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Technical Efficiency and Value Chain of Eastern European Union Companies: An Empirical Application using Semi-Parametric Frontier Methods

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TECHNICAL EFFICIENCY AND VALUE CHAIN OF EASTERN EUROPEAN UNION COMPANIES: AN EMPIRICAL APPLICATION USING SEMI-PARAMETRIC FRONTIER METHODS.[1]

ABSTRACT

This study examines technical efficiency and its determinants in companies from East Europe who recently joined the European Union (EU) using survey data at the sector level. In order to get acquainted with the conditioning factors of the obtained technical efficiency, we resort to the classic concept of *value chain*, as described by M. E. Porter (1985). In terms of the factors that integrate the cited concept, we specify different models regarding the strategic behaviour of the industrial sector firms, with the purpose of learning the impact on the technical efficiency. A Data Envelopment Analysis (DEA) approach is applied to estimate technical efficiency level for individual sectors. In particular, the empirical analysis focuses on country comparisons of company performance and the determinants of technical efficiency among the sectors. One of the most important results that arise from our analysis is the existence of highly heterogeneous efficiency determinants among productive sectors. In this context, while policy priorities may differ across countries and sectors, the identified micro-policies represent practical approaches to common policy challenges in companies from UE member countries from East Europe.

Key words: Technical Efficiency, Value Chain, Micro-Policies, Data Envelopment Analysis (DEA), Bootstrapping.
JEL–Classification: D24, C14, L19

RESUMEN:

Este estudio examina la eficiencia técnica y sus determinantes en las empresas de Europa del Este que recientemente se han incorporado a la Unión Europea (UE). Como marco de referencia para establecer los factores condicionantes de la eficiencia técnica obtenida, se recurre al concepto de cadena de valor, descrito por M. E. Porter (1985).
La metodología empleada adopta un enfoque semi-parametrico en el cual se realiza un análisis de *bootstrap* para determinar los intervalos de confianza de los índices de eficiencia técnica estimados mediante el método del análisis Envolvente de Datos (DEA). El análisis empírico se centra, por tanto, en comparaciones internacionales del rendimiento de la empresa y de sus factores determinantes.
Uno de los resultados más importantes que surgen de nuestro análisis es la existencia de un nivel muy heterogéneo – a nivel de sector de actividad - de factores que determinan la eficiencia técnica de las empresas. En este contexto, mientras que las prioridades políticas pueden ser diferentes entre países y sectores, la identificaron de micro-políticas representan enfoques prácticos a los desafíos de la política común en empresas de los países miembros de la UE del Este de Europa.

Palabras clave: Eficiencia técnica, cadena de valor, Micro-Políticas, Análisis Envolvente de Datos (DEA), Bootstrapping.

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1. INTRODUCTION

The EU enlargement to 27 countries in 2004 and 2007 constitutes a historical benchmark in the forming of the European space. In contrast to previous enlargements, the entering of eastern European countries has peculiar characteristics due to the large number of nations entering the EU and due to the heterogeneity in its parameters and levels of development (Hay, 2003: 13).

Although the eastern European countries have the common trait of their recent history linked to the Soviet Union and the fall of the Berlin Wall, their entry into the European club required the compliance of three conditions: democratic institutions, a market economy capable of insertion in a competitive world and the capacity to take on the Union's goals. These conditions were an important impulse to leave that common trait behind and, to a certain extent, have allowed differentiating the strengths and weaknesses of each country.

On the other hand, one must emphasize that this important enlargement in terms of numbers did not maintain a proportional relation with its economic relevance. Comparing the UE15 (2004) and taking into account data of that year, the contribution in population of the eastern European nations is of about 100 million inhabitants, which translated into a 28% increase in the EU population whereas in added terms, the increase in GDP was of nearly 7%, emphasizing Poland's contribution of 42.7% of that value (Alcalá, 2004: 144).

In terms of rent per capita, the set of the countries of eastern European was placed in 2004 in 4,380 Euros (current exchange rates) and 9,100 (PPP) Euros, respectively, which supposed 20% and 40% of the per capita income in the Europe of the fifteen. By countries the issue was somewhat different: in the case of Rumania the number in PPP was of 24% whereas in Hungary the per capita income was almost a 70% of the EU15. All this put into evidence the retard of these countries, but mainly the effort (with a very high degree of heterogeneity) needed to obtain the much desired real convergence of the EU27.

Another trait to consider is the characteristic of its productive structure: in the countries of the enlargement, more than 20% of the population was occupied in the agricultural sector whereas in the EU15 that percentile was of 4.8%. Among the countries one can highlight are Romania (40%), Bulgaria (28%) and Poland (26%). As far as foreign trade is concerned, the entailment of the 12 countries with the EU15 (exports and imports) approximately reached 60% of its trade balance whereas for the EU15 that value remains below 2.5% (Alcalá, 2004).

In any case, the enlargement is a reality and as all integration processes, it involves benefits and costs to bear in mind. Among the benefits one can mention: the inclusion of new rules in the operation of the society and the economy that allow greater opportunities for

initiatives and creativity, as well as the suppression of tariff barriers and the exploitation of scale economies that allow a suitable resource allocation.

But also the risks related to the appearance of structural deficits are present as a result of the commercial deficit, budgetary deficit of both national governments and the European Union, and deficit in the social cohesion process of the EU27 as a result of a greater number of population and regions with incomes far below the average.

At the micro level, one of the most worrisome problems—and perhaps the one that is of greater interest for our study—is the way in which the productive companies of these countries will respond (the majority of them are of recent creation and are modestly consolidated in terms of management background).

In this sense, it is interesting to analyze the behavior of companies from the point of their technical efficiency, as well as of their contribution to the value chain, which will allow shedding light on some conclusions on policy priorities, not only among the countries but among the productive sectors.[2]

The primary aim of this article is to examine the technical efficiency and its determinants in companies from the countries included in the enlargement of the EU and to know the main conditioning factors of the growth of productivity.[3]

1.1 Technical Efficiency and Value Chain

The studies related to technical efficiency have a common origin linked to the analysis of the total factors productivity and their influence in the rate of economic growth.

The literature developed on the topic is very ample: from the initial exposition of Solow (1957) where the idea of Residual Factor or Total Factor Productivity (TFP) is consolidated, to the later revision of the main idea carried out by Jorgenson and Griliches (1967), up to the

[2] A study on the experience of the start of the internal European market in 1993 (that had as one of its main objectives the increase in company efficiency) shows that during the 1987-1996 period, there has not been an increase in efficiency in the productive sectors of the Union. This paper argues that a possible cause of this stagnation is the possibility that the efficiency has a cyclic character and, therefore, the recession suffered in the beginning of the 90's could explain this situation (Esteban, Gallizo and Hernández, 2002).

[3] In this research paper, the data of Malta and Cyprus have not been taken into consideration since they are considered as Mediterranean countries. On the contrary, data from Moldova (not in the EU) with the sole objective of homogenizing the sample of the block of countries considered as Eastern European.

present time in which the research tree has so many branches that its description would a topic for another research paper.[4]

What is definitely evident is that many of those research studies have derived in the necessity to arrive to the company level as a form of understanding the concept of productivity with greater depth. This concept can initially have two differentiated sources: technical progress and efficiency.

For the purpose of this study and according to Fare, et al. (1994), productivity growth is considered necessary to produce higher quality goods in a more efficient manner, which results in lower costs to consumers and an increase in per capita incomes over time.

On the other hand, it is necessary to advance in the search of factors that are conditioners of that technical efficiency. In order to do so, one must resort to the concept—widely accepted in the theory of the firms—of *value chain* described by M.E. Porter (1985), in which the activities that produce added value in a company are classified in the following manner: (1) Primary Activities that make up the physical creation of the product, the activities related to its sale and post sale assistance[5], and (2) Secondary Activities, that serve as support to Primary Activities.[6]

Using this framework, this paper analyzes efficiency in different sectors, by means of Data Envelopment Analysis (DEA) methodology, pursuing two objectives: to estimate the technical efficiency achieved and to discover if there is a significant relationship among the factors of the Value Chain, defined as factors that are exogenous to the process and the estimated efficiency for each unit.

With this objective in mind, this paper is organized as follows: the next section will present the conceptual framework proposed to study the factors potentially conditioning the technical efficiency in firms. Section 3 will discuss the methodology of the analysis. Section 4 will analyze the main empirical results obtained. Section 5 ends with a summary of the main conclusions and policy implications.

[4] For the revision of the Literature on the origin of the Residual Factor and the measure of productivity, see Griliches, Z (1995), Mas and Shreyer (2006), and OECD (2001a).

[5] These activities are further divided into: Internal Logistics (Reception, Storage and Distribution of Raw Material), Operations (Reception of Raw Material to transform them into the final product), External Logistics (Storage of finished goods and Distribution of the product to the consumer), Sales and Marketing (Activities aimed at letting the product be known), and Post-Sale Services (Activities aimed at maintaining or realize the value of the product).

[6] These activities are further divided into: Company Infrastructure (Activities that serve as support to the whole company, such as Planning, Accounting and Finance), Human Resources Direction (Staff search, hiring and motivation), Technology development (Technology obtainment, betterment and management), Supply (Buying process of materials).

2. MEASUREMENT OF TECHNICAL EFFICIENCY

According to Leibenstein (1966), a company can be categorized as technically efficient if it is able to produce maximum output given available resources. It has been acknowledged in the literature that a gap normally exists between a firm's actual and potential levels of economic performance.[7]

Efficiency will be defined herein as the activity which produces maximum production given a certain set of resources, or in other words, the action which consumes the least possible volume of resources in order to achieve a certain volume of production.

According Farrell's contribution (1957), this paper focuses on technical efficiency, which measures total production volume produced with allocated productive resources.

2.1. Data Envelopment Analysis (DEA) Frontiers

The original DEA estimator proposed by Charnes, Cooper and Rhodes (1978), referred to as the CCR formulation, allows the efficiency of any Decision Making Unit (DMU) to be measured from the maximization of a ratio of weighted outputs with respect to weighted inputs, subject to the restriction that similar ratios for the rest of the DMUs are less than or equal to the unit. More precisely, the linear calculation program would be:

$$\min \theta_0$$

Subject to:

$$\sum_{j=1}^{n} y_{rj}\lambda_j \geq y_{ro}; \quad r = 1,...,s$$

$$\theta_o x_{io} - \sum_{j=1}^{n} x_{ij}\lambda \geq 0; \quad i = 1,...,m$$

$$\lambda_j \geq 0$$

[7] To better illustrate the relation existent between added growth of the productivity an the evidence at the company and sector levels, see Foster, Haltiwagner and Krizan (1998).

This program calculates a virtual unit as a linear combination, where λ_j represents all the weighted units evaluated, and obtains an identical or greater number of outputs with a smaller number of inputs than the unit being evaluated. If it is not possible to find a virtual unit that obtains the same outputs with a smaller number of inputs, the unit is efficient and is situated on the frontier. θ represents the factor that weighs all the inputs, and takes values between 0 and 1. Efficient DMUs will have $\theta = 1$, which means that it is not possible to reduce the number of inputs used to produce an identical level of outputs.

The measurement of technical efficiency calculated by the Banker, Charnes and Cooper (1984) formulation makes it possible to find out whether there is proper use of resources in relation with the production of goods or services of the DMU analyzed. As for scale efficiency, it is equal to the quotient of BCC efficiency and CCR efficiency, and provides a measurement of the distance from the analyzed DMU to a virtual DMU that operates with the most productive scale size (MPSS).

For this purpose, these authors propose the existence of a single difference between the envelopment of the BCC and the CCR formulations: the inclusion of the restriction of convexity (relating to the DMU k): $\sum_{j=1}^{n} \lambda_{jk} = 1$.

3. METHODOLOGY OF ANALYSIS

3.1. Variables and Sample

The statistical source used for this analysis is the World Bank's Enterprise Surveys (ES). The ES collect data from key manufacturing and service sectors in every region of the world. The Surveys use standardized survey instruments and a uniform sampling methodology to minimize measurement error and to yield data that are comparable across the world's economies.

To generate internationally comparable data, the questions in the Core questionnaire are asked in all countries and for all industries where the survey is implemented. In addition to this Core instrument, the Manufacturing Module and Services Module questions are asked to establishments in the manufacturing and services sectors, respectively.

The Core instrument is comprised of eleven sections: the first eight sections contain qualitative questions, asking for the manager's opinion on the business environment and for his motivation for business

decisions[8]. The last three sections of the questionnaire deal with facts and figures specific to the transactions businesses make in order to operate.[9] The Manufacturing Module contains questions about capacity (use of production capacity and hours of operation).

TABLE 1.
Statistical distribution: firms according to country and sector (year 2004).

Country/ industry	Beverages	Chemicals and pharmaceutics	Food	Garments	Leather	Metals and machinery	Non-metallic and plastic materials	Paper	Textiles	Wood and furniture	Other manufacturing
Bulgaria	10	2	2	5	2	9	3	2	5	3	2
Czech	7	3	3	3	1	29	10	4		12	3
Estonia	4		1	5	1	8	2	4	3	4	
Hungary	7		28	41	2	153	9	9	5	4	
Latvia	2			4		5		3	1	8	
Lithuania	4			3		8	3	3	6	10	3
Moldova	40		4	14		20	3	1		3	3
Poland	15	1	46	97	4	178	10	10	9	6	1
Romania	56	9	36	75	2	86	5	6	5	6	1
Slovakia		4	1	1		12	3		1	3	3
Slovenia	1	5	1	2	1	23	8		3	5	
Total	146	24	122	250	13	531	56	42	38	64	16

Source: DDP Quick Query database of WDI & GDF, World Bank.

[8] These sections deals with the characteristics of the business and the investment climate in which it operates including: Control Information, General information (ownership, start-up), Infrastructure and Services (power, water, transport, and communication technologies), Sales and Supplies (imports, exports, supply and demand conditions), Degree of Competition (price and supply changes, competitors), Land (land ownership, land access issues), Crime (extent and losses due to crime), Business-Government Relations (quality of public services, consistency of policy, regulatory compliance costs), and Investment Climate Constraints (evaluation of general obstacles).

[9] More specifically, these sections contain questions on production costs, investment flows, balance sheet information and workforce statistics. These sections include: Finance (sources of finance, terms of finance, financial services), Labor (worker skills training, skill availability, employment, education levels of workers) and Productivity (Numbers and figures needed to estimate productivity).

The previou table comprise the sectors analyzed in this research paper respectively and includes secondary activity (industry) sectors.[10]

The sampling methodology of the World Bank's Enterprise Survey generates sample sizes appropriate for achieving two main objectives:

1. A sample representative of the whole economy that substantiates assertions about the whole economy, not only about the manufacturing sector. In addition to selected manufacturing industries, the overall sample should include services industries and other relevant sectors of the economy.

2. A sample that is large enough in size for selected industries to conduct statistically robust analyses with levels of precision at a minimum 7.5% for 90% confidence intervals about[11]: (a) estimates of population proportions (percentages), at the industry level, and (b) estimates of the average mean of log of sales at the industry level.

3.2. Research Design

Although there is no consensus among researchers regarding the way to establish the process to evaluate the influence of environmental variables on service efficiency levels, in this paper we have attempted to detect the repercussion of certain exogenous factors on the said efficiency levels by using a two-stage process made up of the following steps:

1. Obtaining the Charnes, Cooper and Rhodes (CCR) efficiency index. In order to calculate efficiency, the behavior of each unit observed is optimized, thus determining the efficient production frontier by means of linear segments based on the Decision Making Units (DMUs) that operate with the best practices. This corresponds to the set of units considered efficient in Pareto's terms. Therefore, the only requirement established is that each DMU should belong to the frontier envelopment (Cooper, Park and Yu, 2001: 3).

2. Sensitivity analysis of efficiency scores. Though there is currently information available on statistical inference with a reasonable level of certainty, as a result of advancement in the development of bootstrap techniques (Simar and Wilson 2000), we have opted

[10] The Table with tertiary sectors (services: Advertising and Marketing, Hotels and Resturants, IT services, Real Estate and Rental Services, Retail Wholesale Trade, Telecomunications, Trasnport, Construction) and primary services (mining: Mining and Quarrying.) are not included in the paper due to space reasons. Anyway, in this case the heterogenity of the outcome obtained is the same as that of the other sectors.

[11] A 7.5% precision of an estimate in a 90% confidence interval means that we can guarantee that the population parameter is within the 7.5% range of the observed sample parameter, except in 10% of the cases.

for the traditional application of determinist mathematical models, and as a complement to them, we have used the re-sampling methods and bootstrapping techniques (see Appendix I), in accordance with the contribution by Simar and Wilson (1998).[12] The rationale behind bootstrapping is to simulate a true sampling distribution by mimicking the data-generating process, and the results throughout this paper were obtained from 2,000 bootstrap iterations.

3. Estimating a truncated regression. The choice was made to estimate this dependency model because, according to the results of Simar and Wilson (2007), it provides better statistical inference than the Tobit regression does. The linear regression model we consider here is presented in Appendix I.

[12] Simar and Wilson noted that the DEA efficiency estimates are biased and serially correlated, which invalidates conventional inferences from the two-stage approaches. In this context, the authors proposed a procedure, based on a double bootstrap, that enables consistent inference within models explaining efficiency scores simultaneously producing standard errors and confidence intervals for these efficiency scores.

4. EMPIRICAL ANALYSIS

A variety of features distinguish the business environment in sectors from those typically observed in the OECD. We will begin by mentioning the most remarkable and generally acknowledged among them, as identified by Tybout (1992):

1. Market size (e.g. Population and GDP). Although some economies are quite large, most are not. Hence, with the exception of countries such as Poland or Romania, the size of the domestic market for manufactured products is relatively limited. This means that the strategy of companies must be oriented towards the external sector and thus, must necessarily bear in mind the macroeconomic aspects that are translated through channels such as direct foreign investment, exchange rates and immigration.
2. Access to manufactured inputs (e.g. Merchandise imports and exports). The set of choices of domestically produced intermediate inputs and capital equipment is also often limited.
3. Human capital (e.g. School enrollment, primary). Low rates of secondary education (less than 90%) and an insufficiency of technicians and scientists in countries like Hungary of Lithuania also affect the mix of goods manufactured and the factor proportions used to produce them.
4. Infrastructure (e.g. Road density). Roads, ports, airports, communication facilities, power, and safe water access also tend to be relatively limited in all countries, although they especially affect countries like Bulgaria or Moldova.
5. Financial markets (e.g. Domestic credit to private sector). Credit markets are also relatively thin in countries like Romania or Moldova.
6. Volatility (e.g. Inflation, consumer prices). Macroeconomic and relative price volatility is typically more extreme in countries like Romania or Moldova than in other economies like the Czech Republic or Lithuania.[13]
7. Governance (e.g. Procedures to enforce a contract). Red tape are also relatively high in countries like Poland or Romania, for this reason the protection of contract enforcement can be problematic.[14]

[13] "All developing regions do worse than the industrialized countries", Hausmann and Gavin (1996).
[14] "Anti-trust policy is also often weak, as are environmental standards" Brunetti (1997).

The information on the economic characteristics of the countries analyzed was taken from different World Bank publications. A synthesis is shown in Table 2.

As already mentioned in the introduction, the socio-economic and development indicators for the analyzed countries reflect economies that have gone from a planned system to a mixed system, which has culminated with its incorporation into the European Union (EU). These magnitudes show the necessity of convergence with respect to the set of countries that make up the present EU, both from the nominal and the real points of view:

1. Firstly, in aspects related to infrastructure endowment (highway density), bureaucracy (number of procedures to sign a contract), education (incorporation of the population to primary education), with respect to the rest of the countries that conform the EU.

2. In second place, in aspects related to the efficiency of its productive structure, in order to impulse economic growth and development magnitudes (growth of the per capita Gross Domestic Product)

This second aspect is precisely the object of analysis of this paper, although the interaction between both factors is an aspect that is widely discussed in Literature on economic growth and development. In fact, another line of work with the countries of the East is related to the analysis of the convergence among these countries and the rest of the European Union (Esteban, Gallizo and Hernández, 2002).

4.1. Technical Efficiency and Inter-industry Determinants at the Sector Level

To evaluate the efficiency of manufacturing companies, three inputs[15] (*Labor Cost, Materials and Energy Cost*) and one output (*Sales*) have been incorporated into the model. A synthesis of production function variables and the descriptive statistics for the indicators considered for the sample is presented in Appendix II (Table I).

The results of the analysis of efficiency with monetary inputs are shown in Tables 3 and 4. These results reveal the sensitivity of the efficiency measures with respect to sampling variation. The bias-corrected efficiency in Tables 4 reveals that differences in measurement efficiency are of a different magnitude than when the original efficiency scores are considered. For all of the manufacturing sectors, the efficiency declines slightly.

[15] Coelli, et al. (2005), a commonly-used classification of inputs involve five categories: capital (K), labor (L), energy (E), material inputs (M), and purchased services (S). The use of data according to these categories in productivity measurement is sometimes referred to as KLEMS approach. In this study, Capital (K) and Purchased Services (S) are not available.

TABLE 2.
Socio-Economic and Development Indicators by country (2004 year).

Country/ industry	Total population[1]	GDP per capita, PPP[2]	Industry, value added[3]	Merchandise exports[4]	Merchandise imports[4]	School enrollment, primary[5]	Road density[6]	Domestic credit private sector[7]	Inflation, consumer prices[8]	Procedures to enforce a contract[1]
Bulgaria	7781000	8737.161	4022807808	9932382032	14453494993	94.98052791	40.48639206	36.31128868	6.346133143	34
Czech	10206923	19094.62	22018136064	68986459239	69967456060	..	165.3908879	32.61472877	2.833643175	22
Estonia	1348999	15107.31	1911966336	5932476581	8335935795	93.90955231	134.0858693	40.01893348	3.048071707	25
Hungary	10107095	16306.48	15011529728	55566718661	60538321226	89.09593776	..	45.82225836	6.780023712	21
Latvia	2312791	11885.7	2287386624	4009170454	7095505106	..	111.6262642	50.77709798	6.191878487	24
Lithuania	3435585	12967.48	4650113536	9301566446	12386991757	88.62493488	126.5650925	28.80164646	1.195219124	24
Moldova	3925170	2012.422	290329920	986255000	1773742000	92.37393608	38.73745056	21.23095682	12.5283047	37
Poland	38182200	13091.86	53077282816	75046614430	89696102001	97.51612288	..	28.14845	3.576547231	41
Romania	21684884	8977.659	15057262592	23553215092	32690617860	90.9535242	86.44217391	15.6740974	11.87686787	43
Slovakia	5382449	14989.53	8776060928	27744734233	29861579419	..	89.3970894	30.54339454	7.548500882	27
Slovenia	1997000	22132.83	7092050944	16361365166	17758527740	95.54712377	190.9126156	48.77266733	3.589026796	25

[1] Number.
[2] Constant 2005 international $.
[3] Constant 2000 US$.
[4] Current US$.
[5] % net.
[6] Km of road per 100 sq. km of land area.
[7] % of GDP.
[8] Annual %.

Source: DDP Quick Query database of WDI & GDF, World Bank.

TABLE 3.
Descriptive statistics of the CCR efficiency index (Normal) by Industry and country (year 2004).

Country/ industry	Beverages	Chemicals and pharmaceutics	Food	Garments	Leather	Metals and machinery	Non-metallic and plastic materials	Paper	Textiles	Wood and furniture	Other manufacturing
Bulgaria	0.7806666	0.8196931	0.97719	0.8108433	0.976372	0.7804897	0.842391	0.998703	0.831882	0.7884952	0.9285225
Czech	0.6112682	0.8484424	0.535654	0.554417	1	0.6874574	0.7997714	0.760305		0.8440064	0.9033923
Estonia	0.5468308		0.503373	0.6085443	0.9522	0.7771096	0.7863344	0.842794	0.743194	0.7871332	
Hungary	0.7520595		0.762723	0.7194099	0.870096	0.6998761	0.9122762		0.65928	0.9087663	
Latvia	0.783849			0.7895076		0.7686553		0.919039	0.783576	0.8973708	
Lithuania	0.7511461			0.6060486		0.8699229	0.9063271	0.960094	0.795506	0.9122122	0.9018563
Moldova	0.6651108		0.524539	0.559791		0.6637191	0.7472742	0.543744		0.7361498	0.8111461
Poland	0.6241909	0.70205	0.678462	0.6633458	0.976315	0.7264996	0.7916926	0.912186	0.845295	0.9124915	0.860141
Romania	0.7082586	0.8692058	0.759398	0.7055891	0.960236	0.7328734	0.8347566	0.739531	0.771068	0.7794766	1
Slovakia		0.8164201	0.647249	0.5518764		0.7681044	0.8789363		0.990688	0.9506446	0.8532801
Slovenia	0.7021486	0.905259	0.672676	0.9271314	1	0.9122419	0.9347248		0.869252	0.9807501	
Mean	0.69255291	0.826845067	0.673474	0.6815004	0.962174	0.762449945	0.84344846	0.83455	0.809971	0.863408791	0.894048329

Source: DDP Quick Query database of WDI & GDF, World Bank.

TABLE 4.
Descriptive statistics of the CCR efficiency index (Bias-Corrected) by Industry and country (year 2004).

Country/ industry	Beverages	Chemicals and pharmaceutics	Food	Garments	Leather	Metals and machinery	Non-metallic and plastic materials	Paper	Textiles	Wood and furniture	Other manufacturing
Bulgaria	0.6584934	0.7138284	0.866225	0.6823472	0.944323	0.7179707	0.7662697	0.88917	0.744128	0.7352758	0.8440145
Czech	0.5535702	0.7693674	0.504404	0.5179684	0.951993	0.6560142	0.7524987	0.718928		0.8021691	0.8202675
Estonia	0.4924425		0.42963	0.5662534	0.93262	0.7216774	0.7545111	0.806582	0.702857	0.7285923	
Hungary	0.6527401		0.681023	0.6280557	0.843141	0.6561229	0.828549	0.771248	0.611262	0.8289302	
Latvia	0.6274855			0.6273265		0.6933819		0.814057	0.735335	0.8225906	
Lithuania	0.645109			0.5637372		0.8011747	0.8360677	0.862884	0.713739	0.8490626	0.8428977
Moldova	0.5976521		0.485399	0.5213823		0.6373566	0.7086352	0.52363		0.7058392	0.7587919
Poland	0.5713145	0.6646996	0.616945	0.6197752	0.955419	0.6854021	0.7523907	0.848483	0.767382	0.8464457	0.7988152
Romania	0.6356707	0.7778627	0.682317	0.6293231	0.936757	0.6819127	0.7613535	0.698822	0.697939	0.7288084	0.8811116
Slovakia		0.7579762	0.608242	0.5188474		0.7263779	0.8297549		0.917361	0.8824315	0.7748418
Slovenia	0.6160245	0.8057298	0.620872	0.7812598	0.954211	0.813666	0.8362233		0.730213	0.885439	
Mean	0.60505025	0.748244017	0.610562	0.605116	0.931209	0.708277918	0.78262538	0.770423	0.735579	0.801416764	0.8172486

Source: DDP Quick Query database of WDI & GDF, World Bank.

Having found that there exists wide variation in technical efficiency among the sample firms it is important and useful to understand the factors that influence inter-firm efficiency differences.

Several factors can explain these differences, some of which were mentioned in the introduction. This section will analyze the potential impact on efficiency of variables related to the value chain.

In order to evaluate these activities different models of truncated regression are proposed, which explain the efficiency of the companies based on the management of sales and supplying (model 1), the resources of the company (model 2), their technological activity (model 3), their human resources (model 5). The analysis is completed with the incorporation of variables that characterize the enterprise environment (model 4) and control variables (model 6).

The results of the six models proposed are reported in tables 5-10. For each model[16] we show the value of the coefficients and the Standard Error of the different variables used. The next category of efficiency determinants covers numerous sources of heterogeneity.[17]

Exporting activity (% sales that have been exported directly) may serve as a form of exposure to competition for the manufacturing sector. The significant negative effects may arise because exporting is a source of structural heterogeneity among establishments: some do much, others little or nothing. Other forms of heterogeneity were inferred from broad traits of market structures. It is also important to observe the percentage of sales to the Government as a source of heterogeneity, since this affects the productive structure at the company level in every sector.

One way in which the non-production activities affect efficiency is through the different proportions of non-production workers assigned to manufacturing establishments.

[16] In general, the models present satisfactory indicators of global significance, with chi square values corresponding to significance levels less than 0.1, 0.05, and 0.01, respectively.

[17] Although the variables' significance or insignificance generally has no clear normative implications, their inclusion both reduces the chances of biased estimates for normatively significant regressors and provides useful information about their behavioral importance.

TABLE 5.
Truncated Regression Analysis by industry (year 2004): Model 1 Sales and Supplies.

Industry	Beverages	Chemicals and pharmaceutics	Food	Garments	Leather	Metals and machinery	Non-metallic and plastic materials	Paper	Textiles	Wood and furniture
Model 1 Sales and Supplies	Coef/E. St.	Coef/E. St.	Coef/E. St.	Coef/E. St.	Coef/E. St.	Coef/E. St.	Coef/E. St.	Coef/E. St.	Coef/E. St.	Coef/E. St.
Sales and Material purchases										
Exporting experience (years)	.0010969 [.0073482]		.0010192 [.0034748]	.0013397 [.0012944]		.0018105** [.0008913]	-.0004185 [.0016549]	-.0050388 [.0077618]	.0025178 [.0020874]	.0004367 [.004184]
Days to clear customs for exports	-.0363313*** [.009605]		.0268053 [.0207159]	-.006208 [.0042038]		-.0019832* [.001018]	.0030907 [.0021]	-.0176167* [.0093681]	-.0094584 [.0221023]	-.0151967 [.0095928]
% Sales direct export	-.0016673** [.000664]	.0014048 [.0009159]	.0011634 [.0013342]	-4.01e-06 [.0004429]	.0003857 [.0002584]	.0001789 [.0002911]	-.0005727 [.000744]	.001652 [.0025399]	-.0023825*** [.0009127]	-6.76e-06 [.0006172]
% Domestic sales are to multinationals	-.0012627 [.0009733]	.0025889 [.0019493]	.0019061* [.0010805]	.0002582 [.0005926]	-.0027232*** [.0002535]	.0003575 [.0003709]	-.0001842 [.0006876]	-.0024705 [.0028129]		.0017721* [.0009563]
% Domestic sales are to the government	.032375* [.018764]	.0080587** [.0038089]	-.008648 [.0093518]	-.0010068 [.0016083]	.0003593 [.0005967]	.0010065** [.0004214]	-.000724 [.0020295]	-.0035919 [.0031501]	.0062912 [.0098906]	-.0014266 [.0010291]
% Domestic sales are to affiliated subsidiaries	-.0014858 [.004807]	.0009044 [.0012284]	-.000109 [.0010914]	.0039069 [.0046337]	.0009249* [.0005153]	.0008097 [.0005531]	.0004946 [.0009517]	-.0335349* [.0201446]	-.0150173 [.0098103]	.0004646 [.0007051]
Losses due to breakage or spoilage (as % of consignment value)	-.019621** [.0075667]	.0831485 [.0523607]	-.0277025** [.0125459]	-.001055 [.0091116]	.2339367*** [.0638409]	-.001224 [.0022271]	.0071488 [.0508578]	.4952351 [.4801256]	.0799036 [.083617]	.0181132* [.0097593]
% Materials inputs direct import	.0041142* [.0021368]	.0009506 [.0007919]	-.0017822 [.001123]	-.0001081 [.0003683]	-.0002654 [.0003278]	.0002765 [.0002786]	-.0003097 [.0006479]	-.0005029 [.0020365]	-.0017513* [.0009139]	.0003974 [.0003971]
Supplies										
Dummy customs and trade regulations (No obstacle)	.1128591** [.0531217]	-.0860445 [.068076]	-.0822475 [.0858243]	.0050867 [.0369744]	.0231488 [.0152951]	-.0116379 [.0179816]	.0058091 [.03922]	.0544651 [.055029]	.0995579* [.0554763]	-.0402698 [.0365576]
Constant eq 1	.6973559*** [.0652212]	.6561481*** [.0596963]	.5948797*** [.1187341]	.6279232*** [.0352973]	.9357655*** [.0067045]	.6635719*** .0183847	.8360798*** [.0471505]	.8740913*** [.0814669]	.8845067*** [.0863815]	.8563261*** [.0392847]
Constant sigma	.0651408*** [.0115205]	.10531*** [.0192837]	.0833823*** [.0165853]	.1036042*** [.0095431]	.0125447*** [.0027386]	.1043514*** [.0060274]	.0697841*** [.0117363]	.0576515*** [.0126065]	.0748908*** [.0153374]	.0471014*** [.0081882]
Wald chi2 Prob > chi2 Log likelihood	35.54 0.0000 20.997254	11.48 0.1188 20.659532	18.91 0.0259 13.912558	5.20 0.8164 50.998544	300.63 0.0000 32.638177	16.19 0.0630 142.09305	3.26 0.9531 26.817465	19.70 0.0198 17.565456	19.75 0.0113 15.480584	13.57 0.1385 29.734185
Number of observations	16	22	13	60	11	166	21	12	13	18

Dependent variable: Technical efficiency (CCR) corrected; Low limit 0 and top limit +inf.
$*p\langle 0.1; ** p\langle 0.05; *** p\langle 0.01$

Source: Authors' calculation from the Investment Climate Survey Databank, World Bank.

TABLE 6.

Truncated Regression Analysis by industry (year 2004): Model 2 Resources of the firm.

Industry	Beverages	Chemicals and pharmaceutics	Food	Garments	Leather	Metals and machinery	Non-metallic and plastic materials	Paper	Textiles	Wood and furniture
Model 2 Resources of the firm	Coef/E. St.	Coef/E. St.	Coef/E. St.	Coef/E. St.	Coef/E. St.	Coef/E. St.	Coef/E. St.	Coef/E. St.	Coef/E. St.	Coef/E. St.
Working capital										
% Internal funds or retained earnings	.0010529 [.0010136]	.0795201*** [.0079035]	-.0013162* [.0007952]	-.0004063 [.0005348]	.0112732*** [.0012542]	-.0001593 [.0003382]	-.0061985*** [.0017725]	.0000476 [.0010216]	.0014015 [.001155]	-.0001676 [.0003302]
% Local commercial banks (loan, overdraft)	.0021131* [.0010768]	.0741427*** [.0075232]	-.0022646** [.0009384]	-.0003182 [.0006137]	.01159*** [.0013172]	-.0002708 [.0003873]	-.0075543*** [.0017634]	-.0023745** [.0011784]	-.0039481*** [.0013401]	.0003074 [.0005154]
% Foreign owned commercial banks	.0004033 [.0016514]	.2390358*** [.0232294]	-.0030458 [.0071345]	-.0011705 [.0014482]		.0015458* [.000894]	-.0204551*** [.0032073]		.0187731 [.0149345]	-.0020015*** [.0006251]
% Leasing arrangement	.002901* [.0016998]	.1703001*** [.0148638]	.0011677 [.0019283]	-.0002284 [.0016148]	.0171531*** [.0024664]	.0015361* [.0009006]	-.0081109 [.005129]	.0004552 [.0024015]	.0129769 [.0135592]	-.0007406 [.0016827]
% Investment founds/special development services	-.011604 [.0119014]		-.0020619 [.0034513]			.0017991 [.0013278]				.000428 [.0046981]
% Trade credits (supplier or customer credit)	.0019429 [.0012823]		-.0005577 [.0016006]	-.0008954 [.000804]	.0112225*** [.0011036]	.0005041 [.0005406]	-.0038074* [.0019428]	-.0002621 [.0012059]	-.0004387 [.0016724]	-.0014682** [.0006999]
% Credit cards	.0034471 [.0031085]		.0093217 [.014462]	-.0002919 [.0103385]		-.0010561 [.0063581]				.0306569*** [.0105887]
% Family/friends	.0009655 [.0014388]	.0791208*** [.0096574]	.001367 [.0020605]	-.0004672 [.0021244]	.0112413*** [.0014707]	-.0018079 [.0011082]	-.0031821 [.0023069]	-.0074395*** [.0025767]	.0604961* [.0353587]	.0142536*** [.0054744]
% Informal sources (e.g. money lender)	-.0004853 [.0017553]		-.0013204 [.0047528]	.0153134 [.010981]		-.0032697 [.0027941]	.0332693** [.0163674]	-.0010362 [.0018033]		.0048429*** [.0012795]
Financial resources										
Recent loan or overdraft was approved (year)	.0031511 [.0079384]		.0170954 [.018326]	.0076172 [.0081318]		.0007298 [.0057263]	.0188378*** [.0060261]	-.0074118 [.0159703]	-.0053194 [.017159]	-.0059094 [.0115213]
Value of collateral required (as % of the loan value)	-.0002147 [.0002045]		.0002201 [.000305]	-.000022 [.0001606]		-.0001202 [.0001066]	.0000988 [.0001858]	.000841 [.0006483]	-.0000799 [.0005549]	.0000615 [.0001438]
% Establishment's sales are sold on credit	.0001778 [.0003537]	.000534*** [.0000763]	.0003313 [.0005468]	.0002085 [.0003294]	.0000713 [.0003577]	-.0001657 [.000215]	.0003732 [.0003759]	-.0000617 [.0005544]	.0005785 [.0008082]	.0004814 [.0003343]
Dummy access to financing (No obstacle)	-.0758214** [.0321125]		.027749 [.0435979]	-.0149316 [.0275468]	-.0045733 [.0430454]	.0094956 [.023064]	.1524585*** [.0363055]	.0060362 [.0486218]	-.0138319 [.068294]	.0608819** [.0300352]
Dummy cost of financing (No obstacle)	.0986605** [.0464528]	-.0821003** [.03533]	-.013853 [.0557232]	-.0252734 [.0381021]	.0307598 [.0297588]	-.0146552 [.0296693]	-.2051859*** [.0504957]	-.1325093** [.0616794]	.0448452 [.0664236]	.1157089*** [.034021]
Constant eq 1	-5.812906 [15.90151]	-7.152333*** [.7815855]	-33.54302 36.71068]	-14.62789 [16.29448]	-.1927662 [.1273803]	-.7396066 [11.46859]	-36.35261*** [12.0764]	15.58627 [32.03504]	11.28723 [34.32916]	12.53463 [23.07078]
Constant sigma	.1093446*** [.0090016]	.024989*** [.0058929]	.1328773*** [.0126486]	.1014691*** [.0074739]	.0156404*** [.0032874]	.1077742*** [.0055371]	.039612*** [.0059426]	.056067*** [.0099739]	.0819294*** [.0140069]	.041087*** [.0058367]
Wald chi2	22.64	356.82	12.79	8.14	186.72	18.40	73.82	54.93	26.97	99.38
Prob > chi2	0.0664	0.0000	0.5429	0.8342	0.0000	0.1893	0.0000	0.0000	0.0046	0.0000
Log likelihood	60.653383	20.434092	41.139847	80.914522	32.97179	171.2072	41.773125	25.061222	21.098498	46.312866
Number of observations	76	9	65	93	12	208	23	17	19	26

Dependent variable: Technical efficiency (CCR) corrected; Low limit 0 and top limit +inf. $*p\langle 0.1$:** $p\langle 0.05$; *** $p\langle 0.01$

Source: Authors' calculation from the Investment Climate Survey Databank, World Bank.

TABLE 7.

Truncated Regression Analysis by industry (year 2004): Model 3 Capacity and innovation.

Industry	Beverages	Chemicals and pharmaceutics	Food	Garments	Leather	Metals and machinery	Non-metallic and plastic materials	Paper	Textiles	Wood and furniture
Model 3 Capacity and innovation.	Coef/E. St.	Coef/E. St.	Coef/E. St.	Coef/E. St.	Coef/E. St.	Coef/E. St.	Coef/E. St.	Coef/E. St.	Coef/E. St.	Coef/E. St.
Value added initiatives										
% of net profits were re-invested	-.000515 [.0005266]		-.0001206 [.0006302]	-.0000476 [.0003364]	.0003795** [.0001854]	-.0001064 [.0002038]	-.0005259 [.000398]	-.0012451 [.0008082]		-.0011217** [.0005544]
Dummy Internationally-recognized quality certification	.0240823 [.0515623]	.0122193 [.0584435]	.068253 [.0486895]	.0037632 [.0341312]	-.2806727*** [.0168119]	.0076657 [.0182472]	-.0272914 [.0425938]	-.1051322* [.0551357]	.1263497 [.0849428]	.1435763** [.0680058]
Dummy outsourced a major production activity	.047942 [.0818289]	.4481679*** [.0547915]	-.024418 [.0978413]	-.0823998** [.0408365]		.001006 [.026347]	.0031827 [.0567606]		-.3564095** [.1484406]	-.0802673** [.0384042]
Dummy brought in-house of a major production activity	.0851924 [.0703101]	-.2392328*** [.0628406]	.0089194 [.1325072]	.0772469 [.0477282]		-.0476929** [.0232516]	.120325* [.0640613]	-.0240532 [.0617019]	.1083236 [.0862552]	
Dummy agreed a new joint venture with foreign partner	-.0874701 [.1148599]	-.0989479** [.0468172]		.0693098 [.0497884]	-.0291669 [.0236329]	.0586043* [.0320422]	-.0743648 [.0893139]	-.2571296 [.1850142]	-.6473342*** [.2281007]	.0487232 [.0860174]
Dummy obtained a new licensing agreement	-.0496164 [.0466414]	.1749893*** [.0471889]	-.2053581*** [.0543512]	-.0176819 [.0402627]		-.0432514** [.0204512]	.0681975* [.0373931]	.0132627 [.0875176]	1.322871** [.558321]	.0978* [.0549002]
Dummy member of a business association or chamber of commerce	-.0706447* [.0381836]	-.0066668 [.045112]	-.0740014 [.049803]	.057406** [.0265039]		.0412664*** [.0155015]	.0481593 [.0292596]		.4504043*** [.1131394]	-.0281791 [.0781032]
Design and R&D activity										
Expenditures on design or R&D	.002054 [.0012726]		-.0000558 [.000729]	.0005276 [.000769]	-.0003299*** [.0001228]	.000334** [.0001357]	.0002316* [.0001301]	.0006444 [.000493]	-.0151432** [.0074039]	-.0003535 [.0003819]
Dummy technological innovations (embodied in new machinery)	.0427961 [.0435411]	.2405201*** [.0311563]	.0469725 [.0591048]	-.0069191 [.038988]		-.0224414 [.0179063]	-.0934627*** [.029771]	-.1041251** [.0500815]	.0015572 [.0954446]	.1276618*** [.038473]
Dummy discontinued at least one product line	.0601713 [.046045]	-.1503072** [.06763]	-.0507016 [.054235]	.0026065 [.0317715]	-.036134*** [.0135291]	-.0031933 [.0175845]	.0154932 [.0288076]	.0583004 [.0664474]	-.0519337 [.0642508]	-.0482145 [.1024408]
Dummy upgraded an existing product line	.0181964 [.0497721]	-.139754** [.0635768]	.1227271* [.0691953]	.0076848 [.0357467]	.0266617*** [.0070478]	.0410793** [.0200975]	-.0493566 [.0313267]	.1265323*** [.0473951]	.1588855 [.1125374]	.0306079 [.0265053]
Dummy development a major new product line	-.1029226** [.0451367]	.1301993*** [.0358251]	.121481** [.0478964]	-.0052542 [.0271082]	.0532617*** [.0123325]	.0250182 [.0162381]	-.0483754 [.034245]	.0026343 [.0591709]	.2822017*** [.0970396]	.1059592*** [.0323187]
Constant eq 1	.6737568*** [.0630282]	.7372319*** [.0665819]	.4988185*** [.0948978]	.5780333 *** [.0571987]	.9182656*** [.0080889]	.63971*** [.0271427]	.9104726*** [.0514825]	.9287104*** [.0951281]	.460612*** [.1006681]	.7012448*** [.055771]
Constant sigma	.1099716*** [.0118608]	.0385594*** [.0076271]	.1128131*** [.013626]	.0881611*** [.0079959]	.0083106*** [.0018633]	.094402*** [.0053463]	.0495454*** [.007867]	.0539055*** [.0109268]	.0642508*** [.0131819]	.0343725*** [.005464]
Wald chi2	16.55	117.46	24.13	18.55	684.55	41.79	30.38	40.19	37.65	71.81
Prob > chi2	0.1674	0.0000	0.0122	0.1001	0.0000	0.0000	0.0025	0.0000	0.0001	0.0000
Log likelihood	35.790277	23.906479	29.698776	61.607243	33.717427	155.52096	33.62406	23.655361	17.473311	39.061999
Number of observations	45	13	38	61	10	164	21	15	13	20

Dependent variable: Technical efficiency (CCR) corrected; Low limit 0 and top limit +inf. $*p\langle 0.1 : ** p\langle 0.05 ; *** p\langle 0.01$

Source: Authors' calculation from the Investment Climate Survey Databank, World Bank.

TABLE 8.
Truncated Regression Analysis by industry (year 2004): Model 4 Business-government relations.

Industry	Beverages	Chemicals and pharmaceutics	Food	Garments	Leather	Metals and machinery	Non-metallic and plastic materials	Paper	Textiles	Wood and furniture
Model 4 Business-government relations	Coef/E. St.	Coef/E. St.	Coef/E. St.	Coef/E. St.	Coef/E. St.	Coef/E. St.	Coef/E. St.	Coef/E. St.	Coef/E. St.	Coef/E. St.
Black market, red tape and crime										
Total days spent in inspections (labor and social security)	.0088224 [.0090476]		-.0229716 [.0165859]	.0030195 [.0065618]		.007461* [.0038715]	-.0391695*** [.0151027]		-.0312506 [.1347106]	.0245062 [.0276777]
% Total senior management time (for government requirements)	.0023405 [.0022159]	-.0211004 [.0286297]	-.0012324 [.0032477]	.0002884 [.0013346]	-.0000989 [.00059]	-.0006606 [.0009204]	-.001616 [.0025186]	0062968 [.0058537]	-.0148576 [.013719]	.0037546 [.0032443]
% Total sales reported (tax proposes)	.0022379* [.001179]	-.000324 [.0021172]	-.0018453 [.0016893]	.0005726 [.0006996]	-.0025165*** [.0002127]	-.000209 [.0004736]	-.0004322 [.0007845]	.0010995 [.0017735]	.0033928 [.002205]	-.0021358 [.0016853]
Informal payments (% of annual sales value)	.0070344 [.0074436]	-.2616741 [.3383522]	-.0025927 [.0064398]	-.0040244 [.0058988]		-.0025983 [.0053787]	.0094625 [.0070221]	.0011413 [.0116909]	.0761824 [.069185]	.0075928 [.0073465]
Payments for security (% of annual sales value)	-.0044533 [.0124133]	.2726285 [.3421783]	.0401789** [.0195814]	-.0093058 [.0089263]	.7777206*** [.0589235]	-.0083711 [.0062599]	-.0046663 [.0141023]	-.1736915*** [.0629086]	.0690247 [.1185174]	-.0252396** [.0125019]
Losses due to theft (as % of consignment value)	.0522006*** [.0193095]	-.3837401 [.7201957]	-.0165621 [.0130091]	.0021298 [.0212995]	-4.176112*** [.3170088]	-.0003097 [.0033975]	.0214323 [.0224058]	-.0902945 [.0889855]	.0152314 [.0701044]	.0055969 [.0079501]
Investment climate constraints to the establishment										
Dummy firm previously owned by the state	-.0917477** [.0363465]	.0435364 [.1047738]	-.1764094 ** [.0755761]	.1041356*** [.0338695]	-.3508764*** [.0262684]	.0589998*** [.0191657]	.0395662 [.0317263]	-.1051773 [.1204809]	-.0559029 [.0972674]	.0497963 [.0491345]
Dummy economic and regulatory policy uncertainty (No obstacle)	.0448016 [.0583886]	-.0268803 [.1514399]	-.1809231*** [.0529467]	.0853766** [.0357398]	.0127681** [.0060093]	-.0063038 [.0217411]	.0378252 [.0678675]	-.036476 [.0657408]		-.0236697 [.0750279]
Dummy macroeconomic instability (No obstacle)	.0606708 [.0524954]	.0150093 [.143757]	.1460383** [.0667585]	-.0725575 [.0497763]		.0157178 [.0257845]	.1136526* [.0583988]	.1270806* [.0722214]	.3058285 [.347095]	.0875333 [.069277]
Dummy anti-competitive or informal practices (No obstacle)	-.0868602* [.0457588]	.1085366 [.1078478]	.0547425 [.0481483]	.060539** [.0255312]	-.3398464*** [.0293196]	.009373 [.018669]	.0843915* [.0447071]	-.0093796 [.074793]	.0411978 [.0912012]	-.1474704*** [.0541552]
Constant eq 1	.3956601*** [.1101629]	.7671412*** [.1670501]	.8906348*** [.1685819]	.5344529*** [.0675111]	1.144082*** [.0160571]	.6825308*** [.0459776]	.8317534*** [.0713392]	.7388122*** [.1826199]	.4569306 [.3417034]	.9572071*** [.136989]
Constant sigma	.1123*** [.009987]	.1103179*** [.0260598]	.125646*** [.0135665]	.1011681*** [.0070879]	.0021272*** [.0005014]	.1064368*** [.0054104]	.0519587*** [.0079452]	.0907918*** [.0173595]	.1288784*** [.0257021]	.0730299*** [.0127407]
Wald chi2 Prob > chi2 Log likelihood	20.96 0.0214 51.099536	3.62 0.9343 11.468643	19.83 0.0309 35.294966	25.69 0.0042 90.961864	712.35 0.0000 42.606187	17.50 0.0640 175.8362	22.96 0.0109 33.936669	12.19 0.2026 21.852505	7.37 0.5988 14.183941	14.50 0.1513 28.255447
Number of observations	66	13	51	104	9	211	22	20	19	22

Dependent variable: Technical efficiency (CCR) corrected; Low limit 0 and top limit +inf.
$*p\langle 0.1 : ** p\langle 0.05 ; *** p\langle 0.01$

Source: Authors' calculation from the Investment Climate Survey Databank, World Bank.

According to Álvarez and Crespi (2003: 238), "the effect of overdraft facility should be incorporated in variables age of capital and the ratio of capital per worker. In fact, without access to credit, firms invest less in capital". In the case of Net Profits re-invested, we conclude that firms with high values in this variable have lower efficiency. The significant negative effects found could be related to the effect of fixed costs.

Value Added initiatives affect efficiency of firms at the sector level through four channels: (1) the use of out-sourcing and in-sourcing programs, (2) the development of a new product line, (3) the technological innovations (embodied in new machinery) and (4) expenditures on Design or R&D. In general, this implies that firms that produce new or significantly improved products in the market become more efficient.

The Investment Climate constraints affect efficiency of firms at the sector level through two channels: (1) the economic and regulatory policy uncertainly, and (2) the macroeconomic instability. In general those firms that are in a more instable macroeconomic environment tend to be less efficient. It is also observed that the inefficiency is negatively related based on the property history of the company.

The Labor organization affect efficiency of firms at the sector level through four channels: (1) the use of temporary workers, (2) the labor disputes, (3) the use of workforce with university education, and (4) the percentage of skilled workers trained by the firm.

The organization of a firm and its members can affect efficiency in many ways. One salient feature is the firm's size: various hypotheses based on the effect of fixed costs of replacing equipment or rooting out inefficiency hold that efficiency should increase with firm size. Each industrial sector yielded some definitive results, although neither the model specifications nor the findings are entirely congruent.

We did not find a strict positive relation between efficiency and firm experience (years of the firm). Large experience reduces estimated efficiency in the Paper sector but increase it in Food, Garments sectors. This can be interpreted by the origin of many companies in eastern European countries, where seniority does not necessarily mean a greater experience in the market and Business.

In relation with the services offered by the Associations of Business (or Chambers of Commerce), this study provides some evidence against the efficacy of these services, although a definitive conclusion requires a more robust analysis on this topic.

TABLE 9.
Truncated Regression Analysis by industry (year 2004): Model 5 Organization and Human resources.

Industry	Beverages	Chemicals and pharmaceutics	Food	Garments	Leather	Metals and machinery	Non-metallic and plastic materials	Paper	Textiles	Wood and furniture
Model 5 Organization and Human Resources	Coef/E. St.	Coef/E. St.	Coef/E. St.	Coef/E. St.	Coef/E. St.	Coef/E. St.	Coef/E. St.	Coef/E. St.	Coef/E. St.	Coef/E. St.
Staff and Human capital										
Average number of permanent no production workers	-.0011516 [.0008872]		-.006184*** [.0018913]	-.0005517 [.000999]	.0007112*** [.0000172]	-.0001753 [.0003728]	-.0007732 [.0011334]	.0349182*** [.0088671]	.0002827 [.0007028]	.0012688 [.0018624]
Average number of temporary workers	.0000989 [.0003279]		-.0031014 [.003132]	.0000937 [.0022776]	-.0000527*** [.0000128]	.0002043 [.0004311]	-.0009916 [.0008771]	.009815*** [.0032042]	.0332588 [.0240373]	.0012141 [.0012447]
Average number of skilled production workers	-.0000902 [.000211]	-.0002612 [.0003815]	.0017644*** [.0005713]	.0003999** [.0001829]	.0022519*** [.0003991]	.0001343* [.000072]	.0003909*** [.000139]	-.0050437*** [.0016125]	.0002724 [.0004748]	.0002339 [.000158]
% Workforce whit some university of higher (education level)	.0011359 [.0013237]	.0026968 [.0052275]	.002304 [.0023177]	.0019993 [.0017202]	-.0001726*** [.0000421]	.0001102 [.000613]	.0049374** [.0020669]	-.0054002** [.002419]	-.0100011* [.0055476]	.0008475 [.0041221]
% Skilled workers trained by the firm	-.0012487 [.0013237]	.0007507 [.0013412]	.0003593 [.0005109]	-.0011249** [.000507]		-.0000375 [.0003565]	.0009071* [.0005094]	-.0107668*** [.0032385]	.0016679* [.0008679]	-.0008189 [.0009823]
% Unskilled workers trained by the firm	.0014474 [.0014482]	.0010431 [.0014134]	-.0000881 [.0005488]	.0006197 [.0005547]		.0001003 [.0003811]	.001016 [.0006726]	.0152384** [.0068052]	-.0029713* [.0017207]	.0001861 [.000791]
Labor relations										
Optimal level of employment (as % of existing force)	-.0006409 [.0014021]	-.0064989 [.0045511]	-.0022697 [.001596]	.0012869*** [.0004931]	.0006794*** [.0001443]	.0004117 [.000691]	.0010007 [.001334]	-.0012918 [.0010591]	.0114243*** [.0043971]	.000075 [.0019591]
Weeks external recruitment for a skilled technician	.008932 [.0163124]		.0005142 [.0087204]	.0122659* [.0064712]		-.0019018 [.0018879]	-.0049723 [.0259458]		.0371045 [.0330895]	-.0020503 [.0032717]
Weeks external recruitment for a production/service worker	.0137285 [.0197061]		.0581205** [.0255205]	-.0147736 [.015225]		-.0021532 [.0084159]	.0235584 [.0549044]	.0488495** [.0190961]	-.011623 [.0252061]	.0425211 [.033581]
Days of production lose due to strikes or other labor disputes	-.2788289** [.1252642]			-.1774242** [.0821285]						-.0042494 [.0042915]
Dummy labor regulations (No obstacle)	.0579698 [.0495632]	-.2248307 [.24332]	.0931611 [.0654587]	-.0045674 [.0393202]	.1225413*** [.0092924]	.0014638 [.0217793]	.0454034 [.1138836]	.0240784 [.0632491]	-.1577463 [.3243416]	.0387412 [.0636235]
Dummy skills and education of available workers (No obstacle)	.084512 [.0599581]	.0273705 [.249749]	-.0667598 [.0764359]	-.062289 [.0452526]	-.2035231*** [.006304]	-.0185586 [.0247792]	-.0120275 [.0758254]	.0152463 [.0778368]	-.1487089 [.1626834]	.0043064 [.0475636]
Constant eq 1	.6344569*** [.1696689]	1.413978*** [.4915945]	.7521864*** [.1929047]	.4292781*** [.0723784]	.8783021*** [.0156133]	.6454459*** [.0727345]	.4687116*** [.1623071]	.7378979*** [.1222438]	-.5420866 [.4980977]	.7314202*** [.1535447]
Constant sigma	.1051392*** [.0128853]	.1243282*** [.0292161]	.0997794*** [.0131496]	.0711483*** [.0083911]	.0037496*** [.0007994]	.1001013*** [.0070149]	.0477981*** [.0086713]	.0535173*** [.0114355]	.07062*** [.014455]	.0658113*** [.0124237]
Wald chi2 Prob > chi2 Log likelihood	16.00 0.1912 29.421816	6.22 0.5143 12.32823	23.62 0.0144 29.302059	39.41 0.0001 44.070442	3378.60 0.0000 45.838787	7.32 0.7726 96.419532	57.78 0.0000 26.111844	43.06 0.0000 18.485306	34.48 0.0003 17.845164	11.74 0.4668 25.113669
Number of observations	35	15	32	36	11	108	16	12	14	18

Dependent variable: Technical efficiency (CCR) corrected; Low limit 0 and top limit +inf.

$*p\langle 0.1; ** p\langle 0.05; *** p\langle 0.01$

Source: Authors' calculation from the Investment Climate Survey Databank, World Bank.

TABLE 10.

Truncated Regression Analysis by industry (year 2004): Model 6 Control Variables by Sector.

Industry	Beverages	Chemicals and pharmaceutics	Food	Garments	Leather	Metals and machinery	Non-metallic and plastic materials	Paper	Textiles	Wood and furniture
Model 6 Variables of control	Coef/E. St.	Coef/E. St.	Coef/E. St.	Coef/E. St.	Coef/E. St.	Coef/E. St.	Coef/E. St.	Coef/E. St.	Coef/E. St.	Coef/E. St.
Characteristics of the firm and owners										
% Private domestic owners.	.0011691** [.0004694]	-.0007535*** [.0001382]	.0002286 [.0005885]	.0000914 [.0005855]		-.0002288 [.0002654]	-.0018497*** [.0005105]	.0000143 [.0010097]	-.002177*** [.0002847]	.0015121** [.0006939]
% Held by largest shareholder or owner	-.0005227 [.0005346]	.0007276*** [.0002014]	-.0005272 [.0008308]	-.0004234 [.0005583]		-.0001402 [.0003226]	-.0006715** [.0003229]	.0008207 [.002376]	-.0025292*** [.0006403]	.0003861 .0006087
Age (years of the firm)	-.0007256 [.0004907]	-.0024075*** [.0004217]	-.0003673 [.0010759]	.0009089 [.0007998]	-.0028967* [.0017009]	.0001873 [.0004703]	-.0032877*** [.0007544]	.0020379*** [.0007142]	-.0150929*** [.0015008]	.0015601 [.0011249]
% Capacity utilization (mean)	-.0016761* [.0009375]		.0000213 [.001171]	-.0021805* [.0012424]		-.000304 [.0005334]	.002309*** [.0008549]	-.0012843 [.0015936]	-.0095135*** [.0007589]	.002951* [.0017479]
Dummy Large firm (>99 permanent workers)	.0987816** [.0434317]	.1892702*** [.0070025]	-.0872514 [.0609192]	.0272286 [.0407141]		.0246788 [.022941]	-.0840702* [.0428189]	.0459557 [.0892769]	.5892199*** [.0553229]	.1478288*** [.0494408]
Dummy holdings or operations in other countries	-.1347505 ** [.0532771]			.0507255 [.0744212]		.0139181 [.0328162]	-.1036866*** [.0296087]	-.3320289 [.303752]		.2676234* [.1386057]
Dummy External audit	.007103 [.0402047]	-.1802509*** [.0147069]	.0351938 [.0541669]	-.0034229 [.0333524]		-.0447039** [.0226616]	.046274* [.0263209]	-.1400777 [.1989769]	.0110392 [.0324436]	-.0002587 [.0390895]
Business association or chamber of commerce services										
Dummy lobbying government (no value)	.0053807 [.0365478]	.0378327** [.0157511]	.0742185 [.0516444]	-.0076123 [.0434732]	.1855413*** [.061594]	.0053054 [.0239601]	-.0322672 [.036727]	-.1025348* [.0610587]	-.1565191*** [.0289911]	-.0937136 [.0598069]
Dummy resolution of disputes (no value)	-.0421884 [.0337159]	.0776437*** [.0090255]	.0300428 [.0735613]	.0014933 [.0410852]	-.0841847 [.0879371]	.0187661 [.0254201]	-.0865995*** [.026655]	.012666 [.0972413]	.5027921*** [.042483]	.1368409** [.0692671]
Dummy information and contacts on domestic product/markets (no value)	.1218661* [.0703668]	.19552*** [.0163344]	.04017 [.0664251]	.0676494 [.0445691]	-.1435856*** [.0525785]	-.0149538 [.0349517]	.050332* [.0260705]	-.338701 [.2873753]	-.0971791** [.0434502]	.1091132 [.1209064]
Dummy information and contacts on international prod./mark. (no value)	.0335336 [.0390131]	-.1505486*** [.0164855]	-.0231055 [.0607865]	-.0148346 [.0463829]		.0259796 [.0293215]	.0255952 [.0207925]	.1691085 [.1148237]	.5909907*** [.0606455]	-.1287208 [.0974971]
Dummy accrediting standards or quality of products (no value)	.0314069 [.0495037]	-.0977143*** [.0110288]	.0913884 [.0678704]	-.0026308 [.0407093]		-.0328771 [.0279194]	-.1217528*** [.0293537]	.1582237 [.1746827]	-.2154366*** [.0674627]	
Dummy information on government regulations (no value)	-.0824453 [.0557965]		-.0739754 [.0792598]	-.0316149 [.0473719]		.0047456 [.0289424]	-.0088385 [.0317527]			.0449433 [.0631823]
Constant eq 1	.6601001*** [.1173559]	.8257736*** [.0280219]	.5604982*** [.1462592]	.8082721*** [.1441014]	1.015928*** [.081782]	.7679728*** [.0632686]	.9976102*** [.05697]	.9222589** [.4093676]	1.473681*** [.0987098]	.2998499 [.1863708]
Constant sigma	.0898878*** [.0092138]	.0065082*** [.0013285]	.1036712*** [.0128099]	.1021572*** .0101852	.0425798** [.0167862]	.1131513*** [.006857]	.0277906*** [.004525]	.0595122*** [.011544]	.0225665*** [.0044257]	.0594485*** [.0102772]
Wald chi2	29.62	3517.05	19.88	15.03	14.61	9.20	83.65	26.88	309.74	26.19
Prob > chi2	0.0053	0.0000	0.0694	0.3053	0.0056	0.7574	0.0000	0.0080	0.0000	0.0101
Log likelihood	47.578957	43.389029	29.059443	45.066468	13.111598	125.62558	41.136915	23.426927	30.840532	29.405514
Number of observations	48	12	34	52	6	160	19	16	13	20

Dependent variable: Technical efficiency (CCR) corrected; Low limit 0 and top limit +inf. $*p\langle 0.1 : ** p\langle 0.05 ; *** p\langle 0.01$

Source: Authors' calculation from the Investment Climate Survey Databank, World Bank.

5. CONCLUSIONS AND POLICY IMPLICATIONS

The most important results that arise from our analysis are the existence of highly heterogeneous efficiency determinants among productive sectors. Even if we control for some firm variables, there are elements inherent to some sectors that make them more or less efficient.

Although we could not draw general conclusions, the results presented in the previous section allow us to identify, with respect to the models proposed, a series of factors that potentially influence technical efficiency of firms at the sector level.

Our results suggest that there are some factors that originate differences by sector in the technical efficiency of firms at the sector level. These factors are related to input quality, specifically modernization of capital and technological innovation.

In terms of policy implications, these findings show that generic programs may not be the best way to increase efficiency or productivity. It would be better to design intervention strategies targeted toward specific sectors. In the context of the European Union this is much more important since usually there is a tendency to generate general incentive policies that do not take into account the efficiency determinants at the sector level.

The OECD (2001b) provides a framework allowing policy-makers to identify strong and weak points in their country's business environment by comparing their performance and business environment to that of other OECD countries. The OECD report concludes that four micro-drivers (human capital, information and communications technology, innovation and entrepreneurship) are key drivers of productivity and economic growth performance in knowledge-based economies. The most remarkable micro-policies highlighted in the OECD report are:

1. Increasing access to venture capital corresponds to the driver, "fostering firm creation and entrepreneurship".[18]

2. Enhancing public-private partnerships for innovation relates to the driver "harnessing the potential of innovation and technology diffusion".[19]

[18] Country reviews of Canada, Denmark, Israel, Korea, Portugal, Spain, Sweden, the United Kingdom, and the United States have been completed and the policy recommendations presented in the synthesis report have been agreed (OECD, 2004).

[19] Country reviews of the Netherlands, Australia, France and Austria have been completed.

3. Promoting Information and Communications Technology (ICT) diffusion to business is the driver "seizing the benefits of ICT".[20]

4. Developing highly-skilled workers for future industry needs corresponds to the driver "enhancing human capital and realizing its potential".[21]

The study of micro-policies is recent and there is no agreement on the methodology that must be followed. Nevertheless, we understand that the importance of this paper is the contribution of new data that allow revising the policies in each and every one of the sectors taking into account the drivers.

While the identified micro-policies affect productivity growth through the channels of the four micro-drivers, their contributions to growth are more significant when combined rather than dealt with separately.

According to the OECD (2005), the four drivers–especially entrepreneurship and innovation–interact. Consequently, a coherent strategy is required to reap the full benefits of the four micro-drivers of productivity growth. Given the differences by sector found in our analysis, this strategy should address the unique characteristics and factors of each sector and country.

We close this section with a few reflections on what has not been achieved and implications emerge for future studies.

1. Measured technical efficiency picks up much variance that does not represent inefficiency in any normative sense, but even those components are behaviorally interesting for what they can tell us about the heterogeneity of industrial activities.

2. Although this study only begins to analyze the static measurement of efficiency, it can be integrated with the dynamic microanalysis of productivity growth and efficiency changes. The availability for research of longitudinal databases on individual firms will no doubt stimulate much work and further analysis.

[20] Country reviews of Finland, Korea, Switzerland, Italy, the Netherlands and Norway have been completed (OECD, 2005).
[21] Country reviews of Belgium, Canada, Denmark, Finland, the Netherlands, Norway and Sweden have been completed.

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APPENDIX I

Truncated regression

The linear regression model we consider here has the form:

$$\vartheta_i = z_i\beta + \varepsilon_i \quad [1]$$

Where the $\varepsilon_i \sim N\left(0,\sigma_\varepsilon^2\right)$ is identically, independently distributed for all $i = 1,\ldots,m$ .The left-hand side variable ϑ is said to be censored when, instead of observing ϑ_i for all observations, we observe:

$$\theta_i = \begin{cases} z_i + \varepsilon_i & \text{if} \quad z_i + \varepsilon_i \rangle c_i \\ c_i & \text{otherwise} \end{cases}$$

In this case, ϑ is left-censored at the constant c_i , which may vary across observations. Alternatively, ϑ_i is said to be truncated if we observe $\theta_i = \vartheta_i$ for all $\vartheta_i \geq c_i$, but observe nothing otherwise.

In the case of truncation, if the ϑ_i are assumed normal with left-truncation at c_i , β in $[1]$ can be estimated by maximizing the likelihood function:

$$\ell_1 = \prod_{i=1}^{n} \frac{1}{\sigma_\varepsilon}\phi\left(\frac{\theta_i - z_i\beta}{\sigma_\varepsilon}\right)\left[1 - \Phi\left(\frac{c_i - z_i\beta}{\sigma_\varepsilon}\right)\right]^{-1} \quad [2]$$

Where $\phi(.)$ and $\Phi(.)$ represent the standard normal density and distribution functions, respectively.

Bootstrap procedure

The procedure applied in this study follows Simar and Wilson (2007). It consists of the following steps:

- Standard DEA efficiency point estimates are calculated.

- Truncated maximum likelihood estimation is used to regress the efficiency scores against a set of explanatory variables.

- These estimates are then integrated into a bootstrap procedure that is similar to the smoothed bootstrap procedure of Simar and Wilson (2000). This bootstrap procedure allows correcting for bias.

- The bias corrected scores produced by the preceding bootstrap are used in a parametric bootstrap on the truncated maximum likelihood, thus creating standard errors for the parameters of the regression. Confidence intervals are then constructed for the regression parameters as well as for the efficiency scores.

APPENDIX II

Descriptive statistics

Tables 3 collect the basic statistics of output (sales) and inputs (costs of raw material, energy and personnel) used to estimate the technical efficiency levels for the set of sectors mentioned in the 12 countries of the east of the EU.

TABLE I.

Descriptive statistics of the output and inputs used by sector and country (year 2004).

Variables/industry	Beverages	Chemicals and pharmaceutics	Food	Garments	Leather	Metals and machinery	Non-metallic and plastic materials	Paper	Textiles	Wood and furniture	Other manufacturing
Mean											
Sales (Y)	2476.644	7633.252	895.9026	592.492	707.6014	1030.763	1434.751	4768.526	1792.113	2343.418	3812.466
Materials Cost (X_1)	1282.234	3507.454	453.563	242.7717	222.9767	497.1371	696.7805	1682.171	822.5278	1261.411	1652.137
Energy Cost (X_2)	136.3903	247.8105	50.45932	35.12418	38.33506	53.18183	40.44587	215.7165	123.6157	172.553	141.9014
Personal Cost (X_3)	209.1959	555.0695	80.92757	151.6997	193.4208	149.9907	139.397	1179.918	303.985	458.056	295.8017
Median											
Sales (Y)	196.418	443.7012	262.3651	118.1627	65.91279	82.81187	166.4099	115.7039	300.7863	118.1627	555.8616
Materials Cost (X_1)	85.13541	182.1591	116.6796	46.78612	27.61148	37.21292	71.43224	52.24511	93.57224	60.16585	282.9883
Energy Cost (X_2)	9.772637	9.592033	12.94952	6.90287	5.368899	5.241257	9.085661	7.24773	23.00957	8.218668	14.44584
Personal Cost (X_3)	22.49096	52.04755	23.00957	27.17094	20.10742	14.67552	20.166	23.29762	61.61182	33.11686	56.32904
Standard deviation											
Sales (Y)	9214.583	26645.85	1604.977	1536.927	1783.993	3170.787	5539.375	21426.22	3179.908	9485.55	9355.385
Materials Cost (X_1)	5205.379	11960.72	856.9301	664.3403	476.845	1578.464	2542.945	6369.131	1536.328	5262.198	3865.536
Energy Cost (X_2)	595.0032	618.3085	87.42706	104.0559	93.35887	154.6308	89.91901	671.8001	251.3255	773.8309	289.9367
Personal Cost (X_3)	641.1238	1714.949	154.4191	427.9902	558.1501	445.9945	372.5637	6022.642	547.5825	1853.574	594.4645
Maximum											
Sales (Y)	88827.03	129973.1	8673.232	13709.87	6456.181	30116.26	39841.43	138584.5	12314.86	56677.03	37377.89
Materials Cost (X_1)	52686.09	57510.98	5364.427	5982.488	1614.045	15777.23	17839.45	40483.59	5824.609	33197.98	15290.95
Energy Cost (X_2)	6747.266	2548.492	587.511	875.7089	339.799	1700.407	565.7653	3373.633	1035.008	5706.464	1133.23
Personal Cost (X_3)	5275.788	8126.292	773.6096	3373.633	2038.794	4774.785	2264.76	39134.14	2062.58	11194	2111.851
Minimum											
Sales (Y)	2.154254	3.007511	0.509635	0.2548175	0.3617051	0.3011479	1.808526	0.926609	1.085115	0.5559542	11.76143
Materials Cost (X_1)	0.4787231	0.99134	0.2162088	0.1235479	0.1004736	0.1389914	0.6363331	0.3783654	0.5760489	0.221042	5.645484
Energy Cost (X_2)	0.2393615	0.0736807	0.0386087	0.0154435	0.0200947	0.0154435	0.030887	0.0772174	0.0334912	0.0540522	0.940914
Personal Cost (X_3)	0.4015306	1.158796	0.1081044	0.0540522	0.1473614	0.0540522	0.239374	0.0772174	0.1808526	0.194249	1.411371

Source: Authors' calculation from the Investment Climate Survey Databank, World Bank.

Variables

TABLE II.
Production Function Variables

Variable	Definition
Sales	Used as the measure of output for the production function estimation. For all countries, sales figures in local currency are converted into USD using PPP conversion factor to the official exchange rate ratio
Labor cost	Total expenditures on personnel[1]. For all countries, labor cost figures in local currency are converted into USD using PPP conversion factor to the official exchange rate ratio.
Materials	Total costs of intermediate and raw materials used in production (excluding electricity, fuel, and water). For all countries, materials figures in local currency are converted into USD using PPP conversion factor to the official exchange rate ratio.
Energy Cost	Total annual costs of electricity, fuel, and water.
Other Costs	Total annual costs of communications services, transport for goods (not including fuel), and rental of land/buildings, equipment, furniture, etc.

[1]Including wages, salaries, bonuses and social payments.

Source: Adapted from based in OECD Economic Studies No. 33, 2001/II.

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