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Measuring relative efficiencies in the shoe industry sector in Colombia: a DEA approach*

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Resumen

EVA® (Valor Económico Agregado) es una medida de desempeño comúnmente utilizada para medir la rentabilidad real de una compañía por un periodo específico de tiempo. El atractivo del EVA® radica en su facilidad de cálculo y en el hecho que mide la rentabilidad real de la firma como una función del costo de capital, la utilidad operacional después de impuestos y el capital invertido en esta. Es dentro de este contexto que se utilizó el Análisis Envolvente de Datos (DEA) para analizar la información financiera de 75 compañías del sector del calzado en Colombia. Esto con el propósito de determinar que factor de la fórmula del EVA® es el que más relevancia tiene en la maximización del EVA®. El resultado obtenido fue que para el periodo 2007-2006 el factor más relevante fue el capital invertido y para el año 2005-2004 fue la utilidad operacional después de impuestos.

Palabras clave: EDA, EVA®, Eficiencia.



Abstract

EVA® (Valor Económico Agregado) es una medida de desempeño comúnmente utilizada para medir la rentabilidad real de una compañía por un periodo específico de tiempo. El atractivo del EVA® radica en su facilidad de cálculo y en el hecho que mide la rentabilidad real de la firma como una función del costo de capital, la utilidad operacional después de impuestos y el capital invertido en esta. Es dentro de este contexto que se utilizó el Análisis Envolvente de Datos (DEA) para analizar la información financiera de 75 compañías del sector del calzado en Colombia. Esto con el propósito de determinar que factor de la fórmula del EVA® es el que más relevancia tiene en la maximización del EVA®. El resultado obtenido fue que para el periodo 2007-2006 el factor más relevante fue el capital invertido y para el año 2005-2004 fue la utilidad operacional después de impuestos.

Keywords: EDA, EVA®, Eficiencia.

1. INTRODUCTION

Although the concepts employed for calculating the EVA® (Economic Value Added) of a firm are not new, its popularity comes from the fact that EVA® has made modern finance theory and its managerial implications more accessible to firm managers around the globe (Young & O'Byrne, 2001). The idea behind EVA® is pretty basic, since the firm profitability is measured as a function of its operational profitability relative to the capital invested in the firm (NOPAT/IC). If the profitability of the firm, which is expressed as the return on net assets in percentage terms (RONA%), is greater than the weighted average cost of capital of the firm also expressed in percentage terms (WACC%), then the result is positive and we can calculate EVA® simply by using the following formula: $EVA® = (RONA \% - WACC\%) \times IC$. If indeed, the EVA® of the firm is positive that means that the management is creating value for the shareholders, if on the other hand the value is negative that means that the management is destroying the value of the invested capital entrusted to them by the company's shareholders (Garcia Alonso, 1998).

One of the problems with accounting financial measures such as EVA® is that they are just meaningful in relative terms. This means that the accounting financial measures serve only to highlight a firm specific performance relative to its industry. Therefore, accounting financial measures just make sense when we can obtain a meaningful benchmark given by the industry sector in which a specific firm conducts its business activities (Feroz, Kim, & Raab, 2003).

In the present paper, we introduce the usefulness of Data Envelopment Analysis (DEA) in the process of indentifying specific EVA® benchmarks for a specific industry sector. Also, the DEA model is useful for identifying the relative importance of the input factors (NOPAT and IC) that affect an specified model output (EVA®) in the Colombian Shoe industry sector.

2. LITERATURE REVIEW

There are numerous studies that have demonstrated the utility of Data Envelopment Analysis in different economic and social contexts. For example (Malhotra, Malhotra, & Mariotz, 2005) used DEA to measure the

economic performance of the EU 15 nations relative to one another and to determine the economic factors in which inefficient nations are lagging vs. efficient ones. Usually DEA has become the most common methodology to assess the efficiency of common operating units in different economic sectors such as retailing, defense, transportation, financial, etc. (Malhotra, Malhotra, & Mariotz, 2005).

In finance, most of the research using DEA has been focused on the performance of the mutual fund industry. For example, (Murthi, Choi, & Desai, 1997) used DEA to establish a relation between the mutual funds returns, expense ratios and transaction costs. One of the outcomes of this study was the creation of the DEA portfolio efficiency index (DEPI) that does not require a traditional market benchmark and incorporates transaction costs in its calculation. Another study conducted by (McMullen & Strong, 1998) showed that DEA can be used in assisting an investor in the process of fund selection via a multifactor utility function.

More recent studies, such as the one conducted by (Haslem & Sheraga, 2003) concluded by that using a DEA model in which the Sharpe ratio was treated as an output variable, found that there were substantial differences between the financial performance indicators of the DEA efficient and inefficient funds under study, these differences were noticeable thanks to the concept of DEA technical efficiency. Similarly, (Galadera & Param, 2002) concluded that by using DEA to assess the performance of the Australian mutual fund industry, the risk-adverse funds with conservative assets were the more efficient of the sample under study.

(Basso & Funari, 2003) measured the performance of ethical mutual funds using a performance indicator based on the expected return, the investment risk, redemption costs and treated as a categorical variable the nature of the ethical component of the fund. They concluded that based on the nature of the ethical indicator of a particular fund, the DEA categorical model was the most adequate tool for evaluating investments with categorical variables.

In the field of corporate finance (Feroz, Kim, & Raab, 2003) used DEA as a way to solve the inconsistencies found in traditional financial ratio analysis. They found that by using a DEA model in which the return on

equity (ROE) was the output measure it was possible to find a consistent and reliable measure of operational efficiency of the firm. (Sheu, Lo, & Lin, 2006) used DEA to explore the relation between the diversification and the financial performance of 14 financial holding companies in Taiwan. Their conclusions for the sample in question were: 1) The profitability of the financial holdings companies with a lower degree of diversification was greater than the ones with a higher degree of diversification 2) Diversification activities that are in line with the core business of the company perform better in terms of profitability than diversification activities that are not related with the core business of the holding company.

(Wang & Hsing-Wu, 2006) used a DEA input-output model as a tool to assist the decision maker in setting corporate benchmarks as performance indicators in a business balanced score card (BSC). They concluded that by using DEA along with the BSC the companies under study can use both tools to improve their strategic performance indicators.

(Margaritis & Psillaki, 2007) used DEA to explore the relationship between the capital structure of the firm and its performance. In their study they processed the data of 12,240 firms in New Zealand and found empirical evidence consistent with the agency cost hypothesis that states that a higher leverage in the firm produces a greater technical efficiency in the capital structure of the firm. They also found that the effect of tangible assets and profitability is positively correlated with leverage whereas intangible assets and other assets are negatively correlated with profitability.

Finally, (Neves & Lourenço, 2008) used DEA to propose a 5 input/2 output model to determine the technical efficiencies of 145 hotels around the globe. Their model used EBITDA (Earnings before Interest taxes Depreciation and Amortization) and total revenues as output variables and net fixed assets, current assets, total assets, equity, debt and the cost of goods and services as the input variables. They found that the most efficient companies as measured by the proposed model were located in North America and Oceania. They also found that by concentrating on productivity rather than economies of scale it was possible to obtain to improve the technical efficiency of the inefficient companies of the sam-

ple under study. It is within this context that we will use a 1 output/2 input DEA model to measure the importance of Invested Capital vs. NOPAT in maximizing the technical efficiency of the output variable Economic Value Added (EVA®).

3. DATA ENVELOPMENT ANALYSIS

Data Envelopment Analysis (DEA) was developed by Charnes, Cooper and Rhodes in 1978. It is a common performance technique used to evaluate the relative efficiency of decision making units. For the specific purpose of our study, a DMU can be thought as a performance measure for which the firm through decision making can affect in some degree the desired outcome of the measure, but not with absolute certainty (Beasley, 2004). In other words, this technique can help us to know how a DMU uses the resources (inputs) available to it to maximize a desired output. In the case of our study the DMUs are the myriad of firms that compose the shoe industry sector in Colombia. Therefore, the relative efficiency or productivity of the firms (DMUs) is measured as the ratio of total outputs to total inputs. In this case, the output in the model is the EVA® of a DMU (shoe firm) for a specific time period, and respectively the inputs for the model are: invested capital (IC) and NOPAT. For example, if we have a certain number of DMU (in our case shoes firms), then:

$j=1,2,3,4,\dots,n$ (number of DMUs under observation)

$i=1,2,3,4,\dots,m$ inputs (NOPAT and IC)

$r=1,2,3,4,\dots,s$ outputs (EVA®)

Each one of the observations DMU_{*j*}, $j=1,2,3,4,\dots,n$, uses:

x_{ij} -amount of input i for unit j , $i=1,2,3,4,\dots,m$ and $j=1,2,3,4,\dots,n$

y_{rj} -amount of output r for unit j , $r=1,2,3,4,\dots,s$ and $j=1,2,3,4,\dots,n$

u_r -weight assigned to output r , $r=1,2,3,4,\dots,s$

v_i -weight assigned to input i , $i=1,2,3,4,\dots,m$

In the present methodology the most important issue is finding the values of the weights. Since we do not (know?) the real value of a specific weight, a preset value of 1 is set for each weight that composes the model. Therefore, we can rank the efficiency of an independent DMU in converting inputs to outputs by using the following ratio:

$$Efficiency = \frac{\sum_{r=1}^s u_r y_r}{\sum_{i=1}^m v_i x_i}$$

The weights are found using maximum likelihood through linear programming in which the maximization of the efficiency of a chosen DMU is subject to the constraint that the efficiency of all the other DMUs in the sample are subject to the same weights. Also, these values should be restricted to values between 0 and 1. Therefore, the objective function in the linear programming model should be defined as the o^{th} DMU for which we wish to maximize its efficiency (E_o) given the following linear programming model (Charnes, Cooper, & Rhodes, 1978):

$$\max(E_o) = \frac{\sum_{r=1}^s u_r y_{ro}}{\sum_{i=1}^m v_i x_{io}}$$

subject to:

$$\frac{\sum_{r=1}^s u_r y_r}{\sum_{i=1}^m v_i x_i} \leq 1, \text{ where } u_r > 0 \text{ and } v_r > 0$$

Once we get the optimal DMU that maximizes E_o , this DMU is said to be the most efficient firm in the set of observations, and all the subsequent inefficient DMUs are ranked according to the degree of inefficiency (the inefficiency values are less than 1 but greater than 0). It is important to remember that since DEA is a nonparametric technique, it not possible to do statistical hypothesis testing, and also that being a extreme point technique measurement, errors can lead to significant problems (Beasley, 2004).

4. ECONOMIC VALUE ADDED (EVA®)

As mentioned before EVA® is calculated using the following formula:

$$\text{EVA}^{\circledR} = (\text{RONA} \% - \text{WACC}\%) \times \text{IC}$$

Where:

$\text{RONA}\% = \text{Net Operating profit After taxes (NOPAT)} / \text{Invested capital (IC)}$

$\text{NOPAT} = \text{Earnings Before Interest and taxes (EBIT)} - \text{Taxes for the period under observation}$

$\text{IC} = \text{Fixed assets} + \text{working capital requirement (WCR)}$

$\text{WCR} = \text{Current assets} - \text{Current liabilities}$

$\text{WACC}\% = \text{Weighted average cost of capital which is equal to the sum of each component of capital of the firm (shareholders equity and interest bearing debt each weighted for its relative proportion according to the firm's capital structure)}$

Since the issue of estimating the cost of capital is still an ongoing concern among academics and practitioners, for purposes of simplicity we decided to use a constant WACC for each year for the firms under study. In order to obtain a significant value, we used the values published for the shoe industry sector in the US and observed Colombian country risk premium by Aswath Damodaran in his website, which is one of the most trusted sources for this kind of information both by academics and practitioners (Fernández & Bermejo, 2009). In order to have a more realistic measure for Colombia, we applied a simple Fisher equation in order to estimate and adjusted WACC for the Colombian shoe industry sector in the following way:

$$\text{WACC}_{\text{SboeCol}} = (1 + \text{WACC}_{\text{SboeUS}}) \times (1 + \text{Rp}_{\text{Col}}) \times (1 + i_{\text{inf}}) - 1$$

Where:

$\text{WACC}_{\text{SboeUS}} = \text{Industry consensus for the Shoe industry cost of capital in the United States}$

$\text{Rp}_{\text{Col}} = \text{Country risk premium for Colombia for the year under study}$

$i_{\text{inf}} = \text{Inflation rate for Colombia for the year under study}$

The results are summarized in Table 1:

Table
Proxy WACC for the Shoe Industry Sector in Colombia 2007-2004

	2007	2006	2005	2004
Cost of capital (Shoe industry US)	10,84%	9,02%	9,02%	8,70%
Risk Premium Colombia	2,03%	20,3%	1,80%	1,95%
Inflation Colombia	5,69%	4,16%	4,85%	5,50%
Cost of Capital (Shoe industry Col)	19,525%	15,860%	16,365%	16,915%

For the 75 companies under observation, this was the WACC used for the period under study.

5. METHODOLOGICAL ISSUES

In order to obtain a reliable measure of the shoe industry top performer relative to its peers, the following adjustments were made to the data in order to fit it the primary premises of a DEA model:

1. For each of the firms under study we calculated the EVA® for the period comprehended between 2007 and 2004, for the year 2007 there were 75 observations, for the year 2006 we had 74 observations, for the year 2005 there were 62 observations and finally for the year 2004, there were 31 observations. From all the firms under study, just 31 of them have complete financial information for the period comprehended between 2004 and 2007. The EVA® performance measure was calculated for all the firms that have available financial information for a specific year, even though if in a specific year there were firms that have not stated their financial information in previous years.
2. Since the DEA model does not allow the use of negative numbers, only firms with positive EVA® were included into the final optimization model. For the year 2007, of the 75 firms under study just 23 of them reported positive EVA®, for 2006 the number of firms with positive EVA® was 32 out of a sample of 74 firms. Respectively, for the years 2005 and 2004 just 20 and 8 firms reported positive EVA®.

3. Those companies that reported a positive EVA®, but at the same time reported a negative RONA and negative invested capital (IC) were excluded from the final DEA optimization model.

6. RESULTS

For all the firms under study, we obtained the following EVAs® (output variables), NOPATs (input variables) and ICs (input variables), the results are summarized in Table 2:

Table 2
EVA® (output variable), NOPAT and IC (inputs variables) for the Shoe industry firms under study for the period 2007 and 2004

	2007	2006	2005	2004	2007	2006	2005	2004	2007	2006	2005	2004
	Output	Output	Output	Output	Input	Input	Input	Input	Input	Input	Input	Input
COMPANY NAME	EVA	EVA	EVA	EVA	IC (invested capital)	IC (invested capital)	IC (invested capital)	IC (invested capital)	NOPAT (Net operating profit after taxes)	NOPAT (Net operating profit after taxes)	NOPAT (Net operating profit after taxes)	NOPAT (Net operating profit after taxes)
ALMIRANTE	\$ (363,62)	\$ (294,10)	\$ (492,42)	\$ (285,07)	\$ 1.790,08	\$ 1.661,30	\$ 1.556,61	\$ 1.434,05	\$ (14,11)	\$ (30,62)	\$ (237,69)	\$ (42,50)
ALATTI LTDA	\$ 105,90	\$ 65,66	\$ 73,34		\$ 489,49	\$ 443,07	\$ 311,25		\$ 201,48	\$ 135,94	\$ 124,28	
ALPHA SHOES SA	\$ 46,08	\$ (258,81)	\$ (164,93)	\$ (242,68)	\$ 1.507,92	\$ 1.353,48	\$ 1.820,84	\$ 1.897,23	\$ 340,50	\$ (44,14)	\$ 133,05	\$ 78,23
ARTESA SA	\$ (1.789,78)	\$ (794,86)	\$ (964,47)	\$ (512,15)	\$ 7516,35	\$ 6.872,84	\$ 5.991,24	\$ 5.417,82	\$ (322,22)	\$ 295,20	\$ 16,00	\$ 404,26
BAENA Y MORA CIA LTDA	\$ 402,81	\$ 70,08	\$ 248,98	\$ 132,52	\$ 1.478,48	\$ 1.146,88	\$ 1.143,65	\$ 895,71	\$ 691,49	\$ 251,98	\$ 436,14	\$ 284,03
BRONCO LTDA	\$ 108,85	\$ (13,83)	\$ 737		\$ 724,32	\$ 152,23	\$ 53,94		\$ 250,28	\$ 10,32	\$ 16,20	
BUSTER SHOES LTDA	\$ 54,72	\$ (3,14)	\$ (34,80)		\$ 421,95	\$ 672,10	\$ 652,07		\$ 137,11	\$ 103,46	\$ 68,64	
CAIZA 3 SA	\$ 172,21	\$ 221,26			\$ 361,80	\$ 509,79			\$ 242,86	\$ 302,12		
J.B. LTDA	\$ 22,96	\$ 9,40			\$ 77,43	\$ 66,70			\$ 38,08	\$ 19,98		
FRATELLO LTDA	\$ (805,02)	\$ (885,58)	\$ (209,51)		\$ 5.412,03	\$ 5.302,77	\$ 5.154,66		\$ 251,67	\$ (44,54)	\$ 634,06	
GOLANI LTDA	\$ (28,09)	\$ 21,18	\$ 19,08		\$ 275,30	\$ 220,65	\$ 205,17		\$ 25,66	\$ 56,17	\$ 52,65	
INFANTIL COLININOS LTDA	\$ (30,64)	\$ (32,26)	\$ (53,45)		\$ 201,74	\$ 174,21	\$ 331,93	\$ 0,87	\$ 8,75	\$ (4,64)	\$ 0,87	
OMEGA Y GRULLA SA	\$ (1.207,00)	\$ (608,62)	\$ (591,15)	\$ (1.368,63)	\$ (823,32)	\$ 750,78	\$ 1.710,00	\$ 2.316,86	\$ (1.046,25)	\$ (489,55)	\$ (311,31)	\$ (976,74)
UNIVERSO Y CIA LTDA	\$ (107,69)	\$ (152,53)	\$ (118,13)	\$ (199,53)	\$ 438,32	\$ 430,99	\$ 482,74	\$ 610,38	\$ (22,11)	\$ (84,18)	\$ (39,13)	\$ (96,29)
COVASUELAS LTDA	\$ (58,79)	\$ (5,74)	\$ (28,59)		\$ 342,37	\$ 327,09	\$ 273,26		\$ 8,05	\$ 46,13	\$ 16,13	
COUXE LTDA	\$ 16,19	\$ 139,12			\$ 1.560,71	\$ 1.389,44			\$ 320,92	\$ 359,49		
CONFECCIONES ARGOS LTDA	\$ 57,36	\$ 42,43	\$ 64,77		\$ 216,31	\$ 97,56	\$ 162,54	\$ -	\$ 99,60	\$ 57,90	\$ 91,37	
DARIO ADARVE Y CIA	\$ (138,37)	\$ (50,21)	\$ (47,80)	\$ (47,11)	\$ 202,82	\$ 299,33	\$ 283,36	\$ 269,53	\$ (98,77)	\$ (2,74)	\$ (1,42)	\$ (1,52)
FABRICA COLOMBIANA DE MOLDES LTDA	\$ (252,63)	\$ (121,83)	\$ (147,01)		\$ 1.913,20	\$ 1.356,08	\$ 1.015,12		\$ 120,92	\$ 93,25	\$ 19,11	\$ -
PALERMO LTDA	\$ (258,81)	\$ 107,14	\$ (229,37)	\$ (192,25)	\$ 4.147,07	\$ 3.909,28	\$ 3.401,27	\$ 3.253,41	\$ 550,90	\$ 727,17	\$ 327,25	\$ 358,05
70 SA	\$ (367,33)	\$ (275,26)	\$ (393,40)	\$ (454,23)	\$ 3.606,05	\$ 3.293,00	\$ 3.033,01	\$ 2.933,47	\$ 336,75	\$ 247,02	\$ 102,95	\$ 41,96
KONDOR LTDA	\$ 523,59	\$ 957,57	\$ 360,09	\$ 189,11	\$ 3.416,87	\$ 3.194,75	\$ 2.446,42	\$ 2.194,36	\$ 1.190,73	\$ 1.464,27	\$ 760,44	\$ 560,28
CERAMA LTDA	\$ (67,53)	\$ 17,92	\$ (54,06)	\$ (47,58)	\$ 804,99	\$ 777,01	\$ 828,46	\$ 578,82	\$ 89,64	\$ 141,16	\$ 81,51	\$ 50,33
JULIANA LTDA	\$ (1,56)	\$ (7,40)			\$ 101,86	\$ 122,02			\$ 18,33	\$ 11,96		
LA GRAN COLOMBIA	\$ (176,16)	\$ (117,38)	\$ (184,56)		\$ 1.070,45	\$ 855,27	\$ 1.559,28		\$ 32,84	\$ 18,27	\$ 70,62	
FACALVE LTDA	\$ (221,30)	\$ (157,71)	\$ (200,77)		\$ 2.700,59	\$ 2.443,79	\$ 2.206,53		\$ 305,99	\$ 229,88	\$ 160,33	

Continúa...

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FRATINI LTDA	\$ (18,81)	\$ (9,46)	\$ (1,00)		\$ 448,27	\$ 372,49			\$ 68,71	\$ 49,62		
GAMBINELLI LTDA	\$ (697,01)	\$ (472,11)	\$ (650,04)	\$ (487,99)	\$ 4.966,39	\$ 5.337,81	\$ 5.918,64	\$ 6.385,97	\$ 272,67	\$ 374,49	\$ 318,55	\$ 592,18
GIORGIO SPORT SA	\$ (2,63)	\$ 106,16	\$ (1,88)		\$ 1.459,64	\$ 699,57	\$ 726,32		\$ 282,36	\$ 217,12	\$ 116,98	
GRUPO MODA SA	\$ (1.549,70)	\$ (1.409,08)	\$ (1.805,20)	\$ (1.754,71)	\$ 7830,76	\$ 7.572,07	\$ 6.656,56	\$ 7.123,91	\$ (20,76)	\$ (208,12)	\$ (715,86)	\$ (549,72)
JOVICAL SA	\$ 272,77	\$ 227,59	\$ (353,41)	\$ (391,91)	\$ 3.275,75	\$ 4.120,69	\$ 3.657,06	\$ 3.621,70	\$ 912,36	\$ 881,15	\$ 245,07	\$ 220,69
INDUSTRIAS AGUILES SA	\$ 746,65	\$ 720,07	\$ 14,41	\$ (108,73)	\$ 1.639,17	\$ 2.669,50	\$ 2.021,05	\$ 1.608,28	\$ 1.066,70	\$ 1.143,47	\$ 345,15	\$ 163,31
CAUCHO ZAC LTDA	\$ 22,02	\$ 12,77			\$ 77,69	\$ 42,86			\$ 37,19	\$ 19,56		
SAN CLEMENTE SA	\$ (47,42)				\$ (75,74)				\$ (62,21)			
PONTI LTDA	\$ (41,63)	\$ 42,26	\$ 11,06		\$ 349,51	\$ 58,92	\$ 61,09		\$ 26,61	\$ 51,60	\$ 21,06	
JACK T GALEWSKI Y CIA LTDA	\$ (149,62)	\$ (254,79)	\$ (111,15)		\$ 617,01	\$ 664,18	\$ 749,96		\$ (29,15)	\$ (149,45)	\$ 11,58	
JOSSIG LAND Y CIA LTDA	\$ (152,69)	\$ (41,37)			\$ (324,97)	\$ (63,78)			\$ (216,14)	\$ (51,49)		
KOTZAS LTDA	\$ (269,51)	\$ (289,84)	\$ (196,66)	\$ (466,33)	\$ 1.927,35	\$ 1.820,04	\$ 1.779,38	\$ 1.666,27	\$ 106,80	\$ (1,17)	\$ 94,54	\$ (184,49)
LA MARAVILLA SA	\$ 512,99	\$ 1.628,14	\$ 2.251,61	\$ 3.197,75	\$ 25.758,13	\$ 15.277,58	\$ 12.130,73	\$ 10.372,20	\$ 5.542,23	\$ 4.051,23	\$ 4.236,80	\$ 4.952,18
LARCS LTDA	\$ 1,58	\$ 26,81	\$ (4,31)		\$ 83,27	\$ 77,35	\$ 164,67		\$ 17,84	\$ 39,08	\$ 22,64	
LIUSAMA LTDA	\$ (4,75)	\$ (12,01)	\$ (7,30)		\$ 15,53	\$ 35,26	\$ 40,23		\$ (1,72)	\$ (6,41)	\$ (0,72)	
MACALZADO MERCANTIL LTDA	\$ (19,97)	\$ (47,10)	\$ (66,73)	\$ (74,58)	\$ 630,03	\$ 491,99	\$ 449,89	\$ 419,06	\$ 103,04	\$ 30,93	\$ 6,89	\$ (3,70)
MAIN COLOMBIA SA	\$ (272,22)	\$ (178,17)	\$ (115,71)	\$ (30,40)	\$ 2.143,68	\$ 1.892,96	\$ 1.492,76	\$ 1.173,32	\$ 146,33	\$ 122,06	\$ 128,58	\$ 168,06
MANUFACTURAS AF LTDA	\$ (5,04)	\$ (118,23)	\$ (85,42)		\$ 996,46	\$ 830,58	\$ 897,80		\$ 189,52	\$ 13,51	\$ 61,51	
CHAPLIN LTDA	\$ (22,01)	\$ 22,76			\$ 109,81	\$ 113,23			\$ (0,57)	\$ 40,72		
WILCORTS LTDA	\$ (207,11)	\$ 364,09	\$ 125,95		\$ 2.365,24	\$ 1.886,38	\$ 1.265,66		\$ 254,70	\$ 663,28	\$ 333,08	
WBC LTDA	\$ 109,22	\$ 106,97	\$ 213,49		\$ 671,41	\$ 490,67	\$ 476,03		\$ 240,32	\$ 184,79	\$ 291,39	
VAROMI LTDA	\$ (52,63)	\$ (65,68)	\$ (15,78)		\$ 682,11	\$ 781,93	\$ 496,53		\$ 80,56	\$ 58,34	\$ 65,47	
MANISOL SA	\$ (391,96)	\$ 815,09	\$ 126,71	\$ 944,48	\$ 28.643,91	\$ 26.259,75	\$ 23.490,72	\$ 20.983,38	\$ 5.200,73	\$ 4.979,99	\$ 3.970,97	\$ 4.493,76
MAQUIPLAST LTDA	\$ (247,19)	\$ (349,65)	\$ (482,68)	\$ (696,96)	\$ (349,62)	\$ (215,04)	\$ (194,28)	\$ (203,06)	\$ (178,93)	\$ (315,55)	\$ (450,89)	\$ (662,61)
MARQUICOLOR LTDA	\$ (209,56)	\$ 19,41	\$ (20,96)		\$ 345,93	\$ 475,5	\$ 224,51		\$ (142,02)	\$ 26,96	\$ 15,78	
MISION MODA SA	\$ (321,72)	\$ 26,98	\$ 232,41		\$ 220,12	\$ 545,16	\$ 572,54		\$ (278,74)	\$ 113,44	\$ 326,10	
MODA NOVA LTDA	\$ (5,75)	\$ (62,17)	\$ (26,03)		\$ 399,85	\$ 549,30	\$ 200,38		\$ 72,32	\$ 24,95	\$ 6,76	
MODAPIEL SA	\$ (1.066,12)	\$ (856,35)	\$ (528,22)	\$ (768,82)	\$ 9.236,46	\$ 8.910,45	\$ 6.243,76	\$ 7.451,31	\$ 737,29	\$ 556,89	\$ 493,57	\$ 491,54
NIKE COLOMBIANA SA	\$ (317,77)	\$ (413,04)	\$ (464,89)	\$ (447,47)	\$ 3.177,15	\$ 2.820,11	\$ 2.386,69	\$ 2.081,39	\$ 302,56	\$ 34,24	\$ (74,31)	\$ (95,41)
ORDENA COLOMBIANA SA	\$ (1.213,24)	\$ 170,13	\$ 429,12	\$ 356,04	\$ 477,58	\$ 1.809,30	\$ 1.540,93	\$ 1.314,01	\$ (1.120,00)	\$ 457,09	\$ 681,29	\$ 578,30
ORVAL LTDA	\$ 1,77	\$ 76,98	\$ 32,27	\$ 21,47	\$ 473,01	\$ 462,93	\$ 389,01	\$ 371,79	\$ 94,13	\$ 150,40	\$ 95,93	\$ 84,36
PARISOTTO LTDA	\$ 50,31	\$ 50,17			\$ 402,19	\$ 310,00			\$ 128,83	\$ 99,34		
PREFABRICADOS D MARCA LTDA	\$ 12,87	\$ (5,12)	\$ (4,91)		\$ 261,50	\$ 239,04	\$ 186,11		\$ 63,93	\$ 32,79	\$ 25,55	
PRODUCTORA DE INSUMOS PARA CALZADO SA	\$ 870,90	\$ 1.206,09			\$ 145,33	\$ 107,97			\$ 899,28	\$ 1.223,21		
RAIDERS LTDA	\$ 132,39	\$ 83,24	\$ 52,48		\$ 318,94	\$ 271,92	\$ 208,82		\$ 194,66	\$ 126,37	\$ 86,65	
ROGERS LTDA	\$ 50,20	\$ 9,95	\$ (24,47)	\$ (6,04)	\$ 776,71	\$ 832,93	\$ 922,52	\$ 664,72	\$ 201,85	\$ 142,05	\$ 126,50	\$ 106,39
ROMULO LTDA	\$ (177,09)	\$ (144,61)	\$ 356,09	\$ (734,61)	\$ 4.834,83	\$ 5.166,36	\$ 651,70	\$ 5.583,40	\$ 766,91	\$ 674,79	\$ 462,74	\$ 209,81
SCHONTHAL INTERNATIONAL SA	\$ 229,87	\$ (104,23)	\$ (122,88)	\$ 353,34	\$ 1.957,60	\$ 1.399,90	\$ 1.276,27	\$ 1.033,59	\$ 612,09	\$ 117,80	\$ 85,98	\$ 528,17
SHYIN LTDA	\$ (12,44)	\$ (12,45)	\$ (4,93)		\$ 245,71	\$ 100,55	\$ 123,96		\$ 35,54	\$ 3,50	\$ 15,35	
SIERRA SERRANO	\$ (292,41)	\$ (209,24)	\$ (111,34)	\$ (189,36)	\$ 1.627,23	\$ 1.484,28	\$ 1.370,47	\$ 1.165,84	\$ 25,30	\$ 26,17	\$ 112,93	\$ 7,84
SOLES DE COLOMBIA SA	\$ (806,02)	\$ (1.960,28)	\$ (1.952,36)		\$ (1.194,23)	\$ (673,84)	\$ 14,73		\$ (572,85)	\$ (1.853,40)	\$ (1.949,95)	
SOLSOULE SA	\$ (57,07)	\$ (98,06)			\$ 586,25	\$ 402,14			\$ 57,40	\$ (34,28)		
STANTON Y CIA LTDA	\$ (683,12)	\$ (883,99)	\$ (4.990,18)	\$ (4.457,80)	\$ 28.893,65	\$ 26.556,88	\$ 26.163,43	\$ 34.947,22	\$ 4.958,33	\$ 3.328,04	\$ (708,53)	\$ 1.453,43
UNITED SHOE E.U.	\$ (59,05)	\$ 210,35	\$ 48,37	\$ 48,47	\$ 124,67	\$ 160,15	\$ 236,11	\$ 209,16	\$ (34,71)	\$ 235,75	\$ 87,01	\$ 83,85
ULTRASOLES LTDA	\$ (221,20)	\$ 106,17	\$ 63,08		\$ 5,49	\$ 230,65	\$ 100,98		\$ (220,13)	\$ 142,76	\$ 79,61	
TENIS DARIOO LTDA	\$ (55,63)	\$ (51,47)	\$ (105,35)		\$ 221,96	\$ 219,22	\$ 487,49		\$ (12,29)	\$ (16,70)	\$ (25,58)	

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TECNIMOLPLAST LTDA	\$ (3,22)	\$ (8,79)	\$ 5,57		\$ 85,52	\$ 83,43	\$ 74,63		\$ 13,48	\$ 4,44	\$ 17,79	
TAS DE COLOMBIA SA	\$ 36,65	\$ (86,62)			\$ (360,91)	\$ (95,18)			\$ (33,82)	\$ (101,71)		
SUMINISTROS, TRANSPORTE Y TECNOLOGIA SA	\$ (422,62)	\$ 154,98			\$ 1.872,33	\$ 2.068,11			\$ (5705)	\$ 482,99		

For each year under study, only those companies that reported positive EVA®s, NOPATs and IC were chosen for the EDA model, since EDA does not allow for the use of negative numbers into the model. Therefore, a basic one output, two inputs EDA model for the data exhibited in table 2 was constructed in the following way for each of the years under study:

Table 3
Efficiencies for the selected Shoe Industry Sector firms 2007

2007	EVA	IC (invested capital)	NOPAT (Net operating profit after taxes)	Weighted output	Weighted input	Efficiency	Weighted Output-weighted input
ALIATTI LTDA	\$ 105,90	\$ 489,49	\$ 201,48	105,90	690,97	15,33%	-585,06
ALPHA SHOES SA	\$ 46,08	\$ 1.507,92	\$ 340,50	46,08	1848,42	2,49%	-1802,34
BAENA Y MORA CIA LTDA	\$ 402,81	\$ 1.478,48	\$ 691,49	402,81	2169,97	18,56%	-1767,15
BRONCO LTDA	\$ 108,85	\$ 724,32	\$ 250,28	108,85	974,60	11,17%	-865,75
BUSTER SHOES LTDA	\$ 54,72	\$ 421,95	\$ 137,11	54,72	559,06	9,79%	-504,34
CAIZA 3 SA	\$ 172,21	\$ 361,80	\$ 242,86	172,21	604,66	28,48%	-432,45
J.B. LTDA	\$ 22,96	\$ 77,43	\$ 38,08	22,96	115,50	19,88%	-92,54
COLVEX LTDA	\$ 16,19	\$ 1.560,71	\$ 320,92	16,19	1881,63	0,86%	-1865,44
CONFECCIONES ARGOS LTDA	\$ 57,36	\$ 216,31	\$ 99,60	57,36	315,90	18,16%	-258,54
KONDOR LTDA	\$ 523,59	\$ 3.416,87	\$ 1.190,73	523,59	4607,60	11,36%	-4084,01
JOVICAL SA	\$ 272,77	\$ 3.275,75	\$ 912,36	272,77	4188,11	6,51%	-3915,33
INDUSTRIAS AGUILES SA	\$ 746,65	\$ 1.639,17	\$ 1.066,70	746,65	2705,87	27,59%	-1959,22
CAUCHO ZAC LTDA	\$ 22,02	\$ 77,69	\$ 37,19	22,02	114,87	19,17%	-92,85
LA MARAVILLA SA	\$ 512,99	\$ 25.758,13	\$ 5.542,23	512,99	31300,37	1,64%	-30787,38
LARCS LTDA	\$ 1,58	\$ 83,27	\$ 17,84	1,58	101,11	1,56%	-99,52
V&C LTDA	\$ 109,22	\$ 671,41	\$ 240,32	109,22	911,72	11,98%	-802,50
ORVAL LTDA	\$ 1,77	\$ 473,01	\$ 94,13	1,77	567,14	0,31%	-565,36
PARISOTTO LTDA	\$ 50,31	\$ 402,19	\$ 128,83	50,31	531,03	9,47%	-480,72
PREFABRICADOS D MARCA LTDA	\$ 12,87	\$ 261,50	\$ 63,93	12,87	325,43	3,95%	-312,56
PRODUCTORA DE INSUMOS PARA CALZADO SA	\$ 870,90	\$ 145,33	\$ 899,28	870,90	1044,61	83,37%	-173,71
RAIDERS LTDA	\$ 132,39	\$ 318,94	\$ 194,66	132,39	513,60	25,78%	-381,21
ROGGERS LTDA	\$ 50,20	\$ 776,71	\$ 201,85	50,20	978,56	5,13%	-928,36
SCHONTHAL INTERNATIONAL SA	\$ 229,87	\$ 1.957,60	\$ 612,09	229,87	2569,69	8,95%	-2339,82
Weight	1,00	1,00	1,00				

Where the columns for the model are:

Weighted Output= EVA® X Weight_{EVA}

Weighted Input= (NOPAT X Weight_{NOPAT})+(IC X Weight_{IC})

Efficiency= Weighted Output/Weighted Input

The last column, which is simply the result of Weighted output-Weighted Input acts as the restriction needed to run the optimization model for obtain the relative efficiencies of the firms under study. Tables 4 to 6 summarize the efficiencies obtained for the period comprehended between 2006 and 2004.

Table 4
Efficiencies for the selected Shoe Industry Sector firms 2006

2006	EVA	IC (invested capital)	NOPAT (Net operating profit after taxes)	Weighted output	Weighted input	Efficiency	Weighted Output- weighted input
ALJATTI LTDA	\$ 65,66	\$ 443,07	\$ 135,94	65,66	577,08	11,38%	-511,42
BAENA Y MORA CIA LTDA	\$ 70,08	\$ 1.146,88	\$ 251,98	70,08	1393,88	5,03%	-1323,80
CAIZA 3 SA	\$ 221,26	\$ 509,79	\$ 302,12	221,26	809,70	27,33%	-588,44
J.B. LTDA	\$ 9,40	\$ 66,70	\$ 19,98	9,40	86,39	10,88%	-76,99
GOLANI LTDA	\$ 21,18	\$ 220,65	\$ 56,17	21,18	275,86	7,68%	-254,69
COLVEX LTDA	\$ 139,12	\$ 1.389,44	\$ 359,49	139,12	1742,90	7,98%	-1603,78
CONFECCIONES ARGOS LTDA	\$ 42,43	\$ 97,56	\$ 57,90	42,43	155,04	27,37%	-112,61
PALERMO LTDA	\$ 107,14	\$ 3.909,28	\$ 727,17	107,14	4619,49	2,32%	-4512,35
KONDOR LTDA	\$ 957,57	\$ 3.194,75	\$ 1.464,27	957,57	4645,16	20,61%	-3687,59
GERAMA LTDA	\$ 17,92	\$ 777,01	\$ 141,16	17,92	914,79	1,96%	-896,87
GIORGIO SPORT SA	\$ 106,16	\$ 699,57	\$ 217,12	106,16	913,65	11,62%	-807,49
JOVICAL SA	\$ 227,59	\$ 4.120,69	\$ 881,15	227,59	4983,96	4,57%	-4756,37
INDUSTRIAS AQUILES SA	\$ 720,07	\$ 2.669,50	\$ 1.143,47	720,07	3801,38	18,94%	-3081,31
CAUCHO ZAC LTDA	\$ 12,77	\$ 42,86	\$ 19,56	12,77	62,24	20,51%	-49,47
PONTI LTDA	\$ 42,26	\$ 58,92	\$ 51,60	42,26	110,27	38,32%	-68,02
LA MARAVILLA SA	\$ 1.628,14	\$ 15.277,58	\$ 4.051,23	1628,14	19262,53	8,45%	-17634,39
LARCS LTDA	\$ 26,81	\$ 77,35	\$ 39,08	26,81	116,10	23,09%	-89,29
CHAPLIN LTDA	\$ 22,76	\$ 113,23	\$ 40,72	22,76	153,46	14,83%	-130,70
WILCORTS LTDA	\$ 364,09	\$ 1.886,38	\$ 663,28	364,09	2541,47	14,33%	-2177,38
V&C LTDA	\$ 106,97	\$ 490,67	\$ 184,79	106,97	673,33	15,89%	-566,37
MANISOL SA	\$ 815,09	\$ 26.259,75	\$ 4.979,99	815,09	31125,82	2,62%	-30310,73
MARQUICOLOR LTDA	\$ 19,41	\$ 47,55	\$ 26,96	19,41	74,30	26,13%	-54,89
MISION MODA SA	\$ 26,98	\$ 545,16	\$ 113,44	26,98	656,24	4,11%	-629,26
ORDENA COLOMBIANA SA	\$ 170,13	\$ 1.809,30	\$ 457,09	170,13	2258,54	7,53%	-2088,41
ORIVAL LTDA	\$ 76,98	\$ 462,93	\$ 150,40	76,98	611,32	12,59%	-534,35
PARISOTTO LTDA	\$ 50,17	\$ 310,00	\$ 99,34	50,17	407,99	12,30%	-357,82
PRODUCTORA DE INSUMOS PARA CALZADO SA	\$ 1.206,09	\$ 107,97	\$ 1.223,21	1206,09	1330,72	90,63%	-124,63
RAIDERS LTDA	\$ 83,24	\$ 271,92	\$ 126,37	83,24	397,11	20,96%	-313,87
ROGGERS LTDA	\$ 9,95	\$ 832,93	\$ 142,05	9,95	971,37	1,02%	-961,42
UNITED SHOE E.U.	\$ 210,35	\$ 160,15	\$ 235,75	210,35	395,20	53,23%	-184,85
ULTRASOLES LTDA	\$ 106,17	\$ 230,65	\$ 142,76	106,17	372,40	28,51%	-266,23
SUMINISTROS, TRANSPORTE Y TECNOLOGIA S.A.	\$ 154,98	\$ 2.068,11	\$ 482,99	154,98	2542,12	6,10%	-2387,14
Weight	1,00	1,00	1,00				

Table 5
Efficiencies for the selected Shoe Industry Sector firms 2005

2005	EVA	IC (invested capital)	NOPAT (Net operating profit after taxes)	Weighted output	Weighted input	Efficiency	Weighted Output- weighted input
ALIATTI LTDA	\$ 73,34	\$ 311,25	\$ 124,28	73,34	435,52	16,84%	(362,18)
BAENA Y MORA CIA LTDA	\$ 248,98	\$ 5.991,24	\$ 436,14	248,98	6.427,38	3,87%	(6.178,40)
BRONCO LTDA	\$ 7,37	\$ 53,94	\$ 16,20	7,37	70,14	10,51%	(62,76)
GOLANI LTDA	\$ 19,08	\$ 205,17	\$ 52,65	19,08	257,82	7,40%	(238,74)
CONFECCIONES ARGOS LTDA	\$ 64,77	\$ 162,54	\$ 91,37	64,77	253,91	25,51%	(189,14)
KONDOR LTDA	\$ 360,09	\$ 2.446,42	\$ 760,44	360,09	3.206,87	11,23%	(2.846,78)
INDUSTRIAS AQUILES SA	\$ 14,41	\$ 2.021,05	\$ 345,15	14,41	2.366,20	0,61%	(2.351,80)
PONTI LTDA	\$ 11,06	\$ 61,09	\$ 21,06	11,06	82,15	13,46%	(71,09)
LA MARAVILLA SA	\$ 2.251,61	\$ 12.130,73	\$ 4.236,80	2.251,61	16.367,54	13,76%	(14.115,93)
WILCORTS LTDA	\$ 125,95	\$ 1.265,66	\$ 333,08	125,95	1.598,74	7,88%	(1.472,79)
V&C LTDA	\$ 213,49	\$ 476,03	\$ 291,39	213,49	767,42	27,82%	(553,93)
MANISOL SA	\$ 126,71	\$ 23.490,72	\$ 3.970,97	126,71	27.461,69	0,46%	(27.334,98)
MISION MODA SA	\$ 232,41	\$ 572,54	\$ 326,10	232,41	898,65	25,86%	(666,24)
ORDENA COLOMBIANA SA	\$ 429,12	\$ 1.540,93	\$ 681,29	429,12	2.222,22	19,31%	(1.793,11)
ORVAL LTDA	\$ 32,27	\$ 389,01	\$ 95,93	32,27	484,94	6,65%	(452,67)
RAIDERS LTDA	\$ 52,48	\$ 208,82	\$ 86,65	52,48	295,47	17,76%	(242,99)
ROMULO LTDA	\$ 356,09	\$ 651,70	\$ 462,74	356,09	1.114,44	31,95%	(758,35)
UNITED SHOE E.U.	\$ 48,37	\$ 236,11	\$ 87,01	48,37	323,12	14,97%	(274,75)
ULTRASOLES LTDA	\$ 63,08	\$ 100,98	\$ 79,61	63,08	180,59	34,93%	(117,51)
TECNIMOLPLAST LTDA.	\$ 5,57	\$ 74,63	\$ 17,79	5,57	92,42	6,03%	(86,84)
Weight	1,00	1,00	1,00				

Table 6
Efficiencies for the selected Shoe Industry Sector firms 2005

2004	EVA	IC (invested capital)	NOPAT (Net operating profit after taxes)	Weighted output	Weighted input	Efficiency	Weighted Output- weighted input
BAENA Y MORA CIA LTDA	\$ 132,52	\$ 895,71	\$ 284,03	132,5207418	\$ 1.179,73	11,23%	\$ (1.047,21)
KONDOR LTDA	\$ 189,11	\$ 2.194,36	\$ 560,28	189,1060327	\$ 2.754,64	6,87%	\$ (2.565,53)
LA MARAVILLA SA	\$ 3.197,75	\$ 10.372,20	\$ 4.952,18	3197,745622	\$ 15.324,38	20,87%	\$ (12.126,63)
MANISOL SA	\$ 944,48	\$ 20.983,38	\$ 4.493,76	944,4815479	\$ 25.477,15	3,71%	\$ (24.532,67)
ORDENA COLOMBIANA SA	\$ 356,04	\$ 1.314,01	\$ 578,30	356,038237	\$ 1.892,31	18,82%	\$ (1.536,27)
ORVAL LTDA	\$ 21,47	\$ 371,79	\$ 84,36	21,46904596	\$ 456,15	4,71%	\$ (434,68)
SCHONTHAL INTERNATIONAL SA	\$ 353,34	\$ 1.033,59	\$ 528,17	353,3436623	\$ 1.561,77	22,62%	\$ (1.208,42)
UNITED SHOE E.U.	\$ 48,47	\$ 209,16	\$ 83,85	48,47147257	\$ 293,02	16,54%	\$ (244,54)
Weight	1,00	1,00	1,00				

From the results obtained, it can be observed that for the years under study the companies that exhibited superior technical efficiency were:

- For the year 2007 the company with the best technical efficiency indicator was Productora de Insumos para Calzado S.A. with 83,37%.
- For the year 2006 the company with the best technical efficiency indicator was Productora de Insumos para Calzado S.A. with 90,63%.
- For the year 2005 the company with the best technical efficiency indicator was Ultrasoles Ltda. with 34,93%.
- For the year 2004 the company with the best technical efficiency indicator was Schontal International S.A. with 22,62%.

Therefore, in order to measure the relative efficiencies of the firms under study relative to the most efficient firm in the sample via maximum likelihood, the optimization parameters were:

MAX OBSERVED (Efficiency=Weighted Output/Weighted Input) in the sample must be equal to 100%

By changing:

$Weight_{EVA}$; $Weight_{NOPAT}$; $Weight_{IC}$

Where the restrictions are:

$Weight_{EVA}$; $Weight_{NOPAT}$; $Weight_{IC} \leq 1$ and all observed values of Weighted Output-Weighted Input must be less or equal than zero.

The results for the relative efficiencies of the firms under study for the years under observation are summarized in Tables 7 to 10:

Table 7
Relative Efficiencies for the selected Shoe Industry Sector firms 2007

2007	EVA	IC (invested capital)	NOPAT (Net operating profit after taxes)	Weighted output	Weighted input	Efficiency	Weighted Out- put-weighted input
ALIATTI LTDA	\$ 105,90	\$ 489,49	\$ 201,48	105,90	638,15	16,60%	-532,25
ALPHA SHOES SA	\$ 46,08	\$ 1.507,92	\$ 340,50	46,08	1738,44	2,65%	-1692,37
BAENA Y MORA CIA LTDA	\$ 402,81	\$ 1.478,48	\$ 691,49	402,81	1994,82	20,19%	-1592,00
BRONCO LTDA	\$ 108,85	\$ 724,32	\$ 250,28	108,85	905,45	12,02%	-796,60
BUSTER SHOES LTDA	\$ 54,72	\$ 421,95	\$ 137,11	54,72	520,41	10,51%	-465,69
CAIZA 3 SA	\$ 172,21	\$ 361,80	\$ 242,86	172,21	547,94	31,43%	-375,72
J.B. LTDA	\$ 22,96	\$ 77,43	\$ 38,08	22,96	105,98	21,66%	-83,02
COLVEX LTDA	\$ 16,19	\$ 1.560,71	\$ 320,92	16,19	1773,74	0,91%	-1757,55
CONFECCIONES ARGOS LTDA	\$ 57,36	\$ 216,31	\$ 99,60	57,36	290,57	19,74%	-233,21
KONDOR LTDA	\$ 523,59	\$ 3.416,87	\$ 1.190,73	523,59	4279,50	12,23%	-3755,91
JOVICAL SA	\$ 272,77	\$ 3.275,75	\$ 912,36	272,77	3916,70	6,96%	-3643,93
INDUSTRIAS AGUILES SA	\$ 746,65	\$ 1.639,17	\$ 1.066,70	746,65	2455,20	30,41%	-1708,55
CAUCHO ZAC LTDA	\$ 22,02	\$ 77,69	\$ 37,19	22,02	105,51	20,87%	-83,49
LA MARAVILLA SA	\$ 512,99	\$ 25.758,13	\$ 5.542,23	512,99	29473,44	1,74%	-28960,45
LARCS LTDA	\$ 1,58	\$ 83,27	\$ 17,84	1,58	95,21	1,66%	-93,63
V&C LTDA	\$ 109,22	\$ 671,41	\$ 240,32	109,22	846,06	12,91%	-736,84
ORVAL LTDA	\$ 1,77	\$ 473,01	\$ 94,13	1,77	535,03	0,33%	-533,25
PARISOTTO LTDA	\$ 50,31	\$ 402,19	\$ 128,83	50,31	494,54	10,17%	-444,23
PREFABRICADOS D MARCA LTDA	\$ 12,87	\$ 261,50	\$ 63,93	12,87	305,44	4,21%	-292,57
PRODUCTORA DE INSUMOS PARA CALZADO SA	\$ 870,90	\$ 145,33	\$ 899,28	870,90	870,90	100,00%	0,00
RAIDERS LTDA	\$ 132,39	\$ 318,94	\$ 194,66	132,39	467,26	28,33%	-334,87
ROGGERS LTDA	\$ 50,20	\$ 776,71	\$ 201,85	50,20	916,94	5,47%	-866,74
SCHONTHAL INTERNATIONAL SA	\$ 229,87	\$ 1.957,60	\$ 612,09	229,87	2394,91	9,60%	-2165,04
Weight	1,00	0,97	0,81				
Factor importance IC/NOPAT	1,19						

Table 8
Relative Efficiencies for the selected Shoe Industry Sector firms 2006

2006	EVA	IC (invested capital)	NOPAT (Net operating profit after taxes)	Weighted output	Weighted input	Efficiency	Weighted Output-weight- ed input
ALIATTI LTDA	\$ 65,66	\$ 443,07	\$ 135,94	65,66	559,39	11,74%	-493,72
BAENA Y MORA CIA LTDA	\$ 70,08	\$ 1.146,88	\$ 251,98	70,08	1358,17	5,16%	-1288,09
CAIZA 3 SA	\$ 221,26	\$ 509,79	\$ 302,12	221,26	774,60	28,56%	-553,34
J.B. LTDA	\$ 9,40	\$ 66,70	\$ 19,98	9,40	83,78	11,22%	-74,38
GOLANI LTDA	\$ 21,18	\$ 220,65	\$ 56,17	21,18	268,22	7,90%	-247,04
COLVEX LTDA	\$ 139,12	\$ 1.389,44	\$ 359,49	139,12	1694,16	8,21%	-1555,04
CONFECCIONES ARGOS LTDA	\$ 42,43	\$ 97,56	\$ 57,90	42,43	148,31	28,61%	-105,88
PALERMO LTDA	\$ 107,14	\$ 3.909,28	\$ 727,17	107,14	4511,09	2,38%	-4403,95
KONDOR LTDA	\$ 957,57	\$ 3.194,75	\$ 1.464,27	957,57	4468,61	21,43%	-3511,04
GERAMA LTDA	\$ 17,92	\$ 777,01	\$ 141,16	17,92	893,59	2,01%	-875,67
GIORGIO SPORT SA	\$ 106,16	\$ 699,57	\$ 217,12	106,16	885,46	11,99%	-779,29
JOVICAL SA	\$ 227,59	\$ 4.120,69	\$ 881,15	227,59	4858,11	4,68%	-4630,51
INDUSTRIAS AGUILES SA	\$ 720,07	\$ 2.669,50	\$ 1.143,47	720,07	3661,95	19,66%	-2941,88
CAUCHO ZAC LTDA	\$ 12,77	\$ 42,86	\$ 19,56	12,77	59,88	21,32%	-47,11
PONTI LTDA	\$ 42,26	\$ 58,92	\$ 51,60	42,26	104,53	40,43%	-62,27

Continúa...

LA MARAVILLA SA	\$ 1.628,14	\$ 15.277,58	\$ 4.051,23	1628,14	18716,61	8,70%	-17088,47
LARCS LTDA	\$ 26,81	\$ 77,35	\$ 39,08	26,81	111,45	24,05%	-84,64
CHAPLIN LTDA	\$ 22,76	\$ 113,23	\$ 40,72	22,76	148,33	15,34%	-125,57
WILCORTS LTDA	\$ 364,09	\$ 1.886,38	\$ 663,28	364,09	2457,58	14,82%	-2093,49
V&C LTDA	\$ 106,97	\$ 490,67	\$ 184,79	106,97	650,27	16,45%	-543,31
MANISOL SA	\$ 815,09	\$ 26.259,75	\$ 4.979,99	815,09	30388,00	2,68%	-29572,91
MARQUICOLOR LTDA	\$ 19,41	\$ 47,55	\$ 26,96	19,41	71,15	27,29%	-51,74
MISION MODA SA	\$ 26,98	\$ 545,16	\$ 113,44	26,98	639,90	4,22%	-612,93
ORDENA COLOMBIANA SA	\$ 170,13	\$ 1.809,30	\$ 457,09	170,13	2196,18	7,75%	-2026,06
ORVAL LTDA	\$ 76,98	\$ 462,93	\$ 150,40	76,98	591,99	13,00%	-515,01
PARISOTTO LTDA	\$ 50,17	\$ 310,00	\$ 99,34	50,17	395,18	12,70%	-345,01
PRODUCTORA DE INSUMOS PARA CALZADO SA	\$ 1.206,09	\$ 107,97	\$ 1.223,21	1206,09	1206,09	100,00%	0,00
RAIDERS LTDA	\$ 83,24	\$ 271,92	\$ 126,37	83,24	381,91	21,80%	-298,67
ROGGERS LTDA	\$ 9,95	\$ 832,93	\$ 142,05	9,95	949,57	1,05%	-939,63
UNITED SHOE E.U.	\$ 210,35	\$ 160,15	\$ 235,75	210,35	369,93	56,86%	-159,59
ULTRASOLES LTDA	\$ 106,17	\$ 230,65	\$ 142,76	106,17	355,91	29,83%	-249,74
SUMINISTROS, TRANSPORTE Y TECNOLOGIA S.A.	\$ 154,98	\$ 2.068,11	\$ 482,99	154,98	2474,83	6,26%	-2319,86
Weight	1,00	0,99	0,90				
Factor importance IC/NOPAT	1,10						

Table 9
Relative Efficiencies for the selected Shoe Industry Sector firms 2005

2005	EVA	IC (invested capital)	NOPAT (Net operating profit after taxes)	Weighted output	Weighted input	Efficiency	Weighted Output- weighted input
ALIATTI LTDA	\$ 73,34	\$ 311,25	\$ 124,28	73,34	141,84	51,71%	(68,50)
BAENA Y MORA CIA LTDA	\$ 248,98	\$ 5.991,24	\$ 436,14	248,98	1.880,95	13,24%	(1.631,97)
BRONCO LTDA	\$ 7,37	\$ 53,94	\$ 16,20	7,37	22,26	33,12%	(14,89)
GOLANI LTDA	\$ 19,08	\$ 205,17	\$ 52,65	19,08	80,79	23,61%	(61,71)
CONFECCIONES ARGOS LTDA	\$ 64,77	\$ 162,54	\$ 91,37	64,77	85,57	75,69%	(20,80)
KONDOR LTDA	\$ 360,09	\$ 2.446,42	\$ 760,44	360,09	1.020,94	35,27%	(660,86)
INDUSTRIAS AQUILES SA	\$ 14,41	\$ 2.021,05	\$ 345,15	14,41	720,50	2,00%	(706,10)
PONTI LTDA	\$ 11,06	\$ 61,09	\$ 21,06	11,06	26,39	41,90%	(15,33)
LA MARAVILLA SA	\$ 2.251,61	\$ 12.130,73	\$ 4.236,80	2.251,61	5.264,82	42,77%	(3.013,21)
WILCORTS LTDA	\$ 125,95	\$ 1.265,66	\$ 333,08	125,95	501,98	25,09%	(376,04)
V&C LTDA	\$ 213,49	\$ 476,03	\$ 291,39	213,49	260,94	81,82%	(47,45)
MANISOL SA	\$ 126,71	\$ 23.490,72	\$ 3.970,97	126,71	8.356,74	1,52%	(8.230,03)
MISION MODA SA	\$ 232,41	\$ 572,54	\$ 326,10	232,41	303,26	76,64%	(70,86)
ORDENA COLOMBIANA SA	\$ 429,12	\$ 1.540,93	\$ 681,29	429,12	730,92	58,71%	(301,80)
ORVAL LTDA	\$ 32,27	\$ 389,01	\$ 95,93	32,27	151,49	21,30%	(119,22)
RAIDERS LTDA	\$ 52,48	\$ 208,82	\$ 86,65	52,48	96,59	54,33%	(44,11)
ROMULO LTDA	\$ 356,09	\$ 651,70	\$ 462,74	356,09	384,95	92,50%	(28,86)
UNITED SHOE E.U.	\$ 48,37	\$ 236,11	\$ 87,01	48,37	04,45	46,31%	(56,07)
ULTRASOLES LTDA	\$ 63,08	\$ 100,98	\$ 79,61	63,08	63,08	100,00%	(0,00)
TECNIMOLPLAST LTDA.	\$ 5,57	\$ 74,63	\$ 17,79	5,57	28,79	19,36%	(23,22)
Weight	1,00	0,28	0,43				
Factor importance IC/NOPAT	1,54						

Table 10
Relative Efficiencies for the selected Shoe Industry Sector firms 2004

2004	EVA	IC (invested capital)	NOPAT (Net operating profit after taxes)	Weighted output	Weighted input	Efficiency	Weighted Output-weighted input
BAENA Y MORA CIA LTDA	\$ 132,52	\$ 895,71	\$ 284,03	132,520742	\$ 14,80	61,69%	\$ (82,28)
KONDOR LTDA	\$ 189,11	\$ 2.194,36	\$ 560,28	189,106033	\$ 54,90	41,57%	\$ (265,79)
LA MARAVILLA SA	\$ 3.197,75	\$ 10.372,20	\$ 4.952,18	3197,74562	\$ 3.362,65	95,10%	\$ (164,90)
MANISOL SA	\$ 944,48	\$ 20.983,38	\$ 4.493,76	944,481548	\$ 3.895,34	24,25%	\$ (2.950,86)
ORDENA COLOMBIANA SA	\$ 356,04	\$ 1.314,01	\$ 578,30	356,038237	\$ 400,18	88,97%	\$ (44,14)
ORVAL LTDA	\$ 21,47	\$ 371,79	\$ 84,36	21,469046	\$ 71,51	30,02%	\$ (50,04)
SCHONTHAL INTERNATIONAL SA	\$ 353,34	\$ 1.033,59	\$ 528,17	353,343662	\$ 53,34	100,00%	\$ -
UNITED SHOE E.U.	\$ 48,47	\$ 209,16	\$ 83,85	48,4714726	\$ 59,38	81,62%	\$ (10,91)

One of the most attractive features of DEA analysis is that the weights obtained in the relative efficiency optimization model can give us a further insight of the importance of the inputs needed to obtain a desired output. For our case study, it can be observed that for the year 2007, IC was 1,19 times more important than NOPAT for obtaining our desired output EVA®. In 2006, IC was 1,10 times more important than NOPAT for the same desired output. However, for the years 2005 and 2004 the most important factor was NOPAT with a relative importance of 1,54 for 2005 and a staggering 7,22 for 2004. Within the sample under study, just four of the companies exhibited positive EVA® for all the years in the sample. These firms were: Orval Ltda., La Maravilla S.A., Kondor Ltda., and Baena y Mora Cia. Ltda., being the one with the most consistent technical efficiency Kondor Ltda.

CONCLUSIONS

By using DEA analysis it is possible to measure the technical efficiencies of a particular economic sector using a common financial performance measure such as EVA®. Our study found that for the years 2007 and 2006 invested capital was the most important factor for obtaining positive EVA® for those years. For the years 2005 and 2004, the most relevant factor for obtaining positive EVA® was NOPAT. For the period under observation, none of the firms that exhibited the greatest techni-

cal efficiency for a respective year exhibited positive EVA® for the four years under study. In the case of Productora de Insumos para Calzado S.A. which was the firm that exhibited the best technical efficiency for two years in a row (2007 and 2006), there was not financial information available for the years 2005 and 2004. Also, it is important to mention that with the exception of the year 2007, none of the companies with the highest reported amount of EVA® were the ones with the greatest technical efficiency. For future research, the question remains if indeed the observed factor importance found by this simple DEA analysis is somehow reflected in the managerial practices of the firms under study. Finally, it is possible by using a simple analytical tool such as DEA to measure the relative performance of specific firms that operate in common economic sectors.

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