

where $\mathbf{c}^{\mathbf{0}}$ is **c** without k. Instruments for (25) would include

$$\mathbf{z}_{it2} = (1, k_{it}, l_{it-1},\ \mathbf{c}_{\mathbf{it-1}}, \mathbf{q}_{\mathbf{it-1}})\,, \tag{27}$$

being **q** a set of non-linear functions of **c** (e.g. low order polynomials).

A simple estimation approach is to choose, for each i, a matrix of instruments as

$$\mathbf{Z}_{it} = \begin{pmatrix} (l_{it}, \mathbf{c_{it}}, \mathbf{z}_{it2}) & 0 \\ 0 & \mathbf{z}_{it2} \end{pmatrix}, t = 2, ..., T \tag{28}$$

GMM estimation in (24) and (25) is now straightforward. For each t>1 define a residual function as

$$\mathbf{r}_{it}(\boldsymbol{\theta}) = \begin{pmatrix} r_{it1}(\boldsymbol{\theta}) \\ r_{it2}(\boldsymbol{\theta}) \end{pmatrix} = \begin{pmatrix} y_{it} - \alpha_0 - \alpha_l l_{it} - \alpha_m m_{it} - \alpha_k k_{it} - \lambda \mathbf{c_{it}} \\ y_{it} - \delta_0 - \alpha_l l_{it} - \alpha_m m_{it} - \alpha_k k_{it} - \rho_1(\mathbf{c_{i,t\text{-}1}} \boldsymbol{\lambda}) - ... - \rho_G(\mathbf{c_{i,t\text{-}1}} \boldsymbol{\lambda})^G \end{pmatrix} \tag{29}$$

so that,

$$E[\mathbf{Z}_{it}\text{'}\mathbf{r}_{it}(\boldsymbol{\theta})] = 0, t = 2, ..., T \tag{30}$$

This T-1 conditions can be stacked for each i and standard GMM estimation can be used.

3.5 Further empirical results

Table 8, panel B, shows the estimates of the input elasticities for the LP and ACF procedures in the case of Costa Rica. We apply these procedures only to Costa Rica because the panels of Guatemala, Honduras and Nicaragua are very unbalanced and these procedures use the lag of the inputs as instruments. For the procedure of ACF we use the Wooldridge (2005) GMM procedure with heteroskedastic standard errors. We use a polynomial of degree 3 to approximate equation (23), i.e., Q = 3, and a polynomial of degree 1 to approximate function $f(.)$, i.e. G=1. As expected, in Table 8 panel B, the input-output elasticity of capital obtained by L&P or by ACF are too low, 0.08 and 0.09 respectively. This is not solved by estimating equation (9a) by fixed effects (FE), without controlling for IC variables since the estimated elasticity of capital is 0.07. However, remember that when controlling for IC variables a simple OLS with robust standard errors, or a random effects estimators, provide an elasticity of capital equal to 0.12, see Table 8, panel B. A question of interest for further research is how to extend O&P, L&P and ACF procedures to control for IC variables.

However, the robustness of IC elasticities in TFP is preserved estimating also by these procedures. With the estimated input elasticities (from O&P and ACF) we estimated firms' productivity (TFP) and in a second step we evaluated the impact of the investment climate variables selected in section 2 from equation (12). The results are shown in Table 15. For comparative purpose, the first column shows the results obtained using Solow residual. As can be seen, the IC results on productivity are still robust. None of the IC variables change signs and the magnitudes of the coefficients are similar.

4 Conclusion

There is not a single salient measure of productivity. For the analysis of the investment climate (IC) determinants of productivity in Costa Rica, Guatemala, Honduras and Nicaragua, *productivity* is considered to be that part of the production of goods (sales) that is not explained by the main inputs (labor, intermediate materials and capital). This productivity concept is sometimes called total factor productivity (TFP) or multifactor productivity (MFP).

Several measures are used to evaluate what is broadly understood as productivity and a methodology is developed that produces robust estimates regardless of the measure used. We show that it is possible to get *consistent and robust* estimates (elasticities) of investment climate determinants of productivity. This is so no matter whether we use productivity measures with a low correlation coefficient, such as 0.11 (very different), or a high one, such as 0.98 (similar).

The main requirement of this econometric methodology for *internal consistency* is that the policy implications must be robust: 1) among *different functional forms* of the production functions, 2) among *different consistent estimation procedures*, 3) among *different productivity measures* and 4) among *different levels of aggregation* (industry, country, pooling countries, etc.). In our case, all the signs of the estimated coefficients are as expected. Obviously, the numerical values of those elasticities parameters vary from one productivity measure to the next, but the range of values is reasonable and significant in most cases.

The analysis is undertaken without transforming the variables into rates of growth. There are good reasons explaining that decision: (a) the IC variables are available for only one year; (b) the panel data for Guatemala, Honduras and Nicaragua is very unbalanced with many more observations in 2002 than in 2001, hence computing rates of growth for the non IC variables implies loosing many observations; and (c) measurement errors are enhanced by taking first differences. Therefore, variables in levels are used with logarithmic (logs) transformation of output, labor, intermediate materials and capital.

Productivity is estimated as the residual of the production function. To get consistent least squares estimates of the input-output elasticities it is necessary that all inputs are uncorrelated with productivity. But this is almost never the case with annual data sets, like the IC surveys, since the investment climate (IC) variables affect both the inputs and the productivity. This condition invalidates any two-step least squares procedures where first the productivity variable and then its investment climate determinants are estimated, unless you control in both steps by IC variables. This problem also affects procedures like Olley and Pakes (1996), Levinsohn and Petrin (2003) or Ackerberg et al. (2007).

Given that good instrumental variables are difficult to find for the IC variables, we suggest a single-step least squares estimation procedure where the parameters of the production function (input-output elasticities) are jointly estimated with the coefficients of the IC determinants of productivity.

A valid two-step approach is also used when the input-output elasticities are obtained, following Solow (1957), as cost-shares, since there is no erogeneity requirement of the inputs. Once productivity is measured as the Solow residual in levels (logs), the IC determinants of productivity can be consistently estimated in a second step.

The possible endogeneity of the IC variables is reduced by taking their region-industry averages. To correct for heteroskedasticity (heterogeneity) of the individual unobserved terms, we estimate by least squares (pooling OLS) with robust standard errors and by random effects. The results obtained are very similar.

For policy analysis there is no need to use a single value for the elasticity or semi-elasticity of each IC variable. In fact, it is more interesting to perform a sensitivity analysis based on the range of parameter values obtained for several productivity measures.

Four important categories of investment climate (IC) variables are identified: (a) Infrastructure, (b) Read Tape, Corruption and Crime, (c) Finance and Corporate Governance and (d) Quality, Innovation and Labor Skills. Within each group, all the IC variables always have the expected signs and the estimated elasticities or semi-elasticities are always within a reasonable value range for the ten productivity measures considered. In absolute terms, the higher values of the IC elasticities correspond to the

Solow residual or to the Cobb-Douglas specification, while the lowest usually correspond to the Translog production function. Therefore, we observe a trade-off between the role played by the inputs (labor, intermediate materials and capital) and the role played by the IC variables and other control variables.

In summary, the robustness of these empirical results across 10 productivity measures allows us to obtain consistent empirical evaluations of the IC determinants of productivity. The estimates show consistently the high impact of investment climate on productivity. Overall, it accounts for over 30 percent of productivity. In Guatemala, Honduras and Nicaragua, the two most impacting categories are red tape, corruption and crime, and infrastructure, accounting respectively for about 12 and 9 percent of productivity.

Although more sophisticated econometric techniques could be applied, to take into account that the inputs are not used at full capacity, firms might not be at the frontier of the production possibility frontiers, etc., we plan to apply this simple and robust procedure to several developing countries. The objective is to identify, at the firm level, basic robust empirical regularities on the main bottlenecks on productivity and to make cross county comparisons. Those empirical results could be used later on as a benchmark for further improvements.

The policy implications from this simple analysis are clear. Investment climate matters enormously and the relative size of the impact of the various investment climate variables indicates where the efforts of reform should be placed.

5 References

Ackerberg, D., K. Caves, and G. Frazer (2007). "Structural Identification of Production Functions," mimeo.

Alexander, W. Robert J., Bell, John D., and Knowles, Stephen (2004). "Quantifying Compliance Costs of Small Businesses in New Zealand". Discussion paper, University of Otahgo. http://www.business.otago.ac.nz/econ/research/discussionpapers/DPO406.pdf.

Arellano M. (2003). Panel Data Econometrics. Advanced Texts in Econometrics, Oxford University Press.

Barro R. J. and X. Sala-i-Martin (2004). Economic Growth. The MIT Press, second edition, Cambridge, Massachusetts.

Bartelsman E. J. and M. Doms (2000). "Understanding Productivity: Lessons from Longitudinal Microdata". *Journal of Economic Literature*, Vol. 38, Nº 3, 569-594.

Basu S. and J. Fernand (2001). "Why is Productivity Procyclical? Why do we Care?". In Ch. R. Hulten, E.R. Dean and M. J. Harper (eds.) New Developments in Productivity Analysis, The University of Chicago Press, 225-301.

Blundell R. and S. Bond (2000). "GMM Estimation with Persistent Panel Data: An Application to Production Functions". *Econometric Reviews*, 19 (3), 321-340.

Blundell R. and J. L. Powell (2003). "Endogeneity in Nonparametric and Semiparametric Regression Models" In Advances in Economics and Econonometrics: Theory and Applications, Eighth World Congress, Vol. II, M. Dewatripont, L.P. Hansen and S.J. Turnovsky, eds. Cambridge: Cambridge University Press, 313-357.

Bosworth, Barry and Susan Collins (2003). "The Empirics of Growth: An Update". The Brookings Institution. Washington, D.C. Processed.

Cole, H. L., L. E. Ohanian, A. Riascos and J. A. Schmitz Jr. (2004). "Latin America in the Rearview Mirror". National Bureau of Economic Research WP #11008, December.

De Soto, Hernando (2002). "The Mystery of Capital: Why Capitalism Triumphs in the West and Fails Everywhere Else". New York: Basic Books Press.

Diewert W. Erwin and Alice O. Nakamura (2002) "The Measurement of Aggregate Total Factor Productivity Growth". J. J. Heckman and E. E. Leamer (eds.). Handbook of Econometrics, Vol. 6, forthcoming.

Djankov, Simeon, La Porta, Rafael, Lopez-de-Silanis, Florencio, and Shleifer, Andrei (2002). "The Regulation of Entry". *Quarterly Journal of Economics* 117, February 2002. 1-37.

Dollar, David, Anqing Shi, Shuilin Wang and L. Colin. Xu (2004). "Improving City Competitiveness through the Investment Climate: Ranking 23 Chinese Cities". Washington, D.C., World Bank.

Dollar, David, Mary Hallward-Driemeier and Taye Mengistae (2004). "Investment Climate and International Integration". Washington, D.C., World Bank.

Dollar, David, Mary Hallward-Driemeier and Taye Mengistae (2003). "Investment Climate and Firm Performance in Developing Economies". Washington, D.C., World Bank.

Escribano Alvaro and J. Luis Guasch (2005). "Assessing the Impact of the Investment Climate on Productivity using Firm Level Data: Methodology and the Cases of Guatemala, Honduras and Nicaragua". Policy Research Working Paper # 3621, The World Bank, June.

Escribano Alvaro and J. Luis Guasch (2004). "Econometric Methodology for Investment Climate Assessments (ICA) on Productivity using Firm Level Data: The Case of Guatemala, Honduras and Nicaragua". Mimeo World Bank, June.

Escribano Alvaro and Jorge Pena (2004). "Productivity in Levels or in Differences: Evaluation of the Impact of ICT from Firm Level Data on the Spanish Manufacturing Sector". Mimeo, Universidad Carlos III de Madrid.

Foster L., J. Haltiwanger and C.J. Krizan (1998). "Aggregate Productivity Growth: Lessons from Microeconomic Evidence". *NBER Working Paper* W6803.

Griliches Z. (1996). "The Discovery of the Residual: A Historical Note". *Journal of Economic Literature,* 34, 1324-1330.

Griliches Z. and J. Mairesse (1997). "Production Functions: The Search for Identification". In S. Strom (ed.) Essays in Honor of Ragnar Frisch, Econometric Society Monograph Series, Cambridge University Press, Cambidge.

Guasch, J. Luis. (2004). "An Assesment of Logistic Costs and of their Impact on Competitiveness", World Bank, Washington, DC.

Hall, R. E. (1988). "The Relationship between Price and Marginal Cost in U.S. Industry". *Journal of Political Economy*, 96, 5, 921-947.

Hall, R. E. (1990). "Invariance Properties of Solow´s Productivity Residual". In Peter Diamond (ed.). Growth, Productivity, Employment. Cambridge: MIT Press, 1-53.

Hall, R. E. and C.I. Jones (1990). "Why Do Some Countries So Much More Output per Worker than Others?" *The Quarterly Journal of Economics*, 114, 1, 83-116.

Haltiwanger, John (2002). "Understanding Economic Growth". The Need for Micro Evidence". *New Zealand Economic Papers* 36 (1), 33-58.

He, Kathy S., Morck, Randall, and Yeung, Bernard (2003). "Corporate Stability and Economic Growth". William Davidson Working Paper No. 553.

Hulten Ch. R. (2001). "Total Factor Productivity: A Short Biography". In Ch. R. Hulten, E.R. Dean and M. J. Harper (eds.) New Developments in Productivity Analysis, The University of Chicago Press, 1-47.

Im, K.S., M.H. Pesaran and Y. Shin (2003). "Testing for Unit Roots in Heterogenous Panels". Journal of Economics, 115, 53-74.

Johnson, Simon, McMillan, John, and Woodruff, Christopher (2002). "Property Rights and Finance". *American Economic Review* 92, 1335-56.

Jorgenson D.W. (2001). "Information Technology and the U.S. Economy," *The American Economic Review*, Vol. 91, 1, 1-32.

Jorgenson D.W., F. Gollop and B. Fraumeni (1987). "Productivity and U.S. Economic Growth," Cambridge: Harvard University Press.

Jorgenson D.W. and Z. Griliches (1967). "The Explanation of Productivity Change," *Review of Economic Studies*, 34, 249-280.

Kasper, Wolfgang, (2002), "Losing Sight of the Lodestar of Economic Freedom: A Report Card on New Zeland's Economic Reform," NZ Business Roundtable.

Kerr, Roger (2002). "The Quagmire of Regulation," NZ Business Roundtable. http://www.nzbr.org.nz/documents/speeches/speeches-200/the_quagmire_of_regulation.pdf.

Klapper, Leora, Laeven, Luc, and Rajan, Raghuram (2004). "Business Environment and Firm Entry". NBER paper 10380. http://papers.nber.org/papers/W10380.

Levinsohn J. and A. Petrin (2003). "Estimating Production Functions Using Inputs to Control for Unobservables". *Review of Economic Studies*, 70, 317-341.

Loayza, N.V., A. M. Oviedo and Luis Serven (2004). “Regulation and Macroeconomic Performance”, World Bank, Washington DC.

Marschak J. and W. H. Andrews (1944). “Random Simultaneous Equations and the Theory of Production”. *Econometrica*, 12 (3,4), 143-205.

McMillan, John, (1998), “ Managing Economic Change: Lessons from New Zeland”, *The World Economy 21,* 827-43.

Mc Millan, John (2004), “A Flexible Economy? Entrepeneurship and Productivity in New Zeland”, Working Paper, Graduate Scholl of Business, Stanford University, Stanford, CA.

Olley G. S.and A. Pakes (1996). “The Dynamics of Productivity in the Telecommunications Equipment Industry”. *Econometrica*, Vol. 64, 6, 1263-1297.

Organization for Economic Cooperation and Development (2001). *Businesses' Views on Red Tape,* Paris, OECD. http://www1.oecd.org/publications/e-book/4201101E.PDF.

Prescot, Edward C. (1998) "Needed: A Theory of Total Factor Productivity". International Economic Review, 39, 525-552.

Rodrik, Dani, and Arvind Subramanian (2004). “From ‘Hindu Growth to Productivity Surge: The Mystery of the Indian Growth Transition”. Harvard University, Cambridge, Mass. Processed.

Solow R. M. (1957). “Technical Change and the Aggregate Production Function” *The Review of Economics and Statistics*, 39 (3), 312-320.

Stiroh K.J. (2002). “Information Technology and the U.S. Productivity Revival: Whta Do the Industry Data Say?” *The American Economic Review*, Vol. 92, 5, 1559-1575.

Tornqvist L. (1936). “The Bank of Finland´s Consumption Price Index”. *Bank of Finland Monthly Bulletin,* 10, 1-8.

Wooldridge J. M. (2002). Econometric Analysis of Cross Section and Panel Data. The MIT Press. Cambridge, Massachusetts.

World Bank 2003. “Doing Business in 2004” Understanding Regulation. Washington, D.C. World Bank.

___________ 2004. “Doing Business in 2005: Removing Obstacles to Growth”. Washington, D.C. World Bank.

___________ 2004. “2003 Annual Review of Development Effectiveness: The Effectiveness of Bank Support for Policy Reform. Report 28290”. Washington, D.C.: World Bank Operations Evaluation Department.

___________ 2005. “World Development Report 2005: A Better Investment Climate for Everyone”. World Bank and Oxford University Press. Washington, D.C.

Wilkinson, Bryce (2001). “Constraining Government Regulation”. NZ Business Roundtable. http://www.nzbr.org.nz/documents/publications/publications-2001/constraining_govt.pdf.

Appendix: Tables and Figures

Table 1: General information at plant level and production function variables: Guatemala, Honduras and Nicaragua

General Information at Plant Level	Industrial classification	Apparel, beverages, chemical/rubber, food/tobacco, leather/shoes, nonmetallic minerals, textiles, metal products.
	Regional classification	Guatemala: Guatemala city, Metropolitan area close to Guatemala city, Metropolitan area far from Guatemala city, Altiplano region, Coast region, Northwest region. Honduras: Western region, Center-South region, Olancho region, North cost region. Nicaragua: Managua region, Pacific region.
Production Function Variables	Sales	Used as the measure of output for the production function estimation. For all countries, it is converted into USD using IMF average exchange rates.
	Employment	Total number of workers.
	Materials	Total costs of intermediate and raw materials used in production (excluding fuel). For all countries, it is converted into USD using IMF average exchange rates.
	Capital stock	Net book value of all fixed assets.
	Labor cost	Total expenditures on personnel.

Table 2: General information at plant level and production function variables: Costa Rica

General Information at Plant Level	Industrial classification	Food and beverages; textiles; apparels; wood and furniture; paper and edition; chemicals rubber and plastics; non-metallic products; machinery and equipment-metallic products.
	Regional classification	San José; Alajuela; Cartago; Heredia; Guanacaste; Puntarenas; Provincia Limón. Additional classification used in figures: Great Urban, Rest of Central Valley, Rest of the Country.
Production Function Variables	Sales	Used as the measure of output for the production function estimation. Sales are defined as total sales plus the changes in the inventories of finished goods. The series are deflated by using the Industrial Production Price Index, base 1999.
	Employment	Total number of permanent and temporal workers (full or part time).
	Total hours worked per year	Total number of employees multiplied by the average hours worked per year.
	Materials	Total costs of intermediate and raw materials used in production (excluding fuel). The series are deflated by using the Industrial Production Price Index, base 1999.
	Capital stock	Net book value of all fixed assets (log). The series are deflated by using the Industrial Production Price Index, base 1999.
	User cost of capital	The user cost of capital is defined in terms of the opportunity cost of using capital; it is defined as the long term interest rate in Costa Rica (more than 5 years) plus a depreciation rate of 20% minus the rate of growth of the consumption price index.
	Labor cost	Total expenditures on personnel, deflated by using the Industrial Production Price Index, base 1999.

Table 3.a: Investment climate (IC) variables: Infrastructures

Name of the variable	Description of the variable
Days to clear customs for exports	Average number of days to clear customs for export.
Days to clear customs for imports	Average number of days to clear customs for imports.
Power outages	Number of power outages suffered by a plant in 2004.
Average duration of power outages	Average duration of power outages suffered by the plant in hours.
Losses due to power outages	Value of the losses due to power outages as a percentage of sales (conditional on the plant reporting power outages).
Water outages	Number of water outages suffered by a plant in 2004.
Average duration of water outages	Average duration of water outages suffered by the plant in hours.
Losses due to water outages	Value of the losses due to water outages as a percentage of sales (conditional on the plant reporting water outages).
Fixed phone outages	Number of fixed phone outages suffered by a plant in 2004.
Average duration of fixed phone outages	Average duration of fixed phone outages suffered by the plant in hours.
Losses due to fixed phone outages	Value of the losses due to fixed phone outages as a percentage of sales (conditional on the plant reporting fixed phone outages).
Cellular phone outages	Number of cellular phone outages suffered by a plant in 2004.
Average duration of cellular phone outages	Average duration of cellular phone outages suffered by the plant in hours.
Losses due to cellular phone outages	Value of the losses due to cellular phone outages as a percentage of sales (conditional on the plant reporting cellular outages).
Internet outages	Number of internet outages suffered by a plant in 2004.
Average duration of internet outages	Average duration of internet outages suffered by the plant in hours.
Losses due to internet outages	Value of the losses due to internet outages as a percentage of sales (conditional on the plant reporting water outages).
Shipment losses (domestic sales)	Fraction of the value of the plant's average cargo consignment that was lost in domestic transit due to breakage, theft, spoilage or other deficiencies of the transport means used.
Shipment losses (exports)	Fraction of the value of the plant's average cargo consignment that was lost in international transit due to breakage, theft, spoilage or other deficiencies of the transport means used.
Shipment losses due to spoilages (domestic sales)	Fraction of the value of the plant's average cargo consignment that was lost in domestic transit due to breakage or spoilage.
Shipment losses due to thefts (domestic sales)	Fraction of the value of the plant's average cargo consignment that was lost in domestic transit due to theft
Shipment losses due to spoilages (exports)	Fraction of the value of the plant's average cargo consignment that was lost in international transit due to breakage or spoilage.
Shipment losses due to thefts (exports)	Fraction of the value of the plant's average cargo consignment that was lost in international transit due to theft.
Wait for electric supply	Number of days waiting for a public electric supply since the moment of the application to the day the service was received (number of days)
Wait for water supply	Number of days waiting for a public water supply since the moment of the application to the day the service was received (number of days)
Wait for fixed phone	Number of days waiting for a fixed phone supply since the moment of the application to the day the service was received (number of days)
Wait for cellular phone	Number of days waiting for a cellular phone supply since the moment of the application to the day the service was received (number of days)
Wait for internet connection	Number of days waiting for an internet connection since the moment of the application to the day the service was received (number of days)
E-mail	Dummy variable that takes value 1 if the firm use regularly the e-mail to communicate with its clients and suppliers.
Web page	Dummy variable that takes value 1 if the firm use regularly its own web page to communicate with its clients and suppliers.
Payments through internet	Percentage of firm's sales that has been paid through internet in 2004.

Table 3.b: Investment climate (IC) variables: Red Tabe, Corruption and Crime

Name of the variable	Description of the variable
Criminal attempts	Dummy variable that takes value 1 if the plant suffered any criminal attempt during last year.
Losses due to criminal activity	Value of losses due to criminal activity.
Number of criminal attempts	Total number of criminal attempts suffered by the plant during last year.
Security	Cost in security (equipment, staff, etc).
Illegal payments for protection	Cost due to protection payments, e. g. to organized crime, to prevent violence (bribery).
Manager’s time spent in bureaucratic issues	Percentage of managers' time spent in dealing with bureaucratic issues.
Payments to deal with bureaucratic issues	Dummy that takes value 1 if firms in the main sector occasionally need to give gifts or make informal payments to public officers in order to “get things done” with regard to customs, taxes, licenses, legislations, services, etc.
Average amount of payments to deal with bureaucratic issues	Average amount of payments to deal with bureaucratic issues as a percentage o annual total sales in a standard firm.
Sales declared to taxes	Percentage of total sales declared to taxes.
Labor costs declared	Percentage of workforce declared to taxes.
Number of inspections	In the last year, total number of inspections regarding with taxes, employment, health control, municipal inspectors, etc.
Payments to obtain a contract with the government	Dummy that takes value 1 if firms in the main sector occasionally need to give gifts or make informal payments in order to get a contract with the government.
Average payments to obtain a contract with the government	Value of this gifts or payments as a percentage of the contract value
Conflicts with clients	Dummy variable that takes value 1 if the firm has had any conflict with clients during 2004
Conflicts with employees	Dummy variable that takes value 1 if the firm has had any conflict with employees during 2004
Delayed payments	Percentage of monthly total sales to private customers that were not paid within the agreed time.
Sales never repaid	Percentage of monthly total sales to private customers that were never repaid.
Cost of entry	Cost of entry to the market in terms of days spent waiting for permissions and licenses.
Cost of continuing	Cost of continuing in the market in terms of number of days spent waiting for permissions and licenses.
Absenteeism	Days of production lost due to absenteeism.
Civil protest	Days of production lost due to civil protest.

Table 3.c: Investment climate (IC) variables: Finance and Corporate Governance

Name of the variable	Description of the variable
Trade association	Dummy variable that takes value 1 if the plant belongs to any association or trade chamber.
Credit line	Dummy variable that takes value 1 if the plant reports that it has a credit line.
Debts with creditors	Dummy variable that takes value 1 if the firm has any debt with suppliers.
Loan	Dummy variable that takes value 1 if the plant reports that it has a bank loan.
Loan - Collateral	Dummy variable that takes value 1 if the firm has a loan line and this loan has collateral.
Loan - Value of the collateral	Total vale of the collateral as a percentage of total value of the loan.
Loan - Interest rate	Average interest rate applied to the loan during last year.
Loan - From formal institutions	Dummy variable that takes value 1 if the last loan obtained comes from formal institutions e.g. state-owned banks, domestic private banks, foreign private banks, off-shore banking, etc.
Loan - From informal institutions	Dummy variable that takes value 1 if the last loan obtained comes from non-formal institutions e.g. family or money lenders.
External auditory	Dummy variable that takes value 1 if firm's annual statements are engaged in a process of external auditory.
Profit	Firm's profits after taxes as a percentage of total sales.
Reinvestment	Percentage of profits that were reinvested in the firm last year.
Owner of the lands	Dummy variable that takes value 1 if the firm is the owner of almost all its lands.
Owner of the buildings	Dummy variable that takes value 1 if the firm is the owner of almost all its buildings.
Financing - Internal founds	Percentage of financing that comes from internal founds.
Financing - State-owned banks	Percentage of financing that comes from state-owned banks.
Financing - Domestic private banks	Percentage of financing that comes from domestic private banks.
Financing - Foreign private banks	Percentage of financing that comes from foreign private banks.
Financing - Off-shore banks	Percentage of financing that comes from off-shore banks.
Financing - Governmental programs	Percentage of financing that comes from governmental programs.
Financing - Non-financial institutions	Percentage of financing that comes from non-financial institutions.
Financing - Family loans	Percentage of financing that comes from family loans.
Financing - Informal sources	Percentage of financing that comes from informal sources.
Financing - Credit from suppliers	Percentage of financing that comes from credits from suppliers.
Investment - Internal founds	Percentage of investments financed with internal founds.
Investment - State-owned banks	Percentage of investments financed with state-owned banks.
Investment - Domestic private banks	Percentage of investments financed with domestic private banks.
Investment - Foreign private banks	Percentage of investments financed with foreign private banks.
Investment - Off-shore banks	Percentage of investments financed with off-shore banks.
Investment - Governmental programs	Percentage of investments financed with governmental programs.
Investment - Non-financial institutions	Percentage of investments financed with non-financial institutions.
Investment - Family loans	Percentage of investments financed with family loans.
Investment - Informal sources	Percentage of investments financed with informal sources.
Investment - Credit from suppliers	Percentage of investments financed with credits from suppliers.
Checking account	Dummy variable that takes value 1 if the firm has a checking account
Insurance	Dummy variable that takes value 1 if the firm has insurances.

Table 3.d: Investment climate (IC) variables: Quality innovation, and labor skills

Name of the variable	Description of the variable
Quality certification	Dummy variable that takes value 1 if the plant has a quality certification.
ISO certification	Dummy variable that takes value 1 if the plant has any kind of ISO certification.
New product	Dummy variable that takes value 1 if the plant has developed a new product line.
Product improvement	Dummy variable that takes value 1 if the plant has developed a product improvement.
Joint venture	Dummy variable that takes value 1 if the firm has established a joint venture with a foreign partner.
New technological license	Dummy variable that takes value 1 if the plant has obtained a new agreement of technological license.
Outsourcing	Dummy variable that takes value 1 if the plant has outsourced any activity previously performed in the firm.
LACOMET	Dummy variable that takes value 1 if the plant has obtained a certification of assessment of equipments and installations (LACOMET).
R + D	Dummy variable that takes value 1 if the plant reports to perform R+D activities.
Internal R + D	Dummy variable that takes value 1 if the plant performed internal R+D activities during 2004.
External R + D	Dummy variable that takes value 1 if the plant performed external R+D activities during 2004.
Computer controlled machinery	Dummy variable that takes value 1 if the plant has any computer controlled machinery
Quality control	Number of plant's employees designated to deal with tasks related to quality control of the final products.
Design and engineering	Number of plant's employees designated to deal with tasks related to engineering and design.
New technology	Dummy variable that takes value 1 if the firm has acquired any new technology with important implications in the production process.
Professional workers	Percentage of professional workers in firm's staff.
Skilled workers	Percentage of skilled workers in firm's staff.
Unskilled workers	Percentage of unskilled workers in firm's staff.
Female workers	Percentage of female workers in firm's staff.
Immigrant workers	Percentage of immigrant workers in firm's staff.
Fired workers	Percentage of employees fired during last year.
Training to skilled workers	Percentage of skilled workers that received formal training during last year.
Weeks of training to skilled workers	Average number of weeks of formal training to skilled workers.
Training to unskilled workers	Percentage of unskilled workers that received formal training during last year.
Weeks of training to unskilled workers	Average number of weeks of formal training to unskilled workers.
IT training	Percentage of workers that received training in information and communication technologies during last year.
Staff with computer	Percentage of employees that use a computer.
Strikes	Days of production lost due to strikes.
University staff	Percentage of total staff with at least one year of university education.
Education of the manager	Dummy variable that takes value 1 if the manager of the plant has a bachelor or higher education degree.
Experience of the manager	Number of years of experience of the manager.

Table 3.e: Investment climate (IC) variables: Other Control Variables

Name of the variable	**Description of the variable**
Incorporated company	Dummy variable that takes value 1 if the plant is an incorporated company.
Open incorporated company	Dummy variable that takes value 1 if the plant is an open incorporated company.
Public	Dummy variable that takes value 1 if the firm belongs to the government.
Foreign direct investment	Dummy variable that takes value 1 if any part of the capital of the firm is foreign.
Number of competitors	Number of competitors in the main market.
Industrial zone	Dummy variable that takes value 1 if the firm is located in an industrial zone.
ICC	Dummy variable that takes value 1 if the firm has obtained any profit from the trade agreement signed with the United Sates "Iniciativa de la Cuenca del Caribe" (ICC).
Trade agreements	Dummy variable that takes value 1 if the firm has obtained any profit from any agreement signed by its government related with free trade.
Capacity utilization	Average percentage of capacity used during last year.
Exporter	Dummy variable that takes value 1 if direct exports are greater than 10%.
Importer	Dummy variable that takes value 1 if direct imports are greater than 10%.
Age	Difference between the year that the plant started operations and current year.
Trade union	Percentage of workers that belongs to a syndicate.

Table 4: Total number of observations used in the IC regressions by country and industry

	Pool			Total Pool	Costa Rica
	Guatemala	Honduras	Nicaragua		
Apparel	129	70	64	**263**	111
Food/ Tobacco	102	134	68	**304**	0
Beverages	8	19	17	**44**	0
Food and beverages	0	0	0	**0**	132
Chemical/Rubber	61	35	67	**163**	148
Furniture/ Wood	56	126	127	**309**	145
Leather/ Shoes	6	0	45	**51**	0
Nonmetallic minerals	36	44	69	**149**	104
Textiles	22	9	7	**38**	0
Metal Products	48	35	57	**140**	64
Paper & edition	0	0	0	**0**	128
Machinery & Equipment	0	0	0	**0**	162
Total	**468**	**472**	**521**	**1461**	**994**

Source: Authors' elaboration with Investment Climate Surveys (ICs) data.

Table 5: Total number of observations used in the IC regressions by year and industry

A. Guatemala, Honduras and Nicaragua

	2001	2002	Total
Apparel	71	191	262
Food/ Tobacco	12	32	44
Beverages	52	111	163
Chemical/Rubber	103	201	304
Furniture/ Wood	90	219	309
Leather/ Shoes	15	36	51
Nonmetallic minerals	44	105	149
Textiles	8	30	38
Metal Products	45	95	140
Total	440	1020	1460

Source: Authors' elaboration with Investment Climate Surveys (ICs) data.

B. Costa Rica

	2002	2003	2004	Total
Food & beverages	43	44	45	**132**
Textiles	21	21	22	**64**
Apparels	35	38	38	**111**
Wood & furniture	47	48	50	**145**
Paper & edition	42	43	43	**128**
Chemicals, rubber & plastics	49	49	50	**148**
Non-metallic products	34	34	36	**104**
Machinery & Equipment-Metallic products	52	54	56	**162**
Total	**323**	**331**	**340**	**994**

Source: Authors' elaboration with Investment Climate Surveys (ICs) data.

Table 6: Correlation matrix among productivity measures: Guatemala, Honduras, and Nicaragua

		Two steps		Single step Restricted				Single step Unrestricted			
		Solow's Residual		Cobb Douglas		Translog		Cobb Douglas		Translog	
		Restr.	Unrestr.	OLS	RE	OLS	RE	OLS	RE	OLS	RE
Two steps	**Restricted Solow's residual**	1									
	Unrestricted Solow's residual	0.94	1								
Single step Restricted	**Cobb Douglas OLS**	0.93	0.99	1							
	Cobb Douglas RE	0.91	0.98	0.98	1						
	Translog OLS	0.87	0.93	0.94	0.92	1					
	Translog RE	0.87	0.94	0.94	0.95	0.98	1				
Single step Unrestricted	**Cobb Douglas OLS**	0.69	0.63	0.63	0.61	0.58	0.58	1			
	Cobb Douglas RE	0.63	0.62	0.62	0.63	0.56	0.58	0.90	1		
	Translog OLS	0.25	0.26	0.27	0.33	0.21	0.28	0.23	0.40	1	
	Translog RE	0.14	0.20	0.21	0.26	0.17	0.21	-0.13	0.08	0.83	1

Source: Authors' elaboration with Investment Climate Surveys (ICs) data.
NOTES:
a) Solow residuals in levels are obtained as sales (in logarithms or logs) minus a weighted average of labor, materials, capital (all in logs) where the weights are given by the share in total costs of each of the inputs.
(1) Restricted case: the cost shares are calculated as the averages of the plant-level cost shares across the entire sample in 2001 and 2002.
(2) Unrestricted by Industry case: the cost shares are calculated as the averages across plant-level cost shares in years 2001 and 2002. for each of the nine industries.
(3) Outlier plants were defined as those which had ratios of materials to sales larger than one or had ratios of labor costs to sales larger than one.
b) Estimated Productivity in levels is obtained from Cobb-Douglas and Translog production functions of sales with inputs labor, materials, and capital estimated by OLS and random effects under two different environments:
(1) Restricted: a single set of production function coefficients is obtained using data on plants in the three countries, for all industries in years 2001 and 2002 (excluding outliers).
(2) Unrestricted by Industry: a set of production function coefficients is obtained for each of nine industries using data on all plants for the three countries in years 2001 and 2002 (excluding outliers).

Table 7: Correlation matrix among productivity measures: Costa Rica

		Two steps		Single step Restricted				Single step Unrestricted			
		Solow's Residual		Cobb Douglas		Translog		Cobb Douglas		Translog	
		Restr.	Unrestr.	OLS	RE	OLS	RE	OLS	RE	OLS	RE
Two steps	**Restricted Solow's residual**	1									
	Unrestricted Solow's residual	0.99	1								
Single step Restricted	**Cobb Douglas OLS**	0.99	0.98	1							
	Cobb Douglas RE	0.95	0.93	0.97	1						
	Translog OLS	0.92	0.91	0.93	0.91	1					
	Translog RE	0.91	0.90	0.94	0.95	0.98	1				
Single step Unrestricted	**Cobb Douglas OLS**	0.34	0.35	0.34	0.35	0.34	0.35	1			
	Cobb Douglas RE	0.36	0.38	0.38	0.40	0.37	0.38	0.97	1		
	Translog OLS	0.12	0.11	0.13	0.13	0.13	0.14	0.24	0.21	1	
	Translog RE	0.12	0.11	0.12	0.12	0.13	0.13	0.40	0.36	0.95	1

Source: Authors' elaboration with Investment Climate Surveys (ICs) data.

NOTES:

a) Solow residuals in levels are obtained as sales (in logarithms or logs) minus a weighted average of labor, materials, capital (all in logs) where the weights are given by the share in total costs of each of the inputs.

(1) Restricted case: the cost shares are calculated as the averages of the plant-level cost shares across the entire sample in 2002, 2003 and 2004.

(2) Unrestricted by Industry case: the cost shares are calculated as the averages across plant-level cost shares in years 2002, 2003 and 2004 for each of the nine industries.

(3) Outlier plants were defined as those which had ratios of materials to sales larger than one or had ratios of labor costs to sales larger than one.

b) Estimated Productivity in levels is obtained from Cobb-Douglas and Translog production functions of sales with inputs labor, materials, and capital estimated by OLS and random effects under two different environments:

(1) Restricted: a single set of production function coefficients is obtained using data on plants in the three countries, for all industries in years 2002, 2003 and 2004 (excluding outliers).

(2) Unrestricted by Industry: a set of production function coefficients is obtained for each of nine industries using data on all plants for the three countries in years 2002, 2003 and 2004 (excluding outliers).

Table 8: Production Function Parameters from the Restricted Estimation

A. Guatemala, Honduras and Nicaragua

	Labor (L)	**Materials (M)**	**Capital (K)**	**L2**	**M2**	**K2**	**L*M**	**L*K**	**M*K**
Cost-shares	0.36	0.53	0.11						
Cobb-Douglas controlling for IC variables									
Pool OLS	0.43***	0.52***	0.07***	-	-	-	-	-	-
RE	0.48***	0.45***	0.07***	-	-	-	-	-	-
Test for CRS		OLS	Prob > F = 0.316		RE	Prob > chi2 = 0.636			
Translog controlling for IC variables									
Pool OLS	1.21**	0.05	-0.09	0.06**	0.04***	0.02***	-0.10***	-0.01	-0.02
RE	1.18***	0.07	-0.19**	-0.04***	0.03***	0.02***	-0.07***	-0.02	-0.00
Test for CRS		OLS	Prob > F = 0.619		RE	Prob > F = 0.543			
Test for Cobb-Douglas		OLS	Prob > chi2 = 0.012		RE	Prob > chi2 = 0.000			

B. Costa Rica

	Labor (L)	**Materials (M)**	**Capital (K)**	**L2**	**M2**	**K2**	**L*M**	**L*K**	**M*K**
Cost-shares	0.33	0.56	0.11						
Cobb-Douglas									
Controlling for IC variables:									
Pool OLS	0.31***	0.53***	0.12***	-	-	-	-	-	-
RE	0.29***	0.47***	0.12***	-	-	-	-	-	-
Test for CRS		OLS	Prob > F = 0.0649		RE	Prob > chi2 = 0.0001			
Other estimation methods without controlling for IC variables:									
FE[(a)]	0.10***	0.33***	0.07***	-	-	-	-	-	-
A.C.F.[(b)]	0.29***	0.67***	0.09***	-	-	-	-	-	-
LP[(c)]	0.26***	0.32***	0.08***						
Translog controlling for IC variables									
Pool OLS	0.45**	0.92***	-0.30***	-0.02	0.06***	0.02***	-0.06**	0.09***	-0.09***
RE	0.37	0.70***	-0.23	-0.02	0.05***	0.02**	-0.05	0.07**	-0.08***
Test for CRS		OLS	Prob > F = 0.0001		RE	Prob > F = 0.0001			
Test for Cobb-Douglas		OLS	Prob > chi2 = 0.000		RE	Prob > chi2 = 0.0000			

Source: Authors' elaboration with Investment Climate Surveys (ICs) data.
NOTES:
(a) Fixed effect estimation.
(b) Ackerberg, Caves and Frazer's (2007) procedure using the GMM estimation method of Wooldridge (2005) without IC variables.
(c) Levinsohn and Petrin's (2003) estimation procedure.

(1) Significance is given by robust standard errors.* significant at 10%; ** significant at 5%; *** significant at 1%.
(2) The cost shares of labor, materials and capital are calculated as average (excluding outliers) of the plant-level cost shares of labor, materials and capital across all plants in years 2001 and 2002 (Guatemala, Honduras, and Nicaragua) and 2002, 2003 and 2004 (Costa Rica).
(3) The sample generating the sets of production function coefficients is constituted by all plants (excluding outliers) in years 2001 and 2002 (Guatemala, Honduras, and Nicaragua) and 2002, 2003, and 2004 (Costa Rica).

Table 9.a: Production Function Parameters from the Unrestricted Estimation by Industry, Cobb-Douglas specification: Guatemala, Honduras, and Nicaragua

	Coefficients	Labor	Materials	Capital	Test for Constant Returns to Scale
Apparel	Cost-share	0.42	0.47	0.11	
	Pool OLS	0.41***	0.45***	0.11***	Prob>F=0.5621
	RE	0.42***	0.44**	0.09***	Prob > chi2 = 0.0792
Food and Tobacco	Cost-share	0.27	0.64	0.09	
	Pool OLS	0.56	0.38	0.10	Prob>F=0.5594
	RE	0.53	0.40**	0.10	Prob > chi2 =0.8349
Beverages	Cost-share	0.34	0.59	0.07	
	Pool OLS	0.44	0.52	0.14	Prob>F=0.0884
	RE	0.62***	0.33**	0.17	Prob > chi2 =0.0240
Chemical and Rubber	Cost-share	0.35	0.53	0.11	
	Pool OLS	0.55	0.48	0.05	Prob>F=0.0032
	RE	0.68**	0.34**	0.06	Prob > chi2 = 0.0082
Furniture and Wood	Cost-share	0.34	0.54	0.12	
	Pool OLS	0.23*	0.70***	0.01***	Prob>F=0.2493
	RE	0.24	0.70	0.00***	Prob > chi2 =0.1938
Leather and Shoes	Cost-share	0.37	0.51	0.12	
	Pool OLS	0.88	0.28	0.08	Prob>F=0.0462
	RE	0.79	0.29	0.08	Prob > chi2 = 0.2394
Nonmetallic minerals	Cost-share	0.32	0.56	0.11	
	Pool OLS	0.36	0.55	0.11	Prob>F=0.727
	RE	0.48	0.44	0.11	Prob > chi2 = 0.6256
Textiles	Cost-share	0.34	0.53	0.13	
	Pool OLS	0.43	0.41	0.18	Prob>F=0.7727
	RE	0.50	0.36	0.15	Prob > chi2 = 0.8509
Metal Products	Cost-share	0.37	0.52	0.12	
	Pool OLS	0.32	0.56*	0.06	Prob>F=0.2982
	RE	0.38	0.51	0.06	Prob > chi2 = 0.3733

Source: Authors' elaboration with Investment Climate Surveys (ICs) data.
NOTES:
(1) Significance is given by robust standard errors. * significant at 10%; ** significant at 5%; *** significant at 1%.
(2) The cost shares of labor, materials and capital are calculated as averages of the plant-level cost shares of labor, materials and capital for each industry using all plants for years 2002, 2003 and 2004 (excluding outliers).

Table 9.b: Production Function Parameters from the Unrestricted Estimation by Industry, Cobb-Douglas specification: Costa Rica

	Coefficients	Labor	Materials	Capital	Test for Constant Returns to Scale
Food & beverages	Cost-share	0.24	0.64	0.12	
	Pool OLS	0.43***	0.33***	0.26***	Prob>F=0.646
	RE	0.53***	0.23***	0.22***	Prob > chi2 = 0.652
Textiles	Cost-share	0.29	0.61	0.1	
	Pool OLS	0.49	0.29	0.18	Prob>F=0.726
	RE	0.42	0.30	0.18	Prob > chi2 =0.18
Apparels	Cost-share	0.43	0.47	0.1	
	Pool OLS	0.16***	0.64***	0.06***	Prob>F=0.068
	RE	0.11***	0.68***	0.01**	Prob > chi2 =0.000
Wood & furniture	Cost-share	0.38	0.54	0.08	
	Pool OLS	0.05***	0.53***	0.14**	Prob>F=0.000
	RE	0.18**	0.44*	0.13	Prob > chi2 = 0.0005
Paper & edition	Cost-share	0.36	0.51	0.12	
	Pool OLS	0.33	0.58***	0.08*	Prob>F=0.156
	RE	0.40	0.55***	0.05*	Prob > chi2 =0.000
Chemicals, rubber & plastics	Cost-share	0.26	0.63	0.11	
	Pool OLS	0.21***	0.49***	0.16*	Prob>F=0.012
	RE	0.26**	0.52***	0.11*	Prob > chi2 = 0.723
Non-metallic products	Cost-share	0.31	0.58	0.1	
	Pool OLS	0.39	0.55***	0.05***	Prob>F=0.318
	RE	0.26	0.60***	0.04**	Prob > chi2 = 0.009
Machinery & Equipment - Metallic products	Cost-share	0.36	0.51	0.13	
	Pool OLS	0.37	0.50***	0.10***	Prob>F=0.259
	RE	0.22**	0.54***	0.16	Prob > chi2 = 0.354

Source: Authors' elaboration with Investment Climate Surveys (ICs) data.
NOTES:
(1) Significance is given by robust standard errors. * significant at 10%; ** significant at 5%; *** significant at 1%.
(2) The cost shares of labor, materials and capital are calculated as averages of the plant-level cost shares of labor, materials and capital for each industry using all plants for years 2002, 2003 and 2004 (excluding outliers).

Table 10.a: Production Function Parameters from the Unrestricted Estimation by Industry, Translog specification: Guatemala, Honduras, and Nicaragua

	L	M	K	L2	M2	K2	L*M	L*K	M*K	Test for CD[1]	Test for CRS[1]
Apparel											
Pool OLS	0.90***	-0.30	0.30	0.06**	0.11***	0.03**	-0.17***	0.07**	-0.10***	0.000	0.005
RE	0.70**	-0.28	0.42***	0.03	0.11***	0.02**	-0.14***	0.09***	-0.10***	0.000	0.000
Food and Tobacco											
Pool OLS	0.80	-1.10**	0.85	-0.01	0.06	-0.10**	-0.20	0.16	0.09**	0.000	0.071
RE	1.01	-0.88**	0.67	0.00	0.05	-0.08*	-0.17	0.10	0.08***	0.087	0.517
Beverages											
Pool OLS	0.62	0.65	0.76	0.08	0.06**	0.01	-0.11	0.04	-0.09	0.000	0.113
RE	0.76	0.63	0.76*	0.10	0.06**	0.01	-0.13	0.04	-0.08	0.000	0.035
Chemical and Rubber											
Pool OLS	1.99	-0.35	-0.50*	0.10	0.04*	0.03	-0.11	-0.08**	0.01***	0.004	0.018
RE	1.96	-0.52	-0.54	0.09***	0.03***	0.02	-0.06***	-0.11*	0.04***	0.000	0.142
Furniture and wood											
Pool OLS	1.24*	0.42*	-0.02	0.09	0.00***	-0.01**	-0.07	-0.07**	0.04***	0.357	0.033
RE	1.53	0.10***	-0.19	0.08**	-0.01***	-0.01**	-0.05*	-0.11***	0.07***	0.002	0.738
Leather and shoes											
Pool OLS	0.15	0.57	1.59***	0.18	0.12	0.00	-0.22	0.18	-0.19	0.000	0.000
RE	-0.28	0.97	1.39	0.12	0.08	0.01	-0.13	0.15	-0.18	0.159	0.774
Non metallic minerals											
Pool OLS	0.74	-0.39	0.47	-0.04*	0.09	0.01	-0.07*	0.05	-0.07	0.001	0.092
RE	0.36	-0.21	0.39	-0.01	0.08	0.02	-0.05	0.05	-0.07	0.019	0.490
Textiles											
Pool OLS	5.41*	-2.64***	-1.41	0.16	0.21**	0.10	-0.37**	-0.13	-0.05	0.000	0.142
RE	3.76	-1.38	-1.37	0.06	0.15	0.12	-0.22	-0.09	-0.09	0.007	0.824
Metal Products											
Pool OLS	1.64	0.11	0.01	0.19	0.05*	0.02	-0.17	-0.04*	-0.02*	0.017	0.081
RE	1.35	-0.11	0.28	0.15	0.07	0.00	-0.19	0.03	-0.03*	0.198	0.174

Source: Authors' elaboration with Investment Climate Surveys (ICs) data.
NOTES: [1] p-values.
Significance is given by robust standard errors. * significant at 10%; ** significant at 5%; *** significant at 1%..
The cost shares of labor, materials and capital are calculated as averages of the plant-level cost shares of labor, materials and capital for each industry using all plants for years 2002, 2003 and 2004 (excluding outliers).

Table 10.b: Production Function Parameters from the Unrestricted Estimation by Industry, Translog specification: Costa Rica

	L	M	K	L2	M2	K2	L*M	L*K	M*K	Test for CD[1]	Test for CRS[1]
Food & Beverages											
Pool OLS	0.56	1.03***	0.00	-0.03	0.06***	-0.03**	-0.11***	0.16***	-0.06**	0.000	0.000
RE	0.10	1.18***	0.00	-0.01	0.07***	-0.04**	-0.12***	0.17***	-0.07**	0.000	0.000
Textiles											
Pool OLS	-1.32***	1.19	0.70***	0.17***	0.08*	0.01*	-0.17	0.004**	-0.07	0.000	0.000
RE	-1.11	1.03	0.15	0.14**	0.09	0.01*	-0.17	0.03**	-0.06	0.000	0.199
Apparels											
Pool OLS	1.43	1.69*	-1.12***	-0.16***	0.05	0.03**	-0.04*	0.25	-0.18***	0.000	0.000
RE	1.05	1.63	-1.18***	-0.15***	0.02**	0.01*	-0.01**	0.24	-0.14	0.000	0.007
Wood & furniture											
Pool OLS	0.13	0.04*	0.25	-0.17*	0.003*	-0.04	0.17**	0.18	-0.11	0.033	0.000
RE	0.17	-0.60**	0.26	-0.09	0.05	-0.02	0.09	0.10	-0.08	0.008	0.000
Paper & edition											
Pool OLS	0.71	1.21	-0.17	0.01	0.02	0.02*	-0.07	0.02*	-0.03	0.083	0.425
RE	0.17	1.96	-0.54*	0.09	0.05	0.06***	-0.16	0.005***	-0.07	0.015	0.320
Chemicals, rubber & plastics											
Pool OLS	0.92	0.32*	0.08	-0.05	0.04	-0.01	-0.03	0.06**	-0.03	0.000	0.008
RE	0.88	0.51	-0.24	-0.07	0.02*	0.003**	0.01*	0.07**	-0.04	0.004	0.047
Non-metallic Products											
Pool OLS	0.18	0.73	0.06	0.11*	0.1	0.04**	-0.18	-0.04**	-0.04	0.000	0.269
RE	-0.43	0.5	1.18	0.12	0.01	-0.04	-0.07	-0.09**	0.06	0.322	0.088
Mach. & Equip. – Metallic Prod.											
Pool OLS	0.72	1.32	-0.72***	0.03	0.06	0.00*	-0.17	0.09	-0.02	0.000	0.000
RE	0.41	0.7	-0.21	0.03	0.04	-0.01	-0.12	0.04*	-0.02*	0.054	0.004

Source: Authors' elaboration with Investment Climate Surveys (ICs) data.
NOTES: [1] p-values.
Significance is given by robust standard errors. * significant at 10%; ** significant at 5%; *** significant at 1%.
The cost shares of labor, materials and capital are calculated as averages of the plant-level cost shares of labor, materials and capital for each industry using all plants for years 2002, 2003 and 2004 (excluding outliers).

Table 11: Estimation of IC elasticities and semi-elasticities on productivity controlling for observable fixed effects: Guatemala, Honduras, and Nicaragua

Blocas of IC variables	Explanatory IC variables	Restricted estimation						Unrestricted by industry estimation					
		Two steps		Single step				Two steps		Single step			
		Solow residual		Cobb-Douglas		Translog		Solow residual		Cobb-Douglas		Translog	
		OLS	R.E	OLS	R.E	OLS	R.E	OLS	R.E	OLS	R.E	OLS	R.E
Infrastruc-tures	Average duration of power outages Hours per day (logs) (AV)	-0.078*	-0.066	-0.079*	-0.087	-0.073*	-0.07	-0.082*	-0.071	-0.055	-0.059	-0.026	-0.03
	Average number of days to clear customs for imports (logs) (AV)	-0.101***	-0.099***	-0.103***	-0.093**	-0.114***	-0.111***	-0.098***	-0.096**	-0.100**	-0.095**	-0.096***	-0.096**
	Shipment Losses (Fraction of total sales) (AV)	-1.588**	-1.15	-1.766**	-0.981	-1.289*	-0.565	-1.553*	-1.107	-2.078**	-1.513	-1.934**	-1.296
	Dummy for Internet Access (0 or 1)	0.145***	0.136***	0.147***	0.187***	0.121***	0.163***	0.153***	0.144***	0.130***	0.178***	0.112***	0.144***
Red tape, corruption and crime	Number of days spent in Inspection and Regulation related work Days (logs) (AV)	-0.131***	-0.133***	-0.135***	-0.139***	-0.099***	-0.114***	-0.131***	-0.132***	-0.123***	-0.137***	-0.078**	-0.091**
	Fraction of sales declared to IRS for tax purposes (Fraction of total sales) (AV)	-0.302	-0.305	-0.268	-0.404	-0.324	-0.486*	-0.249	-0.246	-0.38	-0.404	-0.417*	-0.417
	Number of criminal attempts suffered (Number) (AV)	-0.026**	-0.027**	-0.024**	-0.025*	-0.01	-0.012	-0.024**	-0.026**	-0.024**	-0.02	-0.001	-0.005
Finance and corp. gov.	Dummy for external audit of financial statements (0 or 1)	0.177***	0.168***	0.164***	0.193***	0.126***	0.145***	0.176***	0.168***	0.153***	0.181***	0.086**	0.099**
Quality, innovation and labor skills	Fraction computer-controlled machinery of total machinery (Fraction of total machinery)	0.136*	0.169*	0.147*	0.220**	0.145*	0.179*	0.139*	0.172*	0.154*	0.223**	0.138*	0.168*
	Fraction of total staff engaged in R & D (Fraction of total staff)	0.534*	0.473*	0.620**	0.591*	0.545**	0.603**	0.537*	0.479*	0.551**	0.506	0.468*	0.484*
	Dummy for ISO quality certif. (0 or 1)	0.136	0.166*	0.158	0.196*	0.016	0.053	0.149	0.176*	0.17	0.192*	0.068	0.054
	Fraction of total staff with secondary education or more (Fraction of total staff)	0.05	0.085	0.068	0.129*	0.053	0.117*	0.054	0.088	0.069	0.134*	0.076	0.142**
	Dummy for training provided beyond "on the job" (0 or 1)	0.117***	0.116***	0.105***	0.136***	0.087***	0.112***	0.119***	0.117***	0.109***	0.133***	0.102***	0.118***
Other control variables	Dummy for Incorporated Company (0 or 1)	0.121***	0.124***	0.112***	0.142***	0.093**	0.120***	0.124***	0.127***	0.103***	0.119**	0.100***	0.109**
	Age of the firm years (logs)	0.038**	0.040*	0.035*	0.044*	0.035**	0.041*	0.037*	0.039*	0.030*	0.033	0.030*	0.037*
	Share of Imported inputs (Fraction of total inputs)	0.105**	0.108**	0.093*	0.129**	0.086*	0.116**	0.108**	0.110**	0.068	0.099*	0.067	0.076
	Observations	1461	1461	1461	1461	1461	1461	1461	1461	1461	1461	1461	1461
	R-squared	0.25	0.25	0.92	0.92	0.93	0.93	0.19	0.19	0.92	0.92	0.94	0.94

Source: Authors' elaboration with Investment Climate Surveys (ICs) data.

NOTES: (AV) means that the variable enters the regression in form of industry-region average. Significance is given by robust standard errors (very similar results by robust cluster errors). * significant at 10%; ** significant at 5%; *** significant at 1%. The regressions include a constant, industry dummies and year dummies.

Table 12: Estimation of IC elasticities and semi-elasticities on productivity controlling for observable fixed effects: Costa Rica

Block of IC variables	Explanatory ICA variables	Restricted						Unrestricted by industry					
		Two steps estimation		Single step estimation				Two steps estimation		Single step estimation			
		Solow residual		Cobb-Douglas		Translog		Solow residual		Cobb-Douglas		Translog	
		OLS	R.E	OLS	R.E	OLS	R.E	OLS	R.E	OLS	R.E	OLS	R.E
Infrastructures	Average no. of days to clear customs for exports (logs) (AV)	-0.077**	-0.083	-0.076**	-0.066	-0.072**	-0.059	-0.089**	-0.095*	-0.076*	-0.072	-0.044	-0.048
	Average duration of power outages. Hrs. per day (logs) (AV)	-0.027***	-0.026	-0.029***	-0.032*	-0.017**	-0.019	-0.027***	-0.026	-0.030***	-0.031*	-0.022**	-0.033*
	Total number of water outages (logs) (AV)	-0.233***	-0.244*	-0.217***	-0.181	-0.121**	-0.113	-0.237**	-0.247	-0.207***	-0.181	-0.220***	-0.204**
	Average days waiting for an electricity supply (logs) (AV)	-0.130***	-0.135***	-0.128***	-0.134***	-0.089***	-0.094**	-0.118***	-0.124***	-0.106***	-0.120**	-0.054*	-0.055
Red tape, corruption and crime	Percentage of sales declared to IRS for tax purposes (% of total sales) (AV)	0.011***	0.011**	0.010***	0.008**	0.005***	0.004*	0.010***	0.010**	0.010***	0.009***	0.006***	0.005**
	Number of days spent in Inspection and Regulation related work Days (logs)	-0.337***	-0.340***	-0.326***	-0.301***	-0.198***	-0.195**	-0.346***	-0.346***	-0.326***	-0.346***	-0.281***	-0.311***
	Dummy for payments to obtain a contract with the government (0 or 1) (AV)	0.393***	0.427*	0.394***	0.447*	0.177*	0.222	0.419***	0.455*	0.240*	0.292	-0.118	0.041
	Percentage of sales never repaid (% of total sales) (AV)	-0.015***	-0.015**	-0.016***	-0.019***	-0.007*	-0.011*	-0.016***	-0.016*	-0.014***	-0.018***	-0.002	-0.004
	Number of days lost due to absenteeism (logs)	-0.042**	-0.037	-0.042**	-0.038	-0.034**	-0.032	-0.046***	-0.04	-0.023	-0.021	-0.021	-0.027
Finance and corporate governance	Dummy for firm belonging to a trade assoc. (0 or 1) (AV)	0.446***	0.468***	0.447***	0.455***	0.412***	0.373**	0.403***	0.418**	0.568***	0.560***	0.480***	0.409**
	Dummy for credit line (0 or 1)	0.052	0.047	0.070*	0.098	0.038	0.063	0.054	0.05	0.039	0.024	0.035	0.029
	Dummy for debts with creditors (0 or 1) (AV)	0.317*	0.377	0.276	0.294	0.032	0.119	0.276	0.338	0.330*	0.412	0.142	0.058
	Firm's profits after taxes as a percentage of total sales (% of total sales) (AV)	0.019***	0.019**	0.018***	0.016*	0.009**	0.007	0.018***	0.018*	0.014***	0.013*	0.008	0.01
	Dummy for firm owning almost all the lands in which the plant operates (0 or 1)	-0.164***	-0.156**	-0.158***	-0.131*	-0.146***	-0.121**	-0.155***	-0.146**	-0.158***	-0.129**	-0.165***	-0.137**
Quality, innovation and labor skills	Dummy for ISO certification (0 or 1)	0.268***	0.267***	0.301***	0.390***	0.286***	0.310***	0.283***	0.277***	0.180***	0.217*	0.192***	0.237**
	Dummy for new technological license (0 or 1) (AV)	0.169	0.138	0.196*	0.254	0.111	0.156	0.211*	0.178	0.117	0.2	0.214*	0.380**
	Percentage computer-controlled machinery of total machinery (% of total machinery)	0.002***	0.002*	0.003***	0.004**	0.002***	0.003**	0.002**	0.002	0.002***	0.003**	0.001*	0.003**
	Number of plant's employees dealing with engineering and design (logs) (AV)	0.029***	0.029*	0.031***	0.035*	0.017	0.022	0.032***	0.032*	0.017	0.023	0.001	0.018
	Percentage of immigrant workers (% of total staff) (AV)	-0.133*	-0.125	-0.133*	-0.135	-0.069	-0.085	-0.172**	-0.163	-0.023	-0.002	-0.065	-0.105
	Percentage of unskilled workers receiving training (% of unskilled workers) (AV)	0.004	0.003	0.004	0.002	0.007**	0.005	0.004	0.003	0.007**	0.004	0.012***	0.009*
	Percentage of staff using computer at job (% of total staff)	0.002*	0.002	0.002*	0.002	0.002**	0.002	0.001	0.001	0.002**	0.002	0.003***	0.001
Other control variables	Dummy for foreign direct investment (0 or 1)	0.138*	0.141	0.156*	0.198*	0.109	0.129	0.143*	0.146	0.183**	0.263**	0.07	0.118
	Number of competitors in plant's main market (logs) (AV)	0.126***	0.117**	0.125***	0.112**	0.120***	0.109**	0.137***	0.126**	0.107***	0.088*	0.100***	0.141***
	Dummy for benefit from free trade agreements with signed by the government (0 or 1)	0.083*	0.085	0.109**	0.188**	0.083	0.143*	0.056	0.059	0.095*	0.183**	0.116**	0.152*
	Percentage of capacity utilization (percentage)	0.003***	0.003**	0.003***	0.004***	0.004***	0.004***	0.003***	0.003**	0.003***	0.004***	0.003***	0.004**
	Dummy for importer firm (0 or 1)	0.180***	0.176***	0.220***	0.315***	0.212***	0.276***	0.187***	0.184***	0.191***	0.270***	0.186***	0.234***
	Observations	985	985	985	985	985	985	985	985	985	985	985	985
	R2	0.29	0.29	0.94	0.94	0.95	0.95	0.27	0.27	0.95	0.95	0.96	0.96

Source: Authors' elaboration with Investment Climate Surveys (ICs) data.

NOTES: (AV) means that the variable enters the regression in form of industry-region average. Significance is given by robust standard errors (very similar results by robust cluster errors). * significant at 10%; ** significant at 5%; *** significant at 1%. The regressions include a constant, industry dummies and year dummies.

Table 13: IC elasticities and semi-elasticities with respect to productivity without controlling for other IC variables: Guatemala, Honduras, and Nicaragua

Blocas of IC variables	Explanatory IC variables	Restricted estimation						Unrestricted by industry estimation					
		Two steps		Single step				Two steps		Single step			
		Solow residual		Cobb-Douglas		Translog		Solow residual		Cobb-Douglas		Translog	
		OLS	R.E	OLS	R.E	OLS	R.E	OLS	R.E	OLS	R.E	OLS	R.E
Infrastruc-tures	Average duration of power outages Hours per day (logs) (AV)	-0.084**	-0.076	-0.042	-0.071	-0.053	-0.069	-0.087**	-0.079*	-0.027	-0.047	-0.043	-0.054
	Average number of days to clear customs for imports (logs) (AV)	-0.016	-0.015	-0.037	-0.011	-0.044	-0.027	-0.012	-0.011	-0.042	-0.021	-0.028	-0.018
	Shipment Losses (Fraction of total sales) (AV)	1.759**	2.310*	1.450*	2.377*	1.682**	2.602**	1.736**	2.280*	1.357	2.033	0.983	1.782
	Dummy for Internet Access (0 or 1)	0.311***	0.302***	0.217***	0.279***	0.181***	0.232***	0.321***	0.311***	0.202***	0.265***	0.173***	0.206***
Red tape, corruption and crime	Number of days spent in Inspection and Regulation related work Days (logs) (AV)	-0.100***	-0.100***	-0.087***	-0.097***	-0.054**	-0.075**	-0.097***	-0.098***	-0.083***	-0.096***	-0.044*	-0.058*
	Fraction of sales declared to IRS for tax purposes (Fraction of total sales) (AV)	-0.759***	-0.765***	-0.441**	-0.645***	-0.505***	-0.695***	-0.725***	-0.727***	-0.540***	-0.668***	-0.621***	-0.690***
	Number of criminal attempts suffered (Number) (AV)	-0.0004	-0.001	-0.013	-0.008	0.001	0.003	0.002	0.0004	-0.012	-0.007	0.009	0.007
Fin. and Corp. Gov.	Dummy for external audit of financial statements (0 or 1)	0.287***	0.281***	0.182***	0.222***	0.128***	0.158***	0.291***	0.285***	0.180***	0.216***	0.103***	0.118***
Quality, innovation and labor skills	Fraction computer-controlled machinery of total machinery (Fraction of total machinery)	0.184**	0.242**	0.116	0.220**	0.122	0.174*	0.190**	0.250**	0.140*	0.234**	0.142*	0.187*
	Fraction of total staff engaged in R & D (Fraction of total staff)	0.421	0.356	0.774***	0.805***	0.606**	0.742***	0.429	0.364	0.696***	0.722**	0.605***	0.682**
	Dummy for ISO quality certification (0 or 1)	0.288***	0.317***	0.196**	0.269***	0.052	0.104	0.302***	0.327***	0.216**	0.268***	0.12	0.118
	Fraction of total staff with secondary education or more (Fraction of total staff)	0.167***	0.192***	0.175***	0.247***	0.141**	0.215***	0.173***	0.197***	0.164***	0.238***	0.149**	0.221***
	Dummy for training provided beyond "on the job" (0 or 1)	0.218***	0.214***	0.125***	0.169***	0.105***	0.135***	0.224***	0.219***	0.128***	0.161***	0.127***	0.146***
	Dummy for Incorporated Company (0 or 1)	0.254***	0.251***	0.132***	0.180***	0.108***	0.146***	0.262***	0.258***	0.128***	0.160***	0.114***	0.130***
Other control variables	Age of the firm years (logs)	0.031*	0.029	0.021	0.021	0.022	0.023	0.031	0.028	0.021	0.019	0.029*	0.033
	Share of Imported inputs (Fraction of total inputs)	0.280***	0.287***	0.149***	0.205***	0.119***	0.166***	0.288***	0.294***	0.135***	0.189***	0.106**	0.134***

Source: Authors' elaboration with Investment Climate Surveys (ICs) data.
NOTES: (AV) means that the variable enters the regression in form of industry-region average. LIGHT GREY means that the variable changes in significance and magnitude with respect to the full estimation of Table 2. DARK GREY implies that it changes also the direction of the effect. Significance is given by robust standard errors. * significant at 10%; ** significant at 5%; *** significant at 1%. The regressions include a constant, industry dummies and year dummies.

Table 14: IC elasticities and semi-elasticities with respect to productivity without controlling for other IC variables: Costa Rica

Blocas of IC variables	Explanatory IC variables	Restricted estimation						Unrestricted by industry estimation					
		Two steps		Single step				Two steps		Single step			
		Solow residual		Cobb-Douglas		Translog		Solow residual		Cobb-Douglas		Translog	
		OLS	R.E	OLS	R.E	OLS	R.E	OLS	R.E	OLS	R.E	OLS	R.E
Infrastruc-tures	Average number of days to clear customs for exports (logs) (AV)	-0.06	-0.066	-0.073**	-0.071	-0.058*	-0.06	-0.080**	-0.085	-0.062	-0.074	-0.031	-0.052
	Average duration of power outages Hours per day (logs) (AV)	-0.013**	-0.012	-0.011	-0.013	-0.009	-0.013	-0.014**	-0.013	-0.018***	-0.020**	-0.014**	-0.020**
	Total number of water outages (logs) (AV)	-0.144**	-0.156	-0.131**	-0.146	-0.077**	-0.095	-0.156**	-0.167	-0.102*	-0.118	-0.068	-0.087
	Average days waiting for an electricity supply (logs) (AV)	-0.109***	-0.112**	-0.108***	-0.117**	-0.096***	-0.104**	-0.101***	-0.103**	-0.084***	-0.097**	-0.077**	-0.073*
Red tape, corruption and crime	Percentage of sales declared to IRS for tax purposes (% of total sales) (AV)	0.004**	0.004	0.004**	0.003	0.001	0.001	0.004**	0.004	0.004**	0.003	0.001	0.002
	Number of days spent in Inspection and Regulation related work Days (logs)	-0.018	-0.018	-0.070*	-0.014	-0.031	-0.005	-0.027	-0.026	-0.075*	-0.054	-0.084**	-0.086
	Dummy for payments to obtain a contract with the government (0 or 1) (AV)	0.156	0.18	0.143	0.185	0.02	0.05	0.185	0.21	0.053	0.134	-0.142	-0.044
	Percentage of sales never repaid (percentage of total sales) (AV)	-0.015***	-0.015**	-0.012**	-0.018**	-0.006	-0.012*	-0.016***	-0.016**	-0.011**	-0.015**	0.002	-0.002
	Number of days lost due to absenteeism (logs)	-0.026*	-0.022	-0.024	-0.021	-0.014	-0.015	-0.032**	-0.027	-0.007	-0.009	-0.005	-0.014
Finance and corporate governance	Dummy for firm belonging to a trade association (0 or 1) (AV)	0.351***	0.366**	0.252***	0.425**	0.265***	0.307*	0.321***	0.331*	0.251**	0.369**	0.14	0.168
	Dummy for credit line (0 or 1)	0.125***	0.117*	0.083**	0.145**	0.051	0.093	0.126***	0.118*	0.039	0.049	0.055	0.062
	Dummy for debts with creditors (0 or 1) (AV)	0.16	0.196	0.126	0.149	0.037	0.116	0.143	0.182	0.089	0.096	-0.015	-0.029
	Firm's profits after taxes as a percentage of total sales (% of total sales) (AV)	-0.006**	-0.005	-0.003	-0.006	-0.004	-0.008*	-0.007**	-0.007	-0.005	-0.008*	-0.004	-0.007
	Dummy for firm owning almost all the lands in which the plant operates (0 or 1)	-0.135***	-0.132**	-0.182***	-0.152**	-0.170***	-0.144**	-0.120***	-0.117*	-0.176***	-0.147**	-0.190***	-0.154**
Quality, innovation and labor skills	Dummy for ISO certification (0 or 1)	0.549***	0.545***	0.502***	0.707***	0.427***	0.513***	0.549***	0.542***	0.394***	0.518***	0.387***	0.423***
	Dummy for new technological license (0 or 1) (AV)	0.198**	0.184	0.039	0.218	-0.004 (a)	0.109	0.207**	0.195	-0.039 (a)	0.147	-0.079	0.069
	Percentage computer-controlled machinery of total machinery (% of total machinery)	0.005***	0.005***	0.004***	0.006***	0.004***	0.005***	0.005***	0.005***	0.004***	0.006***	0.003***	0.004***
	Number of plant's employees dealing with engineering and design (logs) (AV)	0.036***	0.036*	0.028**	0.041*	0.020**	0.029	0.038***	0.038*	0.017	0.03	0.003	0.012
	Percentage of immigrant workers (perc. of total staff) (AV)	-0.256***	-0.258**	-0.245***	-0.244**	-0.166***	-0.188*	-0.283***	-0.283**	-0.124*	-0.109	-0.109	-0.137
	Percentage of unskilled workers receiving training (perc. of unskilled workers) (AV)	-0.001 (a)	-0.002 (a)	-0.001 (a)	-0.003 (a)	0.002	0.001	-0.002 (a)	-0.002 (a)	0.001	-0.001 (a)	0.004**	0.003
	Percentage of staff using computer at job (perc. of total staff)	0.006***	0.006***	0.005***	0.006***	0.004***	0.005***	0.005***	0.005***	0.005***	0.006***	0.004***	0.004***
Other control variables	Dummy for foreign direct investment (0 or 1)	0.395***	0.387***	0.312***	0.464***	0.225***	0.297***	0.393***	0.384***	0.297***	0.467***	0.196***	0.279**
	Total number of competitors in plant's main market (logs) (AV)	0.021	0.018	0.027	0.009	0.044	0.034	0.023	0.019	0.032	-0.001	0.019	0.022
	Dummy for benefit from free trade agreements with signed by the government (0 or 1)	0.268***	0.264***	0.197***	0.337***	0.144**	0.228***	0.246***	0.242***	0.141**	0.276***	0.184***	0.239***
	Percentage of capacity utilization (percentage)	0.003***	0.003**	0.003***	0.004**	0.004***	0.004***	0.003***	0.003**	0.003***	0.004***	0.003***	0.003**
	Dummy for importer firm (0 or 1)	0.308***	0.303***	0.277***	0.445***	0.246***	0.344***	0.310***	0.304***	0.248***	0.380***	0.259***	0.317***

Source: Authors' elaboration with Investment Climate Surveys (ICs) data.
NOTES: (AV) means that the variable enters the regression in form of industry-region average. Significance is given by robust standard errors. * significant at 10%; ** significant at 5%; *** significant at 1%. The regressions include a constant, industry dummies and year dummies. LIGHT GREY means that the variable changes in significance and magnitude with respect to the full estimation of Table 2. DARK GREY implies that it changes also the direction of the effect. (a) The variable changes the direction of the effect, although statistically insignificant.

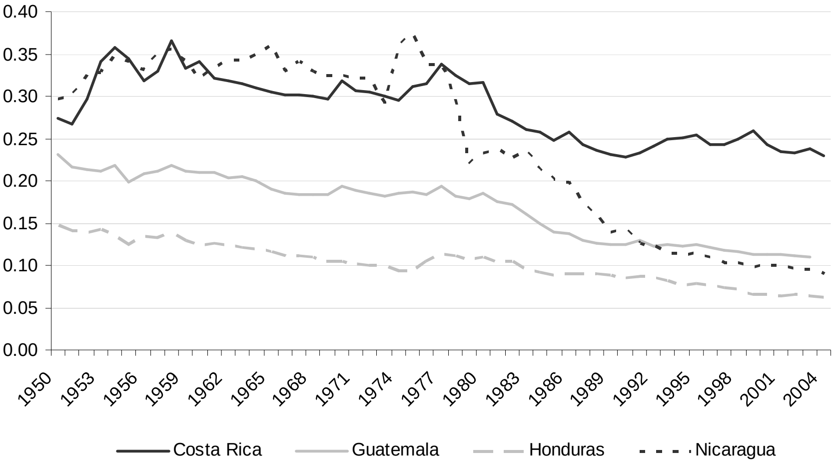
Table 15: Further robustness: Costa Rica

Blocks of IC variables	Explanatory IC variables	Restricted Solow Residual; Cost-Shares	Levinsohn and Petrin	A.C.F (2007) (5)
Infrastructures	Average number of days to clear customs for exports (logs) (AV)	-0.077**	-0.009	-0.082*
	Average duration of power outages Hours per day (logs) (AV)	-0.027***	-0.044***	-0.023*
	Total number of water outages (logs) (AV)	-0.233***	-0.064	-0.301**
	Average days waiting for an electricity supply (logs) (AV)	-0.130***	-0.137***	-0.121***
Red tape, corruption and crime	Percentage of sales declared to IRS for tax purposes (Percentage of total sales) (AV)	0.011***	0.004	0.012***
	Number of days spent in Inspection and Regulation related work Days (logs)	-0.337***	-0.235***	-0.359***
	Dummy for payments to obtain a contract with the government (0 or 1) (AV)	0.393***	0.492***	0.342*
	Percentage of sales never repaid (percentage of total sales) (AV)	-0.015***	-0.026***	-0.011**
	Number of days lost due to absenteeism (logs)	-0.042**	-0.045**	-0.042*
Finance and corporate governance	Dummy for firm belonging to a trade association (0 or 1) (AV)	0.446***	0.403***	0.440***
	Dummy for credit line (0 or 1)	0.052	0.177***	0.024
	Dummy for debts with creditors (0 or 1) (AV)	0.317*	0.228	0.398
	Firm's profits after taxes as a percentage of total sales (perc. of total sales) (AV)	0.019***	0.012**	0.019**
	Dummy for firm owning almost all the lands in which the plant operates (0 or 1)	-0.164***	-0.063	-0.157***
Quality, innovation and labor skills	Dummy for ISO certification (0 or 1)	0.268***	0.611***	0.188**
	Dummy for new technological license (0 or 1) (AV)	0.169	0.536***	0.089
	Percentage computer-controlled machinery of total machinery (perc. of total machinery)	0.002***	0.007***	0.002*
	Number of plant's employees dealing with engineering and design (logs) (AV)	0.029***	0.044***	0.025*
	Percentage of immigrant workers (perc. of total staff) (AV)	-0.133*	-0.155	-0.149
	Percentage of unskilled workers receiving training (perc. of unskilled workers) (AV)	0.004	-0.002	0.007*
	Percentage of staff using computer at job (perc. of total staff)	0.002*	0.002	0.001
Other control variables	Dummy for foreign direct investment (0 or 1)	0.138*	0.342***	0.121
	Total number of competitors in plant's main market (logs) (AV)	0.126***	0.107**	0.135***
	Dummy for benefit from free trade agreements with signed by the government (0 or 1)	0.083*	0.411***	0.033
	Percentage of capacity utilization (percentage)	0.003***	0.004***	0.002*
	Dummy for importer firm (0 or 1)	0.180***	0.569***	0.093*
	Observations	985	985	985
	R^2	0.29	0.58	0.20

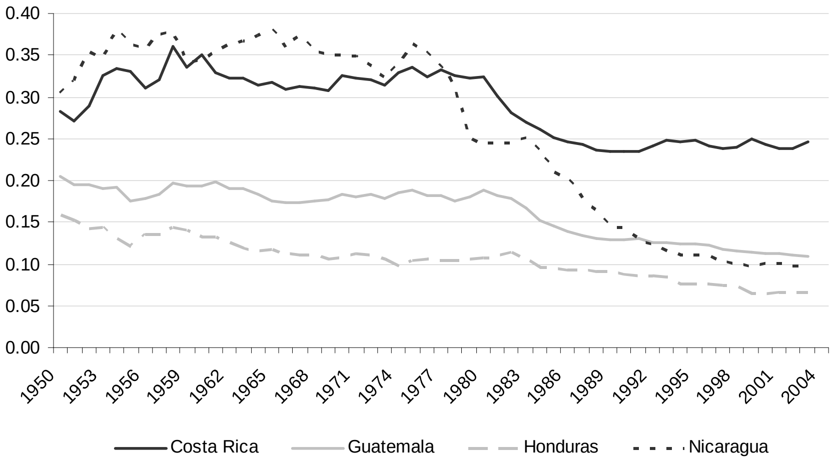
Source: Authors' elaboration with Investment Climate Surveys (ICs) data.
NOTES:
(1) (AV) means that the variable enters the regression in form of industry-region average.
(2) Significance is given by robust standard errors. * significant at 10%; ** significant at 5%; *** significant at 1%.
(3) Two steps estimation, inputs elasticities restricted by industry.
(4) The regressions include a constant, industry dummies and year dummies.
(5) Ackerberg, Caves and Frazer's (2007) GMM estimation method of Wooldridge (2005) without IC variables.

Figure 1: Decomposition of per capita income from 1950 to 2004: Guatemala, Honduras, Nicaragua, and Costa Rica

(a) Real Gross Domestic Product per capita (Relative to US)



(b) Real Gross Domestic Product per worker (Relative to US)



(c) Labor force participation (Relative to US)

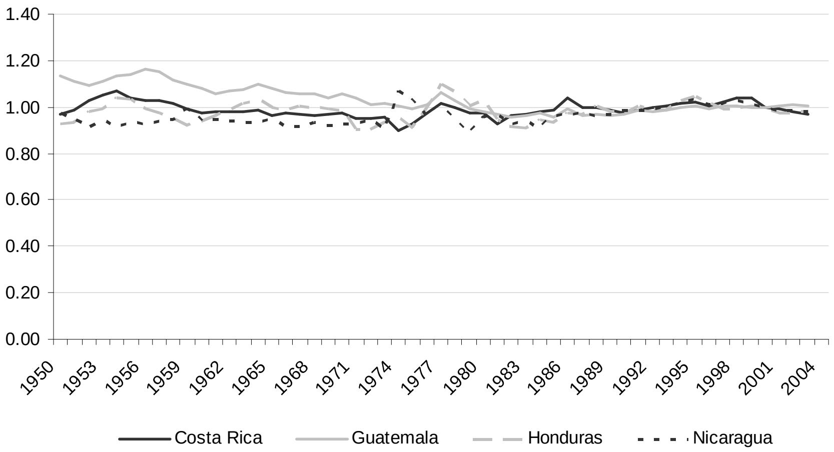
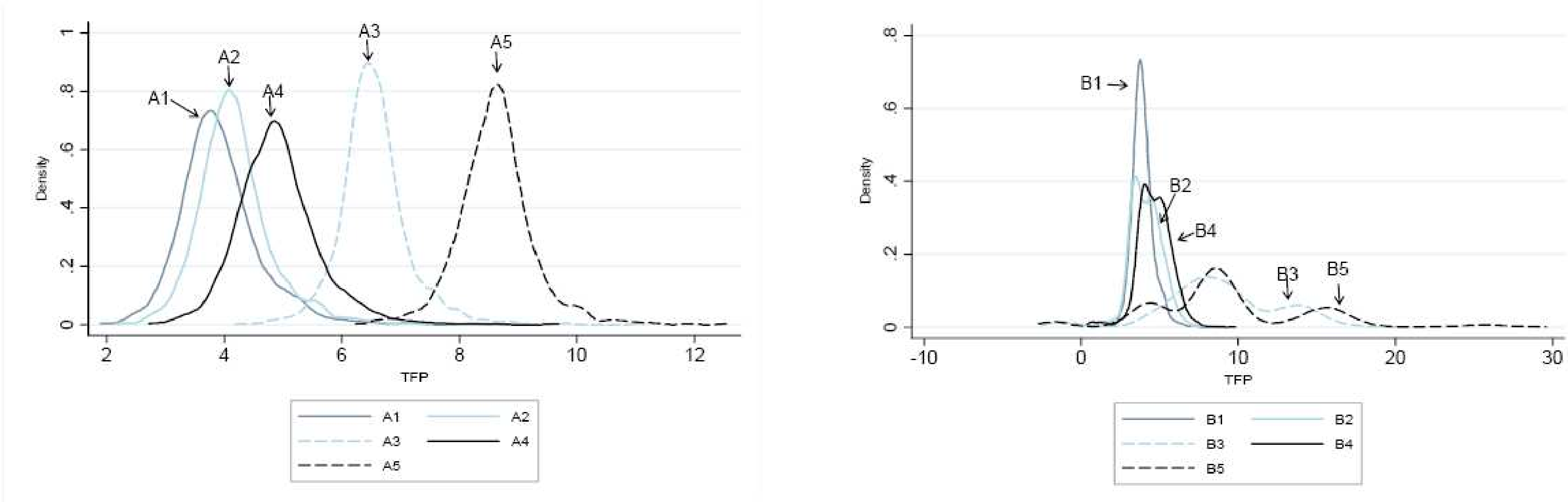


Figure 2: Kernel density of productivity measures: Guatemala, Honduras and Nicaragua

A. Restricted Estimation: Equal input-output elasticities for all the firms in the sample

B. Unrestricted by industry estimation: equal input-output elasticities for all the firms in the same industry (sector)



A.1 Restricted Solow residual;
A2 Single step-restricted-Cobb-Douglas-OLS TFP;
A3 Single step-restricted-Translog-OLS TFP;
A4 Single step-restricted-Cobb-Douglas-RE TFP;
A5 Single step-restricted-Translog-RE TFP.

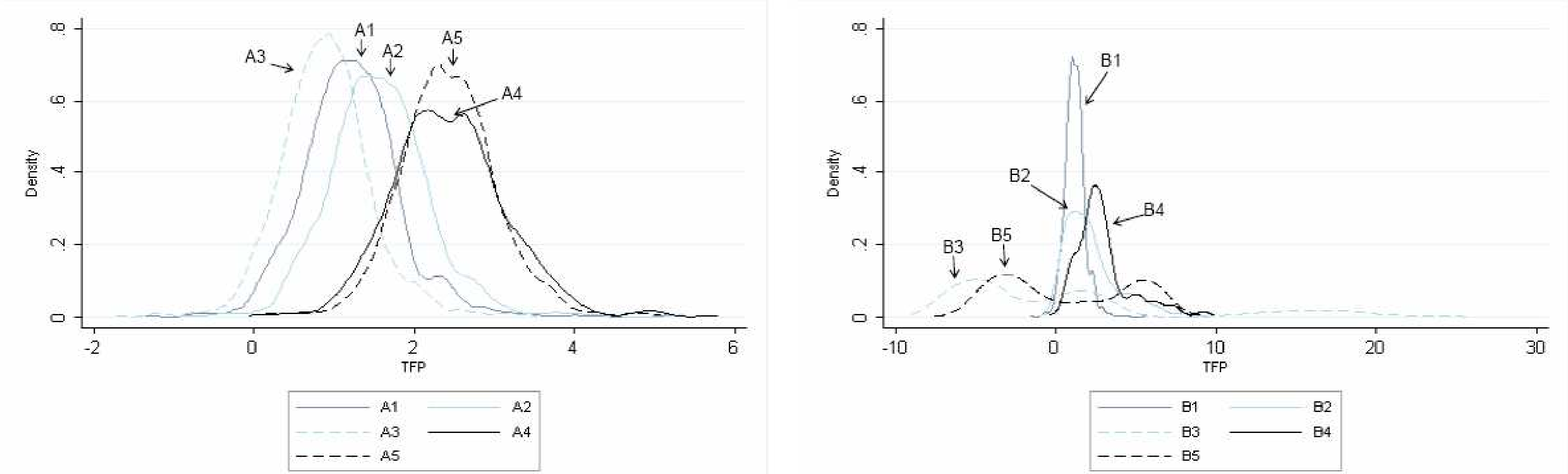
B.1 Unrestricted by industry Solow residual;
B2 Single step-unrestricted-Cobb-Douglas-OLS TFP;
B3 Single step-unrestricted-Translog-OLS TFP;
B4 Single step-unrestricted-Cobb-Douglas-RE TFP;
B5 Single step-unrestricted-Translog-RE TFP.

Source: Authors' elaboration with Investment Climate Surveys (ICs) data.

Figure 3: Kernel density of productivity measures: Costa Rica

A. Restricted Estimation: Equal input-output elasticities for all the firms in the sample

B. Unrestricted by industry estimation: equal input-output elasticities for all the firms in the same industry (sector)

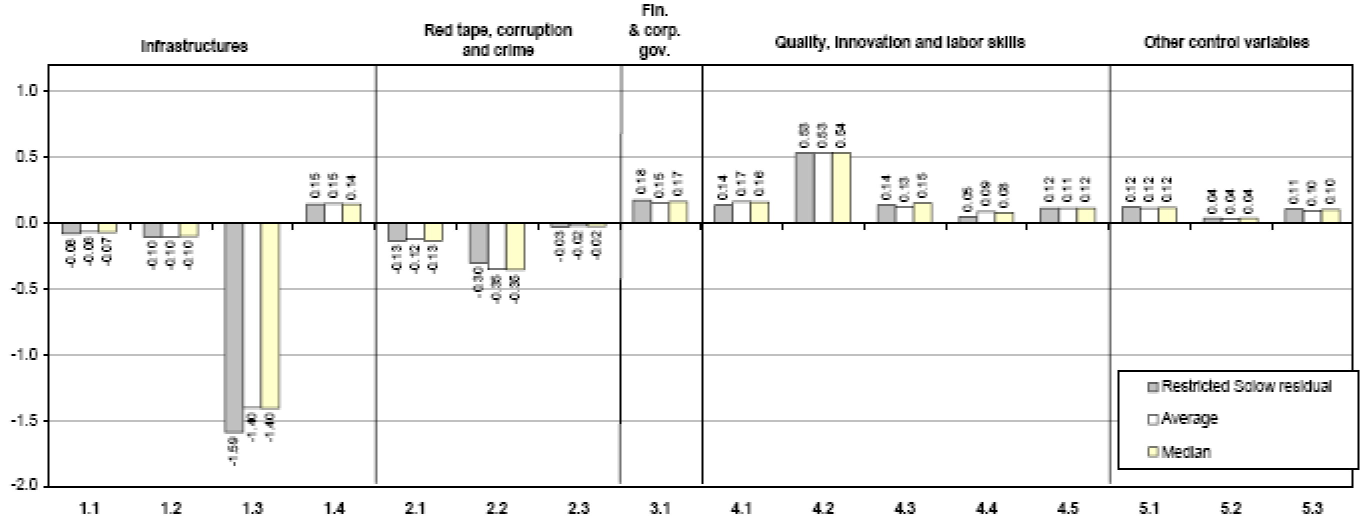


A.1 Restricted Solow residual;
A2 Single step-restricted-Cobb-Douglas-OLS TFP;
A3 Single step-restricted-Translog-OLS TFP;
A4 Single step-restricted-Cobb-Douglas-RE TFP;
A5 Single step-restricted-Translog-RE TFP.

B.1 Unrestricted by industry Solow residual;
B2 Single step-unrestricted-Cobb-Douglas-OLS TFP;
B3 Single step-unrestricted-Translog-OLS TFP;
B4 Single step-unrestricted-Cobb-Douglas-RE TFP;
B5 Single step-unrestricted-Translog-RE TFP.

Source: Authors' elaboration with Investment Climate Surveys (ICs) data.

Figure 4: IC and C elasticities and semi-elasticities with respect to productivity: Guatemala, Honduras, and Nicaragua



1. Infrastructures
1.1 Average duration of power outages Hours per day (logs)
1.2 Average number of days to clear customs for imports (logs)
1.3 Shipment Losses (Fraction of total sales)
1.4 Dummy for Internet Access (0 or 1)

2. Red tape, corruption and crime
2.1 Number of days spent in Inspection and Regulation related work Days (logs)
2.2 Fraction of sales declared to IRS for tax purposes (Fraction of total sales)
2.3 Number of criminal attempts suffered (Number)

3. Finance and corporate governance
3.1 Dummy for external audit of financial statements (0 or 1)

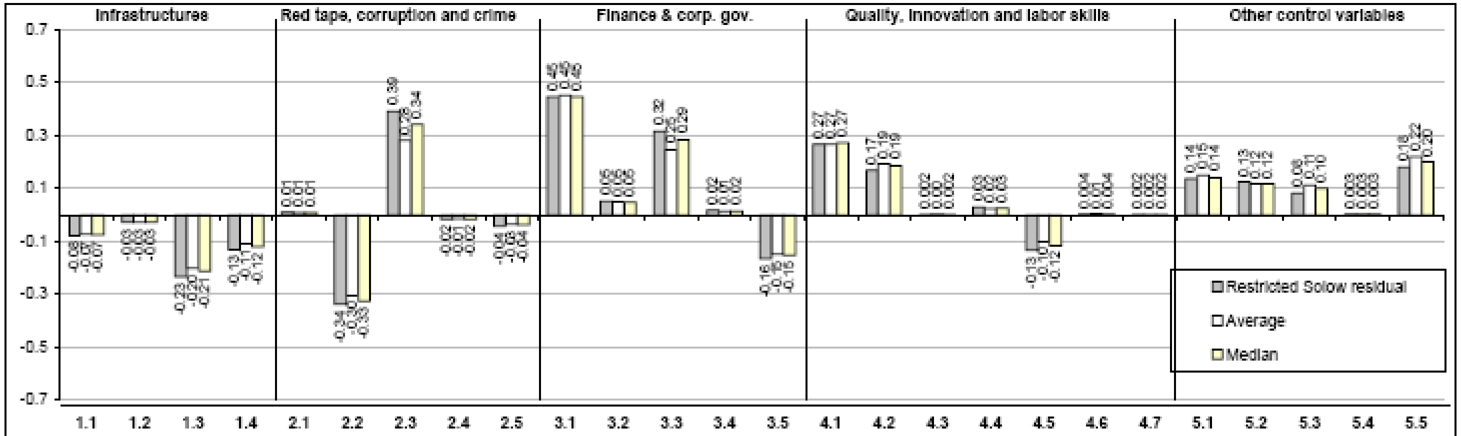
4. Quality, innovation and labor skills
4.1 Fraction computer-controlled machinery of total machinery (Fraction of total machinery)
4.2 Fraction of total staff engaged in R & D (Fraction of total staff)
4.3 Dummy for ISO quality certification (0 or 1)
4.4 Fraction of total staff with secondary education or more (Fraction of total staff)
4.5 Dummy for training provided beyond "on the job" (0 or 1)

5. Other control variables
5.1 Dummy for Incorporated Company (0 or 1)
5.2 Age of the firm years (logs)
5.3 Share of imported inputs (Fraction of total inputs)

* Grey bars correspond to elasticities and semi-elasticities from the restricted Solow residual case.
* White bars correspond to the average value of the twelve elasticities and semi-elasticities from the robust estimation. Light yellow bars correpond to the median of the twelve elasticities and semiealsticities.

Source: Authors' elaboration with Investment Climate Surveys (ICs) data.

Figure 5: IC and C elasticities and semi-elasticities with respect to productivity: Costa Rica



1. Infrastructures
1.1 Average number of days to clear customs for exports (logs)
1.2 Average duration of power outages Hours per day (logs)
1.3 Total number of water outages (logs)
1.4 Average days waiting for an electricity supply (logs)

2. Red tape, corruption and crime
2.1 Percentage of sales declared to IRS for tax purposes (Percentage of total sales)
2.2 Number of days spent in Inspection and Regulation related work Days (logs)
2.3 Dummy for payments to obtain a contract with the government (0 or 1)
2.4 Percentage of sales never repaid (percentage of total sales)

3. Finance and corporate governance
3.1 Dummy for firm belonging to a trade association (0 or 1)
3.2 Dummy for credit line (0 or 1)
3.3 Dummy for debts with creditors (0 or 1)
3.4 Firm's profits after taxes as a percentage of total sales (perc. of total sales)

4. Quality, innovation and labor skills
4.1 Dummy for ISO certification (0 or 1)
4.2 Dummy for new technological license (0 or 1)
4.3 Percentage computer-controlled machinery of total machinery (perc. of total machinery)
4.4 Number of plant's employees dealing with engineering and design (logs)
4.5 Percentage of immigrant workers (perc. of total staff)
4.6 Percentage of unskilled workers receiving training (perc. of unskilled workers)

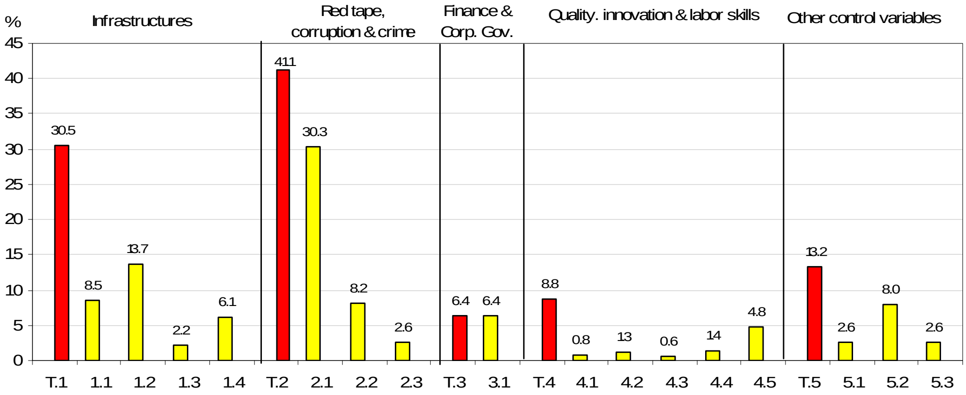
5. Other control variables
5.1 Dummy for foreign direct investment (0 or 1)
5.2 Total number of competitors in plant's main market (logs)
5.3 Dummy for benefit from free trade agreements with signed by the government (0 or 1)
5.4 Percentage of capacity utilization (percentage)
5.5 Dummy for importer firm (0 or 1)

* Grey bars correspond to elasticities and semi-elasticities from the restricted Solow residual case.
* White bars correspond to the average value of the twelve elasticities and semi-elasticities from the robust estimation. Light yellow bars correpond to the median of the twelve elasticities and semielasticities.

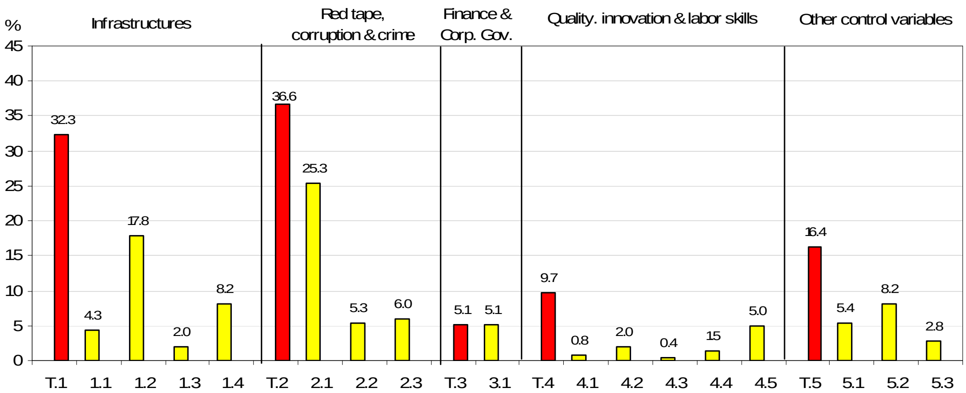
Source: Authors' elaboration with Investment Climate Surveys (ICs) data.

Figure 6: Relative IC effects to average log productivity: Guatemala, Honduras, and Nicaragua

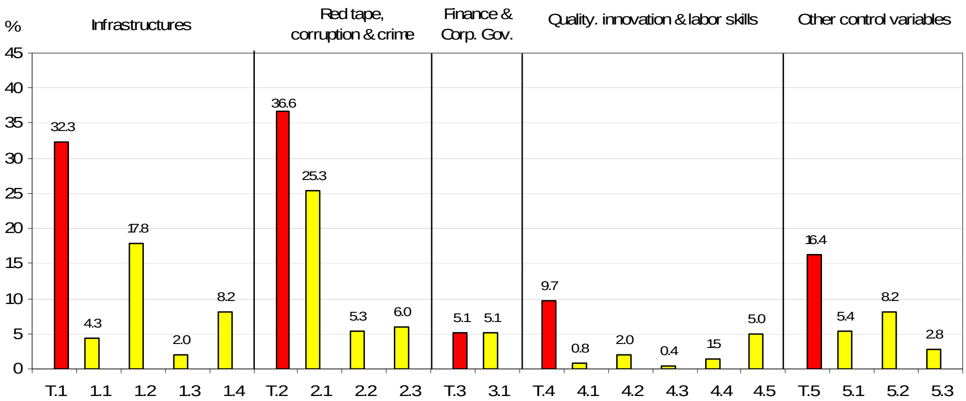
(a) Guatemala



(b) Honduras



(c) Nicaragua



T.1 Total infrastructures
1.1 Average duration of power outage. Hrs. per day.
1.2 Average number of days to clear customs for imports
1.3 Shipment losses
1.4 Dummy for internet acsess
T.2 Total red tape corruption and crime
2.1 Number of days spent in inspection and regulation related work
2.2 Fraction of sales declared to IRS for tax purposes
2.3 Number of criminal attemps suffered
T.3 Total finance and corporate governance
3.1 External audit of financial statements
T.4 Total quality, innovation and labor skills
4.1 Fraction computer-controlled machinery
4.2 Fraction of total staff engaged in R&D
4.3 ISO quality certification
4.4 Fraction of total staff with secondary education or more
4.5 Training provided beyond "on the job"

T.5 Total other control variables
5.1 Dummy incorporated company
5.2 Age of the firm
5.3 Share of imported

Figure 7: Relative IC effects to average log productivity: Costa Rica