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Ph.D. Dissertation

INTANGIBLE ASSETS AND FIRM EFFICIENCY. INTERNATIONAL ANALYSIS IN THE TEXTILE AND APPAREL INDUSTRY.

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"Nothing in life is to be feared. It is only to be understood. Now is the time to understand more, so that we may fear less".

Maria Skłodowska-Curie

To My Parents and Brother

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Abstract

In this dissertation, we aim at assessing efficiency as well as productivity evolution over time of firms in the textile and apparel sector in different regions in the world, and we look at the factors contributing to efficiency outcomes. In particular, we focus on the role that intangible assets play in efficiency.

Theoretically, this research stands upon the Resource-Based View of the Firm with its recent development of the Dynamic Capabilities Approach, the Agency Theory, and the Institutional Theory. We build and test a theoretical model that hypothetically links intangible assets, other internal factors and external factors with firm efficiency.

In this way, this study contributes to the development of intangible assets research by introducing the alternative method for performance measurement, and benefits the efficiency literature by trying to integrate different theoretical perspectives considering the factors affecting efficiency.

We rely on the original dataset which was developed through the linkage of the information from three databases: *COMPUSTAT*, *DATASTREAM* and *OSIRIS*. It consists of 5477 observations (static efficiency) and 4982 observations (productivity evolution over time) of firms from the textile and apparel industry worldwide for the 1995-2004 time-period. The majority of companies come from the USA, Japan, China, Korea, Taiwan, Germany and the UK (regions of Asia, North America and Europe).

Methodology applied in this dissertation involves: 1) the computation of static efficiency indicators of firms in the sample by means of an input distance function using Data Envelopment Analysis (*DEA*) method; 2) the computation of productivity evolution over time through the application of Malmquist index; 3) the model and the hypotheses testing in the panel data truncated regression. In addition, we assess the statistical significance of static and dynamic efficiency indicators through the application of bootstrap methods.

Finally, our conclusions are presented together with their implications for managers and policy makers, reference to the study's limitations, and some recommendations for future research. The main implication of this dissertation indicates that textile and apparel firms need to invest in intangible assets.

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CHAPTER 1

Introduction

1 Introduction

We begin this chapter by explaining the rationale and the motivation of this dissertation. Then we summarize the general and specific research objectives. In the next section we shall discus the potential contributions of investigations undertaken. Then we summarize the situation in the textile and apparel industry worldwide, its importance in economies of different countries, current problems and challenges. Finally, we direct this dissertation into two main research streams: efficiency evaluations and intangible assets of firms. We conclude by outlining the content of each chapter.

1.1 Motivation

Textile and apparel industry[1] has undergone great challenges during the last three decades. The sector is in the process of permanent restructuring and modernization of production, reducing approximately 30% of workforce, increasing labour productivity and reorienting manufacturing towards innovative products with high quality. The important changes that have contributed to this new textile and clothing environment are the globalization and the internationalization of markets, the developments in new technologies, and the customer demands for variety and fashion. Such situation puts new pressures on the textile and apparel enterprises, which in order to increase competitiveness and survive in the global economy need to continue with modernization and focus on products with high quality, develop strong brand names and market niches, and respond to changes in demand very rapidly. As some authors state, the textile and apparel firms need to make constant investments in intangible assets (Owen, 2001; Stengg, 2001; Mittelhauser, 1999).

In addition to be an active field of research, the issues of firms' efficiencies have been of increasing interest to policy makers, managers and industry analysts (Cook and Seiford, 2009). Efficiency is an indicator of firm success, and its measurement allows for exploring the hypotheses concerning the sources of efficiency. Technical progress

[1] The sector is also called textile and clothing industry. In this dissertation we will use both notations exchangeable.

and efficiency are regarded to be central to economic growth and international competitiveness (Fried, Lovell and Schmidt, 2008).

A number of studies have applied econometric or mathematical programming techniques to assess the efficiency of firms in the textile and apparel industry in different countries. Using a variety of input-output specifications almost all studies find considerable inefficiencies reaching a level of 73% (Goncharuk, 2007; Margono and Sharma, 2006; Wadud, 2004; Goaïed and Ayed-Mouelhi, 2000; Jaforullah, 1999). But why does it happen? What are the factors responsible for such inefficiency? Some studies have also assessed the dynamic evolution of firm efficiency, productivity and technology in the textile and clothing industry (Margono and Sharma, 2006; Datta and Christoffersen, 2005; Ayed-Mouelhi and Goaïed, 2003; Chen, 2003; Taymaz and Saatçi, 1997). The large vast of results indicate a technical progress of firms, while a negative trend with respect to efficiency is reported.

To date efforts to explain the variability of firm efficiency, particularly in the textile and clothing sector, have focused on some internal or external factors. Examples of variables studied include: labour characteristics, *R&D* investment, firm ownership, export orientation or geographical location (Yasar and Morrison Paul, 2007; Margono and Sharma, 2006; Christoffersen and Datta, 2004; Jaforullah, 1999). While considerable amount of factors has been considered, the introduction of them has not arisen from theoretical considerations. Only few studies include some theories to explain inefficiency sources such as X-efficiency Theory or Agency Theory (Destefanis and Sena, 2007; Kim, 2003; Benfratello, 2002). Continuing with this research line, we ask in this dissertation which factors are responsible for efficiency outcomes of firms in the textile and clothing sector from the theoretical point of view.

The theoretical frameworks from strategic management research have traditionally focused on business concepts that affect firm performance and efficiency. Since the mid 1980s, the Resource-Based View of the Firm (*RBV*) and subsequently the Dynamic Capabilities Approach are dominant paradigms explaining why some firms perform better than others (Teece, Pisano and Shuen, 1997; Barney, 1991; Grant, 1991; Wernerfelt, 1984). Basing on the *RBV* the main factor contributing to firm performance are intangible assets. Organizations today are facing an increasingly elusive challenge as more and more the value of firms is becoming intangible. As economies evaluate into knowledge- and technology-based, the intangible elements of firms become fundamental determinants of firm current and future competitiveness as well as firm value and growth. Intangibles are nowadays the value drivers of an enterprise and the most valuable assets (Stewart, 1997). They currently constitute between one-half and two-thirds of corporate market value, of both "old" and "new economy" enterprises (Lev, 2001). But do really intangible assets contribute to better performance and can the lack of them explain firm failure?

Only very recently empirical research started asking this question by focusing on the relationship between intangible assets and firm performance analyzing many different sectors, mostly being high-tech industries (Gleason and Klock, 2006; Firer and Williams, 2003; Delios and Beamish, 2001). Despite the relevance of all these works, still more empirical research is needed to test the link between intangible assets and firm performance (Firer and Williams, 2003; Bontis, Keow and Richardson, 2000). Taking into account similarities between *RBV* and efficiency literature outlined elsewhere (Peteraf, 1993; Williamson, 1991), surprisingly none of the studies considers efficiency as a performance measure. Therefore, to differentiate from previous research, in this dissertation we assess firm performance by efficiency. In addition, the analysis of traditionally less knowledge-intensive sector that is the textile and clothing industry is another contribution to this stream of research.

Intangible assets alone, however, cannot explain efficiency differences between textile and clothing firms in rapidly changing markets. The Dynamic Capabilities Approach emphasizes dynamics and evolution of resources and capabilities acquired through history of existence and experience. In particular, learning is a factor contributing to heterogeneity of firm efficiencies (Teece, Pisano and Shuen, 1997; Williamson, 1991). Furthermore, Agency Theory predicts that issuance of debt causes conflicts of interest between different organizational players giving rise to agency costs which in turn impact firm value (Jensen and Meckling, 1976). Hence, on the basis of this theory firm external financing is another internal factor that influences efficiency. However, internal variables themselves bring only a partial understanding of firm efficiencies. For example, Oliver (1997) suggests that both firm resources and external capital are indispensable to competitive advantage. Within this line, Institutional Theory brings about external environment as a variable contributing to firm performance outcomes (North, 1994).

The assessment of efficiency performance of textile and clothing firms and their explanatory factors is a subject of this dissertation. Foremost, we focus on the role that intangible assets play in firm efficiency, and the main hypothesis tested is that intangible assets have a positive impact on firm efficiency. From methodological point of view, we estimate efficiency indicators of firms in the sample, and the evolution of efficiency and productivity over time. Then the static efficiency indicators are explained in the truncated regression with intangible assets, and other internal, external and control factors. The empirical analyses are conducted with an original database consisting of unbalanced panel of international textile and clothing firms. For analysis treating efficiency and its explanatory factors the dataset used sum up to total of 5477 observations, while for productivity evolution over time we have 4982 observations for 1995-2004 time-period.

1.2 Objectives of the dissertation

The main question asked in this dissertation is about the factors that are responsible for efficiency outcomes of firms in the textile and clothing industry. The objectives of this study can be summarized into three main groups. The first objective is focused on estimating the efficiency of firms in the textile and apparel industry in static terms for ten consecutive years, from 1995 to 2004 using Data Envelopment Analysis (*DEA*) methodology. As a second objective, we quantify the evolution of efficiency, productivity and technology over time and its statistical significance for the time-period 1995-2004 applying so-called Malmquist index. Finally, the third objective is to test the hypotheses of this study, focusing mainly on the measurement of intangibles and assessing their role in firm efficiency.

The specific objectives of every part of the dissertation are following:

1) Measurement and analysis of efficiency in the textile and clothing industry in static terms

- Apply existing Data Envelopment Analysis (*DEA*) method to compute efficiency indicators for each firm in the sample and separately for every year of analysis;
- Determine the statistical significance of efficiency results (sensitivity – bootstrap analysis);
- Compare the efficiency in the textile and apparel industry from the point of view of the geographical location;

2) Measurement and analysis of evolution of efficiency and productivity over time in the textile and apparel industry

- Compute productivity change over time expressed by Malmquist index;
- Determine two sources of productivity change over time: efficiency change and changes in the production technology;
- Determine the statistical significance of the results (sensitivity - bootstrap analysis);
- Compare productivity, efficiency and technological change between different regional locations of firms in the textile and clothing sector;

3) Testing the hypotheses of the relationship between intangible assets, other internal, external and control factors, and firm efficiency

- Measure intangible assets;
- Measure other internal factors: debt structure and learning by experience, and external factors: country economic development and economic integration;
- Test the hypothesis of positive relationship between intangible assets and efficiency in the textile and clothing sector;
- Examination of the hypotheses of the relationship between debt structure and learning by experience (other internal factors) and firm efficiency;
- Test the link between country economic development and integration (external factors) and firm efficiency;
- Determine if control variables of firm size, its geographical location, and industry branch relate to firm efficiency.

1.3 Contributions

At least three problems appear in the prior studies that we address in this dissertation.

1) First, the measures of performance used in intangibles research are usually ratios computed from firm financial statements or stock market data like. These measures, however, have well-known conceptual disadvantages.

We address the measurement problem by using efficiency as our indicator of performance. The theoretical link between firm resources and efficiency was first suggested by Williamson (1991), who pointed that *RBV* is an efficiency perspective.

2) Secondly, the extant efficiency literature links firm efficiency indicators with some factors, external and internal to the firm. Although the amount of factors is considerable, they appear without the clear connection with theoretical frameworks.

We address this problem by basis our investigations on the solid theoretical frameworks.

3) Third, most of studies on intangible assets and firm efficiency analyze high-tech sectors as based on those kinds of resources.

To address the third problem we analyze traditionally more labour- and less intangible-intensive sector - textile and clothing industry. We use an unique and original database of firms in the textile and apparel industry in different countries in the world. Hence, this is a new empirical setting for studying of intangible assets and their relationship with performance.

In addition, the use of bootstrapping methods for *DEA* and Malmquist enriches all three contributions of this dissertation.

1.4 Textile and apparel industry worldwide

Textile and clothing industry is one of the oldest sectors in the history of industrial development and is often described as traditional industry, which belongs to "old economy". It is worthwhile to note that it is a very heterogeneous and a diversified sector which covers a wide variety of products from hi-tech synthetic yarns to wool fabrics, cotton bed linen, and industrial filters to high fashion. In particular, textile and clothing compromise following activities (Stengg, 2001):

- The treatment of raw materials that is the preparation or production of various textile fibres and/or manufacture of yarns (spinning);
- The production of knitted and woven fabrics (knitting and weaving);
- Finishing activities undertaken to give fabrics visual, physical and aesthetic properties (bleaching, printing, dyeing, impregnating, coating, plasticizing);
- The transformation of those fabrics into products such as garments, carpets and other textile floor coverings, home textiles and technical or industrial textiles.

Assuming such definition, textile industry can be distinguished from apparel in such way that textile sector produces fabrics which are used by clothing firms to manufacture clothing and other finished goods to be sold in the market.

Depending on which market segment we focus on, the textile and clothing sector is both a labour-intensive, low-wage sector, and a dynamic, innovative industry (Nordås, 2004). One major market segment is a high-quality fashion which is characterized by modern technology, well-paid workers, high degree of flexibility and location of core functions in developed countries. On the other hand, there is a second segment of mass production of lower quality products, which manufacturing is largely located in developing countries, employing mainly female workers.

Generally speaking, textile and clothing sector is a very interesting branch of manufacturing industry given its rich history. As clothing is the most urgent need of people after food and shelter, the industry existed since the beginning of human being. The oldest mentions of textile and clothing development come from prehistoric times (stone age). However, it is not clear which date exactly the spinning and weaving of textiles began. Probably the oldest actual fragment of cloth is dated at about 7000 B.C.

and it was found in southern Turkey. Worth noticing are ancient times of textile and clothing development, when an extensive interconnected network of trade routes across Asian continent connecting Asia with the Mediterranean world, including North Africa and Europe, developed. They were called Silk Routes and in particular silk from China was transported to Mediterranean. However, the route was a trade road for not only silk as also other commodities were transported and most importantly the cultural and technological transmission was occurring for thousand of years. The observation that history repeats seems to be very adequate. Although the civilization has change, still many textile products come from China and Asia in general. Throughout history, until industrial revolution, the manufacture of textile and clothing goods was performed on a limited scale by individual workers in their own houses (domestic-cottage industry). With British Empire at the end of 17^{th} century there was an unlimited access to raw materials as well as a broad market for manufactured goods. Industrial revolution and English inventors in the 18^{th} century began automating manufacturing processes (Chapman, 1997). In 19^{th} century emerged sewing machines, while synthetic fibres were invented in 20^{th} century.

Nowadays, textile and clothing industry experiences the most turbulent chapter in its history associated mainly with three forces that alter the nature of competition in this sector (Owen, 2001): (1) the internationalisation which continuously shifts the production and export from developed to developing countries; (2) the advance in technology with a development of new fabrics and a rapid progress in information technology; and (3) the fashion with increasing demand for variety. Over the last three decades, the industry has been subjected to constant restructuring and modernization. As a result, between 1980 and 1995 over 40% of jobs were lost in European textile and clothing industry, while around 30% decline was experienced by this sector in the USA. Over the same period Asia managed to substantially increase employment (Stengg, 2001). However, following 1995, the decline in the USA and Europe was less sharp, while Asian industry began to lose jobs more drastically as a result of adjusting reforms. For example, in China government implemented a “restructuring, downsizing and efficiency policy” which led to around 40% employment decrease between 1995 and 2001 (Yeung and Mok, 2004).

The detailed employment figures for some American, European and Asian countries are presented in Table below.

Table 1 Employment in textiles and clothing (thousands)

	1995	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
	Textiles							
USA	688	660	653	642	614	595	539	489
Mexico	187	184	198	240	263	269	317	-
Czech Republic	100	86	90	86	74	79	76	72
France	134	129	126	126	123	119	116	109
Germany	261	209	188	194	184	168	154	146
Italy	332	340	326	351	334	352	344	335
Poland	159	153	146	128	108	97	88	-
Portugal	99	87	83	101	101	100	106	104
Romania	186	189	159	128	105	94	98	91
Spain	108	91	94	99	99	101	101	99
Turkey	-	-	-	-	-	471	493	584
UK	188	185	184	178	162	149	135	120
China	6730	6340	7302	5780	5109	4829	4775	-
Hong Kong	59	48	41	33	31	27	27	25
India	1579	1518	1529	1330	1283	1289	-	-
Indonesia	-	-	-	595	638	662	679	-
	Clothing							
USA	814	743	700	639	556	497	427	358
Mexico	476	486	525	740	723	760	681	-
Czech Republic	50	52	49	50	47	41	37	36
France	137	128	121	115	106	95	87	81
Germany	122	133	128	120	114	117	118	105
Italy	274	243	235	229	209	206	206	198
Poland	240	260	254	259	225	211	194	-
Portugal	143	131	124	176	164	156	151	143
Romania	189	203	181	246	240	261	290	302
Spain	117	114	120	111	126	123	125	116
Turkey	-	-	-	-	-	487	468	501
UK	173	165	163	159	133	109	88	78
China	1750	1680	2439	2117	2027	2156	2027	-
Hong Kong	80	64	53	44	40	36	30	23
India	264	267	283	279	296	331	-	-
Indonesia	-	-	-	349	436	485	462	-

Source: Nordås (2004)

Table 1 indicates a long-term decline in employment in many countries. It is clear that the employment decrease impacted mostly the clothing sector, although in the USA, Germany, the UK and Romania it also decreased substantially in the textile branch. Portugal and Spain avoided the job losses in clothing sector, as well as Turkey and Romania which increased substantially the employment. Also Mexico experienced job growth in both textile and clothing sector. From Asian countries India and Indonesia saw a significant job growth in clothing sector. Finally, the employment declined in some Eastern European countries such as Poland and Czech Republic in both textile and clothing, as well as in China and Hong Kong due to restructuring of this sector.

Although the employment decline is expected to continue in the world textile and apparel industry, still, as many firms adapt to the changes, this sector remains relatively important in economies of countries as a substantial provider of jobs and a crucial producer of value added in manufacturing. For instance, in 2004 in the USA its value added accounted for around 8% of total value added in manufacturing, in Japan for more than 9%, in China for around 11%, while in Italy for more than 11% (*World Bank*). According to the latest statistics of the European Apparel and Textile Organization (*EURATEX)*, textile and clothing industry in the European Union (*EU)* provided the employment for more than 2 million people in 2005. In the same period, in the USA the industry employed 1.3 million workers (Mittelhauser, 1999).

In 2004 in the *EU* the textile and clothing industry represented some 219000 of firms with production of 184.5 billion euros, while average firm produced 1.4 and 0.6 million euros in textile and clothing, respectively[2]. Within *EU* countries, the position of the industry in New Member States (*NMS*)[3] is significantly higher than in Old Member States (so called *EU*-15[4] countries). In 2002 the firms produced the value added reaching 5 billion euros, which came to 6% of total manufacturing and 1.2% of

[2] According to the European Commission study „Study on the competitiveness, economic situation and location of production in the textiles and clothing, footwear, leather and furniture industries".

[3] New Member States refer to 12 countries which entered the *EU* in 2004 and 2007, that is including Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovak Republic, Slovenia, Bulgaria and Romania.

[4] *EU*-15 refers to the European Union countries prior to accession of 12 members in 2004 and 2007 that is comprising of Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden, United Kingdom.

combined Gross Domestic Product (*GDP)* of *NMS*, while in *EU*-15 it contributed in only 4% to manufacturing value added and 0.7% to *GDP*[5].

Furthermore, the globalization and the interconnectedness of the international economy are other impacting trends in the textile and apparel sector (Mittelhauser, 1999). Traditionally, this industry was one of the least liberalized and most highly protected industries in international economy. For the last 40 years international trade relations have been dominated by the Multi-Fibre Arrangement (*MFA*), which has played a crucial role in protecting producers against imports from developing countries. It consisted of a number of bilateral agreements establishing quotas for some product lines. Since 1995 the quotas were removed gradually until 2005 when quota-free trade came into realization. It is worthwhile to note that the common view that increased liberalization will solely benefit the textile and apparel industry in developing countries should be formulated with caution, as firms from those regions have ahead difficult adjustments as well (Owen, 2001). Finally, another impacting factors are the changes in consumer demands, who start to search for variety and choose products with more value-added that is with better design, quality, brand and more fashionable (Owen, 2001).

The textile and clothing industry has to maintain and increase the competitive advantage by improving production technology, designing new products, investing in innovation and *R&D*, and adopting information and communication technologies (Owen, 2001; Stengg, 2001). In the *EU* sector the investment in *R&D* is estimated at 3-5% of turnover of average firm (Stengg, 2001). In all *EU* countries between 2001 and 2004 the investment tendency was oriented towards the reduction of tangible assets or productive assets in proportion of their sales in both textile and clothing. In textile sector the companies have not yet turned towards the development of intangible assets as indicated by low intangible / tangible assets ratios, on the contrary to clothing firms which became focused on immaterial issues as shown by high intangible / tangible ratios[6].

[5] Source: European Commission study “The textiles and clothing industries in an enlarged community and the outlook in the candidate states”.

[6] Source: European Commission study „Study on the competitiveness, economic situation and location of production in the textiles and clothing, footwear, leather and furniture industries”.

While textile and clothing sub-sectors are closely related, there are, however, some differences in their production structures. The clothing production is largely low-tech and labour-intensive, while textile industry is more capital-intensive and less unskilled labour-intensive (Datta and Christoffersen, 2005; Nordås, 2004; Stengg, 2001). In textile sector one can find the largest number of innovations, while clothing firms are not usually interested in technical innovations, but focused on fashion and brand issues[7]. Although some of the clothing operations have been mechanised and the preparation and finishing stages have benefited from advance in microelectronics which improved the efficiency, still the main activity of sewing, accounting for about 80% of employee costs, remains labour-intensive (Chapman, 1997). Textile firms are more affected by technological change because much of production process is uniform. Apparel companies have difficulties in automating production due to varied nature of fabrics, the complexity of assembly process and the modifications needed because of rapidly changing fashions (Mittelhauser, 1997). As a result, investment levels in textiles tend to be higher than in apparel. On the other hand, however, textile industry is less flexible in terms of adjusting to consumer tastes than clothing (Nordås, 2004). Finally, both branches are strongly dependent on women employment.

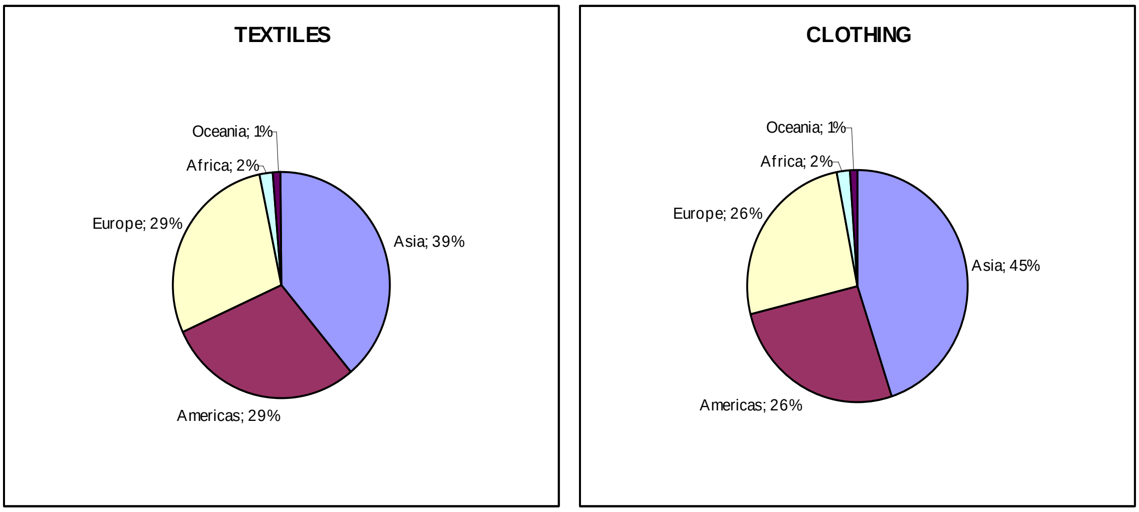
Comparing textile and clothing industry in developed and developing countries, in general the former one are more competitive in textiles than in clothing due to the fact that modern technologies can be used more easily in the textile branch. On the other hand, developing countries are more competitive in clothing where they can better exploit the labour cost advantages (Stengg, 2001). Although developed countries have the advantage over developing countries in terms of labour productivity, it is not large enough to compensate for the huge differences in wage costs which benefit developing countries (Stengg, 2001).

In 1998 Asian share in the world production of textiles was 39%, falling in front of Europe and Americas share of 29%. With respect to clothing production, once again Asia leads with 45% share, while Europe and Americas was of 26% (Figure 1). Among the worldwide producers of textile and clothing, Europe and USA put a particular

[7] According to the European Commission study „Study on the competitiveness, economic situation and location of production in the textiles and clothing, footwear, leather and furniture industries".

emphasis on high value added products. Within European countries, textile and clothing industries in Italy, followed by the UK, Germany, France and Spain are the most important (Stengg, 2001).

Figure 1 World production in textiles and clothing in 1998 (based on values in the USA dollars)



Source: Stengg (2001)

The world top 100 textile and clothing companies in 1999 come from the USA (31 firms), *EU*-15 (27), Japan (24), Taiwan (5), South Korea (4) and other countries (9) (Owen, 2001). Concerning textile trade, Europe is the world's largest importer of both textiles (40% of world imports) and clothing (over 45%). Within world exports, *EU*-15, China, South Korea, Taiwan, Hong Kong and the USA are the leading players (Table 2). The latest periods have seen significant expansion of exports of textile and clothing from China, and their high and rapidly increasing market share. China has the biggest share in exports in both textile and clothing in 2003 as well as exhibits the highest increase in exports between 1990 and 2003. China's lead is most significant in clothing.

Table 2 World exports of textile and clothing

	Exports of textiles (million USA dollars)		
	1990	**1995**	**2003**
World	104350 (100%)	152320 (100%)	169420 (100%)
China	13261 (12.7%)	25919 (17.0%)	39228 (23.2%)
EU (intra)	35672 (34.2%)	40218 (26.4%)	32567 (19.2%)
EU (extra)	15123 (14.5%)	21978 (14.4%)	26371 (15.6%)
USA	5039 (4.8%)	7372 (4.8%)	10917 (6.4%)
South Korea	6076 (5.8%)	12313 (8.1%)	10122 (6.0%)
Taiwan	6128 (5.9%)	11882 (7.8%)	9321 (5.5%)
Japan	5859 (5.6%)	7178 (4.7%)	6431 (3.8%)
	Exports of clothing (million USA dollars)		
World	108130 (100%)	158350 (100%)	225940 (100%)
China	15809 (14.6%)	35806 (22.6%)	67013 (29.7%)
EU (intra)	29444 (27.2%)	33518 (21.2%)	40903 (18.1%)
EU (extra)	11338 (10.5%)	14939 (9.4%)	19044 (8.4%)
Turkey	3331 (3.1%)	6119 (3.9%)	9937 (4.4%)
Hong Kong	9266 (8.6%)	9540 (6.0%)	8200 (3.6%)
USA	2565 (2.4%)	6651 (4.2%)	5537 (2.5%)

Source: World Trade Organization, "International trade statistics 2004"

1.5 Area of research and outline of the dissertation

Present dissertation is focused on assessing efficiency and factors explaining efficiency for firms in the textile and apparel industry in different regions in the world. In particular, the main objective is to test the relationship between intangible assets and efficiency of firms. Therefore, we can direct this study into two main research fields and two different strands in the literature: performance and efficiency evaluation of firms, and their intangible resources, which usually have been analyzed separately. We aim to further contribute to the literature on the relationship between intangibles and performance by introducing multidimensional performance measurement that is firm efficiency. On the other hand, the theoretical grounded research contributes further to the efficiency literature, which analyzing many different factors mostly introduce them without clear connections with theoretical frameworks..

In order to reach objectives of this study, this dissertation is arranged into five Chapters.

Chapter 2 consists of a conceptual development of this dissertation. We briefly explain the main concepts of this dissertation: intangible assets and efficiency of firms. Then we review the literature that relates to the efficiency and intangible assets, and show their limitations. Firstly, we analyze in details the studies in the textile and clothing industry, in particular the factors used to explain efficiency. We notice that the majority of studies conduct analysis without frames of theories. Then we focus on the several papers that have sought to empirically investigate the impact the intangible assets have on firm performance. We see that the studies use different methods to evaluate firm performance. Literature review and objectives of this dissertation allow us to choose and outline the theoretical frameworks applied. Based on the theoretical and empirical predictions, a number of hypotheses are developed to explain the relationship between intangible assets, other internal factors and external variables, and firm efficiency.

In **Chapter 3** the data, the methods, and the variables are explained. We describe in details our database. We outline the sources for our data and the modifications we needed to introduce in order to make it comparable between different countries and periods of time, and to control for the presence of outliers. The chapter continues with description of the methods used to compute efficiency indicators and productivity evolution over time: Data Envelopment Analysis and Malmquist index. With regard to both methods we describe the essence of bootstrapping. Then we explain the truncated regression for panel data, which we apply to test the hypotheses of this dissertation. Finally, the chapter explains in details and justifies the measurement of variables.

Chapter 4 presents and discusses the principal findings of this dissertation. The results are structured into three parts regarding static efficiency, productivity, efficiency and technology evolution over time, and hypotheses testing in the regression. Static efficiency results are presented for each year of analysis encompassing of ten periods from 1995 to 2004, their statistical significance is assessed by analysis of bootstrap, and the differences are discussed between regions and industrial branches. Productivity evolution over time is decomposed into technical and efficiency change, the bootstrap results are discussed with respect to all components and the differences are assessed between regions and sub-sectors of textile and clothing industry. Finally, the regression results are presented and discussed with respect to the hypotheses of this dissertation.

Chapter 5 concludes and highlights significant contributions of this dissertation, acknowledges its limitations, emphasizes the implications for business managers and public policy, and draws attention to areas for future research.

CHAPTER 2

Conceptual Development

2 Conceptual Development

This chapter elaborates on the conceptual development of this dissertation. First, we explain two fundamental concepts of this dissertation: intangible assets and efficiency. Then we proceed with literature review. We recapitulate the conclusions of the last fifteen years of efficiency studies in the textile and clothing industry. Then we present a classification of different factors used to explain efficiency, referring especially to those studies of the textile and apparel industry. From the point of view of intangibles' research, we summarize the investigations on the relationship between intangible assets and performance. Basing on the literature review undertaken and objectives of this dissertation, we provide a brief overview of the theories which we found to be adequate for our analysis. We outline the Resource-Based View of the Firm with its latest extension in the form of the Dynamic Capabilities Approach, the Agency Theory and the Institutional Theory from the point of view of determinant factors that might explain firm performance and efficiency. In the last section, drawing from the above mentioned theories we develop the hypotheses to be tested in this dissertation. The final conceptual framework is defined by the relationship between efficiency and intangible assets, other internal and external factors, which concludes this chapter.

2.1 Main concepts of this dissertation

2.1.1 Intangible assets

The economic importance of intangible assets has long been recognized. However, it is only recently that it has become the field of research. The lack of maturity of this investigation line is manifested through the fact that it does not exist an uniform term to coin intangible assets as well as consensus on the definition of those resources. While intangible assets are theoretically interesting, they suffer from being extremely hard to identify and measure.

Different terms are used to coin intangibles in literature: intangible assets, intangible resources, intellectual capital, and in general different authors use them exchangeable. There exists also another element that refers to a more tangible part of intangible assets that is intellectual property. Intellectual property consists of patents, copyrights and trademarks that can be more easily valued than other intangible assets (Bollen, Vergauwen, Schnieders, 2005). It is worth pointing out that intangible assets is a term taken from accounting theory. Basing on this, the discussion is undertaken on the differences between intangible assets and intellectual capital. The general view prevails that there is a substantial overlap of intellectual capital and intangible assets that is firm balance sheet shows considerable information on the elements of intellectual capital (Boekestein, 2006). In addition, sometimes intellectual capital is considered as all intangible assets together with their interconnections (Bontis et al., 1999). Because we focus in this dissertation on accounting information, we refer to this kind of resources as intangibles or intangible assets/resources.

Another problem of intangibles research is a definition of these resources. Although the early studies of intangible assets focused extensively on these issues, in the literature neither one unified definition nor one general classification can be found, and conceptualizations are not fully identical (Table 3). For example, for Stewart (1997) intangible assets are knowledge, information, intellectual property and experience which can be used to create wealth. He particularly distinguishes between human capital, structural capital and customer (relational) capital. Structural capital is then subdivided into two smaller components: innovation and process capital. In a similar way, Sveiby (1997) divides intangibles into three groups: employee competence, internal structure and external structure. Taking different perspectives, from accounting point of view, Hendriksen and Van Breda (1992) see intangibles as traditional intangibles such as patents and brand names, and deferred charges consisting of research and development and advertising, while marketing view defines intangibles as value creators, marketing assets and value manifestations (Guilding and Pike, 1990).

Table 3 Classifications of intangibles

Classification	Examples and/or definition	Reference authors
Human capital	individual tacit knowledge, raw intelligence, skills, expertise, education, innovativeness and competence of employees, commitment, motivation, loyalty, experience;	Stewart, (1997), Bontis (1998)
Customer (Relational) capital	firm's value of its franchise, ongoing relationships with people or organizations to which it sells, market share, customer retention, defection rates, customer profitability, knowledge embedded in marketing channels and customer relationships, brand equity;	
Structural capital: Innovation and Process capital	technologies, inventions, data, publications, strategy, culture, systems, organizational routines and procedures, organizational structure, patents, trademarks, hardware, software, databases, brand, network system organization, management process, supplier relation, customer loyalty, organizational charts, process manuals, information systems, laboratories, competitive and market intelligence, management focus;	
Innovation capital	*R&D*;	Mortensen, Eustace and Lannoo (1997)
Structural capital	intellectual capital, knowledge assets, organizational coherence, flexibility, workforce skills and loyalty;	
Executory contracts	operating licenses, franchises, media and other broadcast licenses, agricultural and other production quotas in regulated industries, maintenance, servicing and environmental liabilities, outsourced operations of over a year of duration, material employment contracts, risk-hedging financial instruments, derivatives;	
Market capital	brands, trademarks, mastheads;	
Goodwill	reputation;	
Employee competence	ability to act in different situations, skills, education, experience, values and motivation;	Sveiby (1997)
Internal structure	patents, concepts, models, computer and administrative systems, organizational culture;	
External structure	relationships between customers and suppliers, brand names, trademarks, organizational reputation and image;	

Table 3 - continued

Market assets	equal to the potential an organization has due to the market related intangibles such as brands, customers, distribution channels, contracts and agreements;	Brooking (1996)
Human-centred assets	collective expertise, leadership, entrepreneurial and managerial skills embodied by employees of the company;	
Intellectual property assets	legal mechanism for protecting assets including know-how, trade secrets, copyright or patent;	
Infrastructure assets	include those technologies, methodologies and processes that enable a company to function like culture or methodologies for assessing risk;	
Traditional intangibles	goodwill, brand names, patents;	Hendriksen and Van Breda (1992)
Deferred charges	advertising, research and development, training cost;	
Assets	trade marks, patents, copyright, registered designs contracts, trade secrets, reputation, networks, brands;	Hall (1992)
Skills	know-how, culture;	
Value creators	advertising, product development, other marketing support;	Guilding and Pike (1990)
Marketing assets	trademarks, brands, entry barriers, information systems;	
Value manifestations	image, reputation, premium price;	

Source: own elaboration

Synthesizing the above discussions, for the purposes of this dissertation we shall define intangible resources as all those resources that firm possesses that are invisible in character, but contribute to increased incomes and value generating processes of the company. In particular, we embed intangible assets in a difference between firm market and accounting value as the stock market assessment of intangibles considers them as a ratio between market to book value of the firm. In this dissertation we assume this aspect of intangibles.

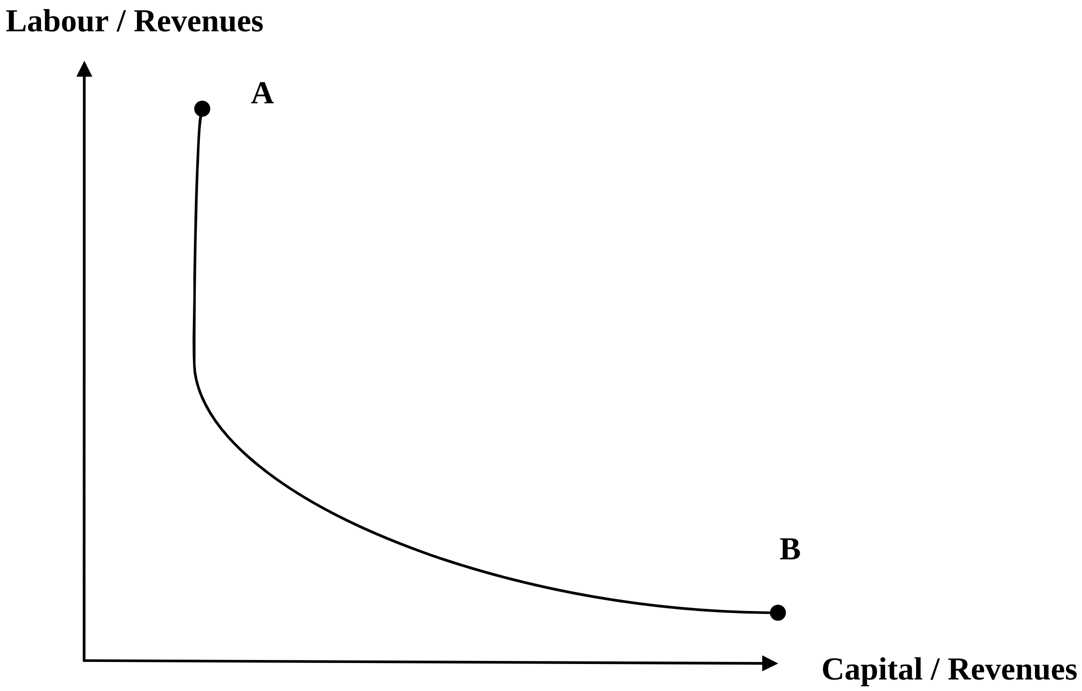
2.1.2 Performance, productivity and efficiency of firms

Throughout history performance measurement is used to assess the success of organizations across different industrial sectors. It is important to both the firm managers and the policy makers for a number of reasons. Firstly, performance assessment derive useful information which may help both the worst and the best performing firms to make improvements, and companies' managers to support their decisions. In addition, it allows for the analysis and hypotheses testing regarding the sources of performance differentials (Fried, Lovell and Schmidt, 2008). Furthermore, it is essential to policy making designed to improve performance over industries. In the broadest sense it is intended to secure control of an organization (Thanassoulis, 2001). At the same time measurement of performance is a difficult task due to multidimensionality of this construct. One can measure performance by variables relating to productivity, profitability or growth, or customers' satisfaction. Although all those indicators are correlated with each other to some extent, this relation is not perfect and one needs to choose the measure that best accomplishes research objectives (Barbosa and Louri, 2005).

2.1.2.1 Productivity concept

Every production process of the firm involves the use of a set of resources, referred to as inputs, to transform them into a set of outcomes, named outputs. In the simplest case, productivity can be defined as a ratio of output to input of production process. Such index is coined a partial productivity ratio as it includes only one dimension of a production process. The most widely used indicator of productivity in this group of ratios is labour productivity. As such it is easy to compute, however it is conceptually unsatisfying as it does not incorporate many other important factors like, for example, the firm technology. The usage of this ratio can lead to wrong results of productivity measurement as it is isolated estimation of only separate production factors. Interpreting the labour productivity ratio we might mistakenly attribute the gain in output, that is caused by an increase in capital, to the labour, even though the performance of labour worsen during the period considered. Consequently, when we compare productivity between different countries, our conclusions might be misleading and we obtain an unfair image in favour of one country. For the illustration, let's analyze a simple example. We sketch a graph where on the vertical axis we put the reciprocal of the labour productivity ratio, computed as for example Labour to Revenues, and on the horizontal - reciprocal of capital productivity ratio that is Capital to Revenues.

Figure 2 Labour and capital requirement



The ratio Labour / Revenues can be interpreted as the labour requirement (how much of work we need to produce the revenues of a one monetary unit), while Capital / Revenues as capital requirement (how much capital is necessary to produce the revenues of a one monetary unit). When we consider the example of firm A, we see that it requires a big quantity of labour and a small quantity of capital, as opposite to firm B, which needs a lot of capital and a very few labour. Textile and clothing firms which are less developed are closer to point A, while more technologically advanced are closer to point B. Therefore, if we analyze the firm only with regard to the labour productivity we can conclude that the labour productivity of firm A is low compared to firm B. But when we take both dimensions, we see the situation slightly different – firm A is less technological and requires more labour, while firm B substitutes labour with technology. That is why we need to consider more dimensions of firm production process, and move from partial productivity ratio to the total factor productivity ratio that is the index of output divided by an index of total input usage. Also in the aspect of multidimensionality of production process as it is more likely that the producer uses several inputs to produce several outputs. There are many possible methods within this framework; one of them is the efficiency, which in addition to considering multidimensionality of production allows for the comparison between firms.

2.1.2.2 Efficiency concept

While productivity informs about the productive firm performance in general terms, efficiency brings a relative element and it can be summarized as a relative productive performance. Firm efficiency equals to the maximization of the ratio of output to input of production process. In other words, the firm is efficient when it is the best. According to the definition of Organization for Economic Cooperation and Development (*OECD*), efficiency refers to the degree to which a production process reflects the best practice. Consequently, the efficiency has a relative notion as we compare firms with the best practice benchmark. The intuitive definition of efficiency is the result of comparison between the observed and the optimal values of the input and output to the firm production process (Fried, Lovell and Schmidt, 2008). The production units exhibiting those optimal values represent the so-called frontier function. Formally, frontier can be defined as a best-practice technology against which the efficiency of firms can be measured (Coelli, 1995). The measurement in terms of production possibilities and technological aspects of production described here results in the technical notion of efficiency. However, it is also possible to define the optimum in terms of the behavioural goal of the producer that is by comparing the values of observed and optimum cost, revenue or profit. In such comparisons the significance of efficiency is economic.

Koopmans (1951) offered a formal definition and characterization of technical efficiency as a such situation of production unit when an increase in any output requires a reduction in at least one other output or an increase in at least one input, and when a reduction in any input requires an increase in at least one other input or a reduction in at least one output. Debreu (1951) and Farrell (1957) were first to introduce a measure of technical efficiency, which focuses on the maximum feasible equiproportionate reduction in all inputs or the maximum feasible equiproportionate expansion of all outputs. As such they distinguished between input- and output-oriented efficiency measurements. In input orientation, efficiency is measured as one (100% efficiency) minus the maximum equiproportionate reduction in inputs while maintaining the production of originally specified output levels. Within output orientation, efficiency measure is defined as one (100% efficiency) plus the maximum equiproportionate augmentation of outputs while still utilizing the originally specified input levels. According to such measures, a score of unity would indicate technical efficiency, because no equiproportionate reduction of input or expansion of output is possible; while a score less than unity (input orientation) or more than unity (output orientation) implies inefficiency. Their indicator is a radial measure since its value depends exclusively on the distance from the best practice frontier; it is independent of unit of measurement. Therefore, because of this characteristic it is a very convenient indicator. However, it has its disadvantage because the production unit that achieves the maximum feasible input contraction or output expansion is considered to be technically efficient, even if there are slack in outputs or inputs. That is a production unit which is efficient in Debreu-Farrell sense may be technically inefficient on the basis of Koopmans' definition: it may lie on the boundary of the production possibilities but not on the efficient subset of the boundary (Färe, Grosskopf and Lovell, 1994).

2.2 Literature review

2.2.1 Efficiency in the textile and apparel industry: empirical evidence

In order to find studies concerning efficiency in the textile and apparel industry we searched the *ABI/Inform*, *EconLit* and *Scopus* databases for published journal articles, including proceedings from conferences. The period of time considered was the last fifteen years. To ensure the relevance of the findings we required that the selected papers contain two primary keywords in their abstract: 1) efficiency / productivity; and 2) textile / apparel / clothing. Then from all articles found we have chosen the most relevant by reading the abstracts to find out about the methodologies used. Of course we consolidated the results from databases by eliminating duplicate articles. Table 4 summarizes all efficiency studies identified using the methodology described.

Table 4 Studies of efficiency in the textile and clothing sector

Study	Country	Period	Methodology	Average efficiency / Productivity growth / Technical change / other findings
Papers treating solely the textile and clothing sector				
Wadud (2007)	Australia	1995-1998	Stochastic frontier	Productivity growth decline in 1995-1997 for both textile and clothing firms; in 1997-1998 improve for clothing and decline for textile firms
Aras (2006)	Turkey	1992-2003	*DEA*	Efficiency of 96% in 2000 and 67% in 1997
Datta and Christoffersen (2005)	USA	1953-2001	Translog cost function	Technical change of 2.4% in textiles and 0.7% in clothing Productivity growth of 2.1% in textiles and 1% in clothing
Battese, Rao and O'Donnell (2004)	Indonesia	1990-1995	Metafrontier production function	Efficiency of 42.6%-53% depending on the region
Wadud (2004)	Australia	1995-1998	Stochastic frontier	Efficiency of 43%-51% in textiles and 42%-45% in clothing
Ayed-Mouelhi and Goaïed (2003)	Tunisia	1983-1994	Dynamic production frontier	Efficiency of 68% Technical progress of 0.9%
Kambhampati (2003)	India	1986-1994	Stochastic frontier	Efficiency of 90%
Goaïed and Ayed-Mouelhi (2000)	Tunisia	1983-1994	Stochastic frontier	Efficiency of 66.5% Technical regress of -1%
Jaforullah (1999)	Bangladesh	1990	Stochastic frontier	Efficiency of 41%
Chandra et al. (1998)	Canada	1994	*DEA*	Efficiency of 69%
Hill and Kalirajan (1993)	Indonesia	1986	Stochastic frontier	Efficiency of 62.6%
Papers treating different sectors of manufacturing				
Bhaumik, Gangopadhyay and Krishnan (2007)	India	2000/2001 as compared to 1989/1990	Stochastic frontier	Efficiency of 59% in 1989/1990 and 52% in 2000/2001
Goncharuk (2007)	Ukraine	2004 and 2005	*DEA*	Efficiency of 27% in 2004 and 40.1% in 2005
Margono and Sharma (2006)	Indonesia	1993-2000	Stochastic frontier	Efficiency of 47% Efficiency growth of 1.1% Negative productivity growth of -0.26% Technical progress of 0.62%
Chapelle and Plane (2005a,b)	Côte d'Ivoire	1995	Stochastic frontier *DEA*	Efficiency of 33%
Millán and Aldaz (2004)	Spain	1980-1992	Intertemporal and intersectoral *DEA*	Efficiency of 66%

Table 4 - continued

Chen (2003)	China	1966-1985	Non-radial Malmquist index	Technical progress of 9.09% (1966-1975), 20.14% (1971-1980), 0.93% (1976-1985) Productivity change of 12.50% (1966-1975), 12.04% (1971-1980), 1.91% (1976-1985) Efficiency change of 3.75% (1966-1975), -10.14% (1971-1980), 0.98% (1976-1985)
Deraniyagala (2001)	Sri Lanka	1992	Stochastic frontier	Efficiency of 60%
Lundvall and Battese (2000)	Kenya	1993-1995	Stochastic frontier	Efficiency of 76%
Kong, Marks and Wan (1999)	China	1990-1994	Stochastic frontier	Efficiency of 75.7% No technical change Efficiency change negative Total factor productivity growth negative (-3.8%)
Yiu, Wing and Hong (1999)	China	1989-1992	*DEA*	Efficiency of 53% in textile and 62% in clothing
Chow and Fung (1997)	China	1989-1992	Stochastic frontier	Efficiency of 85% (joint ventures) and 80% (state-owned) in textile firms; 85% (joint ventures) and 83% (state-owned) for clothing
Taymaz and Saatçi (1997)	Turkey	1987-1992	Stochastic frontier	Efficiency of 79.3% Technical progress of 6%

Source: own elaboration

Among the studies found two groups can be distinguished: 1) referring exclusively to the textile and clothing industry as a whole (or separately to the textile or clothing sector); 2) analyzing the different branches of manufacturing industry in general, including the textile and clothing sector.

Regarding the first set of studies, textile and clothing firms in Asia are analyzed very often and general conclusions indicate the relatively low levels of efficiency ranging from 41% to 62.6% in such countries as Indonesia and Bangladesh (Battese, Rao and O'Donnell, 2004, Jaforullah, 1999; Hill and Kalirajan, 1993). Only Kambhampati (2003) employing stochastic production frontier reported a relatively high efficiency of textile firms in India reaching 90% level. From European countries, Turkish sector is considered and fluctuating trend of efficiency is found (Aras, 2006). Some studies analyze African countries such as Tunisia (Ayed-Mouelhi and Goaïed, 2003; Goaïed and Ayed-Mouelhi, 2000). Again the relatively low efficiencies are reported of approximately 67%, at the same time a technical regress or a very slight progress is found. A number of studies analyze textile and clothing industry in developed countries such as the USA, Canada and Australia. The relatively low levels of efficiencies are found for textile and clothing firms in Australia and Canada, lower for textile as compared to clothing companies (Wadud, 2007, 2004; Chandra et al., 1998). For this industry in the USA positive technical change is found, and textile firms are reported to make more technological improvements than clothing (Datta and Christoffersen, 2005).

The second group of studies conducts efficiency analysis of different manufacturing branches, among them investigating the textile and clothing sector. Most of papers geographically refer to Asian industry analyzing Indonesian, Indian, Sri Lankan and Chinese firms (Bhaumik, Gangopadhyay and Krishnan, 2007; Margono and Sharma, 2006; Chen, 2003; Deraniyagala, 2001; Kong, Marks and Wan, 1999; Yiu, Wing and Hong, 1999; Chow and Fung, 1997). The studies show a relatively low efficiency in almost all samples considered. Only some studies in the textile and clothing sector in China report the relatively high efficiency scores (Kong, Marks and Wan, 1999; Chow and Fung, 1997). Significant reductions of efficiency in time are reported for India and China (Bhaumik, Gangopadhyay and Krishnan, 2007; Kong, Marks and Wan, 1999). Further, the papers reveal technical progress in Indonesia and China (Margono and Sharma, 2006; Chen, 2003). Some of the studies identified treat African industry. The general conclusions made indicate very low levels of efficiency for Ivorian and Kenyan textile and clothing firms (Lundvall and Battese, 2000; Chapelle and Plane, 2005a, b). Referring to manufacturing industry in Europe, Goncharuk (2007) and Millán and Aldaz (2004) summarize the relatively low efficiency scores for textile and clothing firms in Ukraine and Spain, respectively. More optimistic view is pictured with regard to Turkish textile industry: relatively high efficiency and technical progress (Taymaz and Saatçi, 1997).

To sum up, each of efficiency studies of the textile and clothing industry reported in Table 4 approach this sector in one country. Most of papers analyze efficiency of Asian firms, for example in China, India or Indonesia. Some exceptions refer to the USA, Australia, Canada and Europe (foremost Turkey and some studies treat Ukraine and Spain). Other papers encompass this industry in Africa (Kenya, Tunisia and Côte d'Ivoire). Moreover, the data applied most frequently is rather old one, infolding 1980s or 1990s. Only few studies analyze the databases from the year 2000.

Table 4 also indicates the variety of techniques used to compute efficiency indicators. Among them two prevail: stochastic frontier model and Data Envelopment Analysis (*DEA*), the former being applied most frequently (14 out of 24 studies identified). More dynamic approximations of efficiency appear in only two studies. It is worth pointing out that some studies introduce new techniques to efficiency literature like metafrontier production function, non-radial Malmquist index or intertemporal and intersectoral *DEA* using textile and clothing industry only as an example to show the application of those methodological novelties.

Foremost, the picture of the textile and clothing industry drawn from the studies is rather worrying: the considerable inefficiencies have been found. At the same time, however, most of papers report firms' technological progress with time, higher for textile than clothing firms. Another message from the results is that such external forces as market liberalization or economic crisis can impact firms' efficiency, the former in a positive way and the later with a negative significance. In addition, larger firms which are publicly-held or with foreign participation (international joint ventures) on the contrary to state-owned are considered to be more efficient. Finally, the results of studies are inconsistent regarding which branch of textile and clothing industry is more efficient, and some papers report higher efficiency for textile, while others for clothing enterprises.

2.2.2 Factors affecting efficiency with a special reference to the textile and clothing industry

We begin by analyzing factors considered in efficiency literature in general. In order to find the relevant papers we consulted the last ten years of publications in leading journals in the field: *European Journal of Operational Research* and *Journal of Productivity Analysis*. We completed the list of studies with articles encountered in other important journals which treat similar subjects (some of them are indexed in Social Science Citation Index): *Review of Industrial Organization*, *Managerial and Decision Economics* and *Journal of Comparative Economics*[8]. After careful review of this literature, we suggest that the factors considered to impact efficiency can be generally classified into two categories: 1) internal that is specific to a firm and under its control; and 2) external, referring to environment and country context in which firm operates[9]. Table 5 presents the overview of those factors basing on the most relevant articles found.

[8] There are plenty of papers that analyze factors affecting efficiency and it would not be possible to include all of them. Moreover, to our knowledge there is no article that reviews the findings of previous literature. Therefore, we decide to restrict our review to those 5 important journals.

[9] Some of the factors classified, like for example industrial activity, mostly play a role of a control variable, which tries to correct for possible correlation with some other determinants.

Table 5 Classification of factors affecting efficiency

Category	Factors affecting efficiency	Measures	Authors	Sectors	Period	Theoretical framework
Internal factors	Quality of labour	white-collar to blue-collar workers; white-collar to total workers	Piesse and Thirtle (2000)	Hungarian light manufacturing sector;	1985-1991	---
	Labour intensity	labour to capital ratio	Piesse and Thirtle (2000)			
	Origin of workforce	share of hired labour	Latruffe, Davidova, Balcombe (2008); Balcombe, Davidova and Latruffe (2008);	Czech farms; Polish farms;	1999 1996-2000	--- ---
	Education level	dummy denoting if worker has any formal education; average level of education	Balcombe et al. (2008); Tian and Wan (2000);	Bangladesh rice farming; China grain production;	not reported 1983-1996	--- ---
	Finance constraints	debt to asset ratio; interest coverage ratio	Sena (2006)	Italian manufacturing firms;	1990	---
	Sources of financing / Leverage	interest plus rentals / total output; debt value/total assets; dummy denoting firm ability to gain credit; dummy denoting if firm finances from own or own and loan capital;	Latruffe, Davidova, Balcombe (2008); Weill (2008)**; Balcombe et al. (2008); Margaritis and Psillaki (2007); Majumdar and Chhibber (1999)**; Pushner (1995)**;	Czech farms; Firms from 7 European countries; Bangladesh rice farming; New Zealand firms; Indian firms Japanese manufacturing;	1999 1998-2000 not reported 2004 1988-1994 1976-1989	--- Agency Theory --- --- Agency Theory Agency Theory
	Capital intensity	capital to labour ratio	Latruffe, Davidova, Balcombe (2008)	Czech farms;	1999	---
	Diversification	share of other income to total income	Balcombe, Davidova and Latruffe (2008)	Polish farms;	1996-2000	---
	Rental of production factors	share of rented land	Latruffe, Davidova, Balcombe (2008)	Czech farms;	1999	---

Table 5 - continued

Internal factors	High-tech production techniques	% of firms using: computer aided design, numerical control of metal working machinery, robotic production, automated inspection and computer quality control	Amato and Amato (2000)	USA manufacturing industries;	1989-1994	---
	Age	number of years since establishment	Balcombe et al. (2008); Majumdar and Chhibber (1999); Ahuja and Majumdar (1998); Majumdar (1997);	Bangladesh rice farming; Indian firms; Indian manufacturing firms; Indian firms;	not reported 1988-1994 1987-1991 1998-1994	--- --- --- ---
	Size	ln of total revenue; total net non current assets; ln of sales	Latruffe, Davidova, Balcombe (2008); Zelenyuk and Zheka (2006)*; Tian and Wan (2000); Majumdar and Chhibber (1999); Ahuja and Majumdar (1998); Majumdar (1997);	Czech farms; Ukrainian industrial firms; China grain production; Indian firms; Indian state-owned firms; Indian firms;	1999 2000-2001 1983-1996 1988-1994 1987-1991 1988-1994	--- X-efficiency Theory --- --- --- ---
	Firm ownership	ownership concentration, pyramidal group belonging, characteristics of the main shareholder; ownership structure; corporate ownership and ownership structure; private/public hospitals; ownership categories (collective, private, foreign, HMT, domestic joint ventures); non-profit, for-profit and public hospitals	Destefanis and Sena (2007)**; Zelenyuk and Zheka (2006)*; Zheka (2005); Chang, Cheng and Das (2004); Zhang, Zhang and Zhao (2001); Dalmau-Matarrodona and Puig-Junoy (1998);	Italian manufacturing industry; Ukrainian industrial firms; Ukrainian companies; Taiwanese hospitals; Chinese industrial firms; Hospitals in Spain;	1994 and 1997 2000-2001 2000-2001 1996-1997 1996-1998 1995	Agency Theory X-efficiency Theory --- --- --- ---
	Vertical integration	integration categories: non-integrated, partly integrated, fully integrated	Månsson (2004)	Swedish sawmill industry;	1995	---

Table 5 - continued

Internal factors	Mergers and Acquisitions	merged against non-merged firms, acquired firms versus control sample	Benfratello (2002); Garden and Ralston (1999); Akhavein et al. (1997);	Italian pasta industry; Australian credit union; USA banking;	1981-1997 1992-1997 1981- 1989	X-efficiency Theory X-efficiency Theory X-efficiency Theory
	Export orientation	dummy denoting if firm exports	Piesse and Thirtle (2000)	Hungarian light manufacturing sector;	1985-1991	---
External factors	Market competition and structure	firm exposure to competition; number of competitors; market concentration	Zhang, Zhang and Zhao (2001); Dalmau-Matarrodona and Puig-Junoy (1998);	Chinese industrial firms; Hospitals in Spain;	1996-1998 1995	--- ---
	Monopoly status	dummy indicating if firm is monopoly	Ahuja and Majumdar (1998)	Indian manufacturing firms;	1987-1991	---
	Industrial activity	dummies for categories of industrial branches	Zelenyuk and Zheka (2006)*; Zheka (2005);	Ukrainian industrial firms; Ukrainian companies;	2000-2001 2000-2001	X-efficiency Theory ---
	Liberalization	time period	Denizer, Dinc and Tarimcilar (2007)	Turkish banking;	1970-1994	---
	Subsidies from the state	subsidies in value terms; dummy denoting if firm receives a subsidy	Piesse and Thirtle (2000)	Hungarian light manufacturing sector;	1985-1991	---
	Regulation on prices	regulation with and without price change; revenues received from support institutions	Aubert and Reynaud (2005); Dalmau-Matarrodona and Puig-Junoy (1998);	Water utilities in the USA; Hospitals in Spain;	1998-2000 1990	--- ---
	Governmental reforms	dummy indicating year	Ahuja and Majumdar (1998)	Indian state-owned manufacturing firms;	1987-1991	---
	Helping institutions	dummy indicating firm interaction with extension services	Balcombe et al. (2008)	Bangladesh rice farming;	not reported	---
	Institutional control	dummy denoting if firm is controlled by specific institutions	Ahuja and Majumdar (1998)	Indian state-owned manufacturing firms;	1987-1991	---
	Country wealth	*GDP* per capita	Afonso and Aubyn (2006)	25 *OECD* countries;	2003	---

Source: own elaboration

Internal factors related to firm efficiency include such elements as characteristics of firm financing structure and finance constraints, company workforce (quality and intensity of labour, origin and education level of workers), diversification, rental of factors of production, and use of high-tech technologies. For example, Amato and Amato (2000) find that multifactor productivity is positively associated with the use of high technology in some manufacturing industries in the USA. The variable analyzed in this category compromises also of the firm export orientation (Piesse and Thirtle, 2000). Other factors examined very often refer to firm organizational form. Among the variables from this group, a very large stream of research is represented by the analysis of ownership influence on firm efficiency. For example, Destefanis and Sena (2007) find that the percentage of the company shares owned by the largest shareholder as well as the firm's belonging to pyramidal group are associated with higher efficiency for Italian manufacturing firms. Furthermore, the levels of vertical integration as well as the impact of mergers and acquisitions on efficiency are another variables referring to firm organizational form analyzed very frequently (Månsson, 2004; Benfratello, 2002). In addition, age and size represent other internal variables related to firm efficiency[10]. For instance, Majumdar (1997) for firms operating in India finds that larger size is associated with lower productivity, whereas older firms are more productive.

With regard to external factors, the characteristics of the market or industry are variables in this group which are considered to influence efficiency. Dalmau-Matarrodona and Puig-Junoy (1998) suggest that the number of competitors in the market contributes positively to technical efficiency of Spanish hospitals. Finally, such factors as subsidies from the state, country wealth represented by *GDP* per capita, regulation on prices, governmental reforms and control proceeding from institutional environment are other variables belonging to this category that are investigated in a number of studies (Afonso and Aubyn, 2006; Ahuja and Majumdar, 1998; Dalmau-Matarrodona and Puig-Junoy, 1998).

[10] Sometimes those variables are treated as control factors.

Having the general picture of factors considered in a broad efficiency literature, we now analyze them in more details within the studies in the textile and apparel industry. We consider almost the same set of papers as introduced in the previous section referring to the efficiency of textile and clothing firms, with small exceptions. Some studies did not appear previously or are not included in this new classification due to the fact that not all papers simultaneously report efficiency results with analyzing factors impacting efficiency. After reviewing carefully the factors identified we also categorize them into internal and external. Table 6 shows the summary of variables identified. It differs from Table 5 in the way that we remove the columns representing the sector and period analyzed, and add the one showing the variable' relationship with efficiency as found in the studies.

Table 6 Classification of factors affecting efficiency in the textile and clothing sector

Group variable	Factors affecting efficiency	Measures	Impact on efficiency (+, -, 0)	Authors
Internal factors	Quality of labour	proportion of non-production to total workers	-	Wadud (2004)
	Labour intensity	labour to capital ratio	-	Jaforullah (1999)
	Female participation	male to female ratio / dummy indicating if women exceed 50% of total workforce	- +	Jaforullah (1999) Hill and Kalirajan (1993)
	Origin of the workforce	hired to family ratio	-	Jaforullah (1999)
	Proportion of unpaid workers	dummy indicating if unpaid workers exceed 50% of total workforce	-	Hill and Kalirajan (1993)
	Working time	overtime (proportion of number of hours worked in the first shift to total number of hours)	+	Taymaz and Saatçi (1997)
	Bonus payment	proportion of bonuses payments in the total wage bill	+	Kong, Marks and Wan (1999)
	Capital intensity	capital to labour ratio	+ - -	Christoffersen and Datta (2004) Wadud (2004) Kambhampati (2003)
	Material intensity	yarn to capital ratio	+	Jaforullah (1999)
	Risk taking / Sources of financing / External capital	usage of short term financial debt / interest payments to total capital / dummy denoting if firm finances from own or own and loan capital	- - +	Aras (2006) Kim (2003)* Hill and Kalirajan (1993)

Table 6 - continued

Internal factors	*R&D* intensity	*R&D* employment to total employment / *R&D* spending / *R&D* spending to total output	+ 0 +	Christoffersen and Datta (2004) Wadud (2004) Kim (2003)
	Investment in information technology	value of information technology investment as a share of total capital	0	Christoffersen and Datta (2004)
	Innovations	equipment, material and instrument innovations	+	Chakrabarti (1990)
	Technology accumulation	technical change / technological capabilities (skills and knowledge)	+	Deraniyagala (2001)
	Capacity utilization	yearly rate of capacity utilization	+	Deraniyagala (2001)
	Firm ownership	dummy indicating if firm is private (1) or public (0)	Private more efficient	Margono and Sharma (2006)
	Legal status / Formal status	dummy indicating if firm is incorporated (1) or unincorporated (0) / dummy indicating is firm is formally registered	incorporated more efficient; formal less efficient	Wadud (2004) Chapelle and Plane (2005a)
	Age of equipment	new / worn-out equipment	+ +	Ayed-Mouelhi and Goaïed (2003) Goaïed and Ayed-Mouelhi (2000)
	Age	number of years since establishment / division into young and old firms / ln of number of years of operation	0 + U-shape - for small firms, + for big firms -	Margono and Sharma (2006) Wadud (2004) Kambhampati (2003) Lundvall and Battese (2000) Hill and Kalirajan (1993)
	Size	dummy denoting different values of firm output / total net non current assets / division into small and large firms according to number of employees / firm output to total industry output / ln of intermediate inputs	+ + + + inverted U-shape + +	Margono and Sharma (2006) Chapelle and Plane (2005a) Wadud (2004) Ayed-Mouelhi and Goaïed (2003) Kim (2003) Lundvall and Battese (2000) Mini and Rodriguez (2000)
	Subcontracting	proportion of inputs subcontracted to suppliers to total inputs costs	+	Taymaz and Saatçi (1997)

Table 6 - continued

Internal factors	Export orientation	export to total sales / dummy denoting if firm exports / total exports of the firm to aggregate output of the industry / export revenues / export earnings to total sales	+ 0 + + - + 0 + +	Yasar and Morrison Paul (2007) Wadud (2004) Ayed-Mouelhi and Goaïed (2003) Kambhampati (2003) Kim (2003) Deraniyagala (2001) Goaïed and Ayed-Mouelhi (2000) Mini and Rodriguez (2000) Hill and Kalirajan (1993)
	Foreign direct investment	dummy denoting if firm has foreign direct investment / foreign share	+	Yasar and Morrison Paul (2007)
	Import intensity	imports to domestic production / import expenditure to total sales	0 +	Christoffersen and Datta (2004) Kambhampati (2003)
	Technology transfer	dummies denoting if firm imported or purchased by licensing any equipment or international technology	+	Yasar and Morrison Paul (2007)
External factors	Industrial activity	dummies for categories of branches	not conclusive	Wadud (2004) Goaïed and Ayed-Mouelhi (2000) Yiu, Wing and Hong (1999)
	Market share	not indicated	+	Kambhampati (2003)
	Market concentration	Herfindahl index	-	Kambhampati (2003)
	Subsidies from the state	dummy denoting if firm received any type of subsidy	+	Mini and Rodriguez (2000)
	Trade unions	dummy denoting the presence of trade union	-	Chapelle and Plane (2005a)
	Geographical location	dummies indicating specific regional locations	has a significant impact	Margono and Sharma (2006) Kambhampati (2003) Kong, Marks and Wan (1999)

** study referring to Agency Theory*

Source: own elaboration

With regard to internal variables, the first set of factors analyzed in the studies refers to the characteristics of firm workforce. The elements considered include quality and intensity of labour, female participation, origin of the workforce and proportion of unpaid workers. Wadud (2004) in the Australian textile and apparel industry shows that quality of labour as reflected by the proportion of non-production to total workers exhibits a negative association with technical efficiency. Furthermore, technical efficiency in the textile industry in Bangladesh may be improved by lowering labour/capital ratio (using less labour assuming capital stock constant) (Jaforullah, 1999). Concerning the female participation in the workforce, the studies identify it as a factor correlating positively with efficiency (Hill and Kalirajan, 1993). In particular, efficiency can be improved by substituting male workers for female workers (Jaforullah, 1999). Moreover, Hill and Kalirajan (1993) for apparel industry in Indonesia find that the proportion of unpaid workers is associated with lower levels of efficiency. Treating origin of the workforce, Jaforullah (1999) concludes that efficiency can be improved by lowering hired-family ratio that is family labour is found to be more productive than hired.

The second set of factors among those of internal nature considers the characteristics of the workplace like working time and bonus system of payment. Kong, Marks and Wan (1999) in Chinese textile industry find a positive association of efficiency with bonus system of payments. In the same direction, Taymaz and Saatçi (1997) for Turkish textile industry conclude that technical efficiency increases with longer working time (overtime).

Furthermore, the ratios of capital to labour and yarn to capital are analyzed very frequently. The effect of capitalization on the firm efficiency is not clear. On the one hand, Christoffersen and Datta (2004) conclude that a greater capitalization in the textile industry in the USA has a positive impact on total factor productivity. On the other hand, other studies show that it decreases efficiency (Wadud, 2004; Kambhampati, 2003). In addition, it is reported that a negative impact is stronger in the period before market liberalization (Kambhampati, 2003). With regard to material intensity, Jaforullah (1999) concludes that technical efficiency may be improved by increasing yarn/capital ratio (using more yarn per unit of capital).

Other important set of studies encompass firm financing structure. The papers consider how the usage of external capital impacts firm efficiency. The results are almost conclusive. According to Aras (2006) the relationship between efficiency and the usage of short term financial debt is negative. Kim (2003) also reports a negative relationship with external funds as measured by ratio of interest payments to total capital in Korean textile and clothing firms. However, Hill and Kalirajan (1993) shows that financing with own and loan capital has a positive impact on efficiency.

The next large group of variables refers to the characteristics connected with firm innovativeness. Following factors are considered: *R&D* intensity, investment in information technology, innovations and technology accumulation. In general the message of the studies is clear as almost all report positive association between those variables and efficiency. *R&D* intensity is concluded to have either strongly positive impact or positive but not significant (Christoffersen and Datta, 2004; Wadud, 2004; Kim, 2003). At the same time, investment in information technology does not produce productivity gains (Christoffersen and Datta (2004). Furthermore, Chakrabarti (1990) for the textile industry in the USA finds that innovations are related with productivity growth. Finally, Deraniyagala (2001) examined the relationship between technology accumulation and technical efficiency in Sri Lankan clothing industry. The study confirms positive relationship between technical change as well as technological capabilities and efficiency.

Furthermore, a very extensive group of studies consider age of the firm and of its equipment, and firm size. While firms with new equipment are found to have higher levels of efficiency (Ayed-Mouelhi and Goaïed, 2003; Goaïed and Ayed-Mouelhi, 2000), the impact of firm age is not clear. Age is found to have a positive impact in the study of Wadud (2004) in Australian textile and apparel industry, while in Lundvall and Battese (2000) this association is confirmed only for the largest size categories of firms. Hill and Kalirajan (1993) reports years in operation to be associated with lower levels of efficiency. Also age is found to have a negative impact for smallest firms (Lundvall and Battese, 2000). Furthermore in Kambhampati (2003) very young and very old firms are reported to have higher efficiency. With respect to the impact of size, the results are conclusive as most of studies support positive association. For example, Margono and Sharma (2006) reports higher efficiency for larger firms in the textile industry in Indonesia and Mini and Rodriguez (2000) show that efficiency and firm size are positively correlated in Philippines textile sector. Kim (2003), however, provides the evidence for inverted U-shaped relationship with size.

Moreover, the other group of factors treats firm organizational form. Private and incorporated firms are found to be more efficient (Margono and Sharma, 2006; Wadud, 2004). Chapelle and Plane (2005a) finds the negative impact of being formal on firm efficiency as formal status means that firms have to manage a more restrictive regulatory environment.

Finally, the last group of internal variables encompasses the relations of firms with external environment[11]. The factors analyzed consider subcontracting, export, foreign direct investment, import intensity and technology transfer. Export orientation is foremost found to be a positive factor for firm efficiency (Yasar and Morrison Paul, 2007; Ayed-Mouelhi and Goaïed, 2003; Kambhampati, 2003; Deraniyagala, 2001; Mini and Rodriguez, 2000; Hill and Kalirajan, 1993). For example, the findings of Deraniyagala (2001) suggest positive impact of the proportion of firm's total sales which are exported on firm efficiency. Only study of Kim (2003) for Korean textile firms provides the evidence for negative relationship with exports – many exporting firms target low-priced products and do not necessarily produce at the frontier of technology. Other form of firm international linkages – foreign direct investment – is found to exert a positive influence on productivity (Yasar and Morrison Paul, 2007). Furthermore, Taymaz and Saatçi (1997) for Turkish textile industry conclude that technical efficiency increases with the usage of subcontracted inputs. In addition, firms that import equipment or obtain technology through licensing are found to be more productive (Yasar and Morrison Paul, 2007). Finally, Kambhampati (2003) concludes that import intensity increase efficiency and its impact is more significant in the period before liberalization of markets.

With respect to external factors, very frequently investigated variable treats firm geographical location. All studies are consistent that efficiency differs considering the region where the firm operates (Margono and Sharma, 2006; Kambhampati, 2003; Kong, Marks and Wan, 1999). The papers also report that efficiency increases when the distance from a major urban centre increases (Kambhampati, 2003).

[11] In fact the factors belonging to this group could be also classified as between internal and external.

Considering characteristics of the market, Kambhampati (2003) for textile firms in India reports a positive impact of market share and a negative of market concentration on efficiency. Such association is found for both pre- and post-liberalization periods.

The branches of textile and clothing industry are also factors considered in efficiency literature, playing a role of control variables. However, the impact reported is not consistent. Some studies show that textile firms are more efficient (Goaïed and Ayed-Mouelhi, 2000 for Tunisian firms; Wadud, 2004 for firms in Australia), while others that clothing (Yiu, Wing and Hong, 1999 for Chinese companies).

Finally, the impact of subsidies from the state and trade unions is investigated in some studies (Chapelle and Plane, 2005a; Mini and Rodriguez, 2000). The associations with efficiency found are opposite: Mini and Rodriguez (2000) report in Philippines textile sector the positive impact of government support in the form of subsidies, while Chapelle and Plane (2005a) in Ivorian textile and clothing sector confirm the negative association with trade unions.

Summarizing, from literature review developed in this section the following conclusions can be drawn. As we can observe there are a lot applications which explain firm efficiency by internal and/or external variables. In particular, many different factors are introduced to explain efficiency in the textile and clothing industry. What one might observe from Tables 5 and 6 is that internal factors exceed those of external character. Furthermore, the signs of variables impacts' found are not always conclusive.

Foremost, it is worth noticing that both internal and external variables are mostly chosen considering the availability of data and they miss the clear connections with theoretical frameworks. Perhaps the only one attempt in this direction are studies based on the X-efficiency theory (Zelenyuk and Zheka, 2006; Benfratello, 2002; Garden and Ralston, 1999; Akhavein et al., 1997). However, X-efficiency is only used as a concept to refer to efficiency indexes computed. Another exception are studies traditionally based on Agency Theory that is linking firm financing structure or ownership with firm efficiency (Weill, 2008; Destefanis and Sena, 2007; Margaritis and Psillaki, 2007; Zelenyuk and Zheka, 2006). The situation with this respect is even more apparent for the literature on the factors affecting efficiency in the textile and clothing industry as only one study identified bases the research on the theoretical framework. Being important the specification of the factors affecting efficiency, the advantage of theoretical framework is that it helps to generalise the results beyond the context they come from. In this dissertation we try to fill in this gap by introducing the theories to explain efficiency sources. We further try to contribute to efficiency studies in the textile and clothing industry by theoretical explanation of factors in this specific empirical setting.

2.2.3 Intangible assets and performance – overview of research

Regarding the role that intangible assets play in efficiency of firms, now we move to a specific case of studies relating intangibles and company performance. To identify relevant papers we applied a similar procedure as for efficiency research. We searched the *ABI/Inform*, *EconLit* and *Scopus* databases for published journal articles only (including proceedings from conferences), which contain two primary keywords in their abstract: 1) intangibles / intangible assets / intellectual capital / intangible resources; and 2) performance. Then we asserted that the articles are relevant by reading the abstracts (we reconsider if paper contained empirical application and ensure that both concepts, intangibles and performance, are measured). Application of this procedure allowed us to consider 21 studies. The review of the relevant aspects of those studies is summarized in Table 7. Note that we include here also the summary of two papers which do not exactly link intangibles with performance, but use some of the techniques from efficiency literature to assess the efficiency of intangibles usage. Hence, they are of interest too.

Table 7 Studies relating intangible assets with firm performance

Author (s)	Intangible dimensions and their measurement	Performance: dimensions and measures	What other variables used to control for?	Period / Sample	Main results and conclusions
Gleason and Klock (2006)	Advertising expenditures; *R&D* expenditures;	*Tobin's Q*	Age; Industry;	1982-2001 / 7024 observations for firms from pharmaceutical and chemical industry in the USA	Intangibles are significant determinants of *Tobin's Q;* Older firms have lower levels of *Tobin's Q;*
Wu et al. (2006)	Efficiency in intangibles management measured by *DEA* and Malmquist index;	------------------------------------	------------------------------------	1999-2002 / 39 Taiwanese design companies	Some firms are more efficient than others utilizing intellectual capital;
Bollen, Vergauwen and Schnieders (2005)	Subjective indicators of human, structural and relational capital, and intellectual property assessed on 5-point Likert scale;	Market leadership, Future outlook, Revenue, Growth in revenue, Growth in sales, Return on assets, Return on sales, Success of the introduction of new products, Overall performance assessed on 5-point Likert scale;	------------------------------------	Static analysis / Different managers in 5 German pharmaceutical firms	Human, structural and relational capital are all interrelated; There are significant relationships between human, structural, relational capital and intellectual property; There is positive relationship between intellectual property and performance;
Chen, Cheng and Hwang (2005)	Value Added Intellectual Coefficient (*VAIC™*); *R&D* expenditures / Book value of common stocks; Advertising expenditures / Book value of common stocks;	**Market performance**: Market to book value; **Financial performance**: Return on equity (*ROE*); Return on assets (*ROA*); Growth in revenues (*GR*); Employee productivity (*EP*: pre-tax income/number of employees);	------------------------------------	1992-2002 / 4254 observations for firms listed in the Taiwanese Stock Exchange	Companies with greater physical, human and structural capital efficiency and greater *R&D* expenditure tend to have higher market-to-book value ratios; Intellectual capital efficiency is positively related to firms' current and future performance;

Table 7 – continued

Wang and Chang (2005)	The indicators of human capital, customer capital, innovation capital and process capital adopted from literature;	Return on assets (*ROA*); Adjusted return on assets; Return on stockholders´ equity (*ROE*); Adjusted return on stockholders´ equity; Operating income ratio; Stock price; Market value; Market value-Book value; Market-to-book;	-----------------------------------	1997-2001 / Listed firms in the information technology (*IT*) industry in Taiwan	Innovation, process and customer capital have positive influence on performance; Human capital positively affects innovation, process and customer capital; process capital and customer capital in turn affect performance; Human capital positively affects innovation and process capital, and process capital affects customer capital, which then affects performance;
Carmeli and Tishler (2004)	Subjective measures of managerial capabilities, human capital, perceived organizational reputation, internal auditing, labour relations and organizational culture taken from literature assessed on 7-point Likert scale;	Financial performance (self-income ratio and collecting efficiency ratio); The employment rate; Municipal development; Internal migration;	Environmental uncertainty; Community size; Geographical location;	1997-1998 / 263 Local authorities in Israel	Intangible assets and interactions among them impact positively performance; Organizational culture and perceived organizational reputation are the most important elements for performance; No impact of community size on performance; Impact of environmental uncertainty and geographical location on performance;
Chen, Zhu and Xie (2004)	Measurement model categorizing intellectual capital into four elements: human, structural, innovation and customer capital assessed on 7-point Likert scale;	Rate of returns of net assets; Prospect of an enterprise (arithmetical mean of the score of the rate of returns of net assets and the score of enterprise growth);	-----------------------------------	Static analysis / 31 Chinese enterprises, mainly high-tech	There is a significant relationship between intellectual capital of a company and performance;
Juma and Payne (2004)	Economic value added (*EVA™*); Market to book value;	**Operating performance**: Return on assets (*ROA*); Return on investments (*ROI*); **Market performance**: Market return; Stock price change over time;	Inter-firm collaborations; Age; Size; Industry;	1996-2001 / New ventures in the USA, high-tech	Negative relationship between *EVA* and *ROA;* Positive relationship between *EVA* and *ROI;* Negative relationship between *EVA* and Market return;

Table 7 – continued

Li and Wu (2004)	Human capital: The number of the total personnel, The education level of the personnel; Structural capital: *R&D* expenses, Advertisement expenses;	Total profits; Sales growth; Profit growth; Return on assets (*ROA*);	Industry; Size;	Static analysis / 73 Public firms in China	Level of human and structural capital has a positive effect on performance; Structural capital plays more important role in firm performance than human capital;
Villalonga (2004)	*Tobin's Q;* *Hedonic Q*: predicted value obtained from the regression of *Tobin's Q* on three accounting measures of intangible assets (*R&D* stock, advertising stock and intangibles-in book);	**Firm-specific profits:** difference between firm profitability and the average profitability of the industry in any given year; **Profitability:** Return on assets (*ROA*);	Industry;	1981-1997 / 1641 public corporations in the USA	The greater the intangibility of firm's resources, the greater the sustainability of its competitive advantage or disadvantage; The impact of resource intangibility on the sustainability of firm's competitive advantage differs significantly across industries;
Youndt, Subra-maniam and Snell (2004)	Multi-item indicators of human, social and organizational capital assessed on Likert scale;	*Tobin's Q*; Return on assets (*ROA);* Return on equity (*ROE);*	Age; Size; Industry munificence, dynamism and complexity;	Static analysis / 208 public firms in the USA	Firms of profile with higher levels of intellectual capital outperform those with lower levels;
Engström, Westnes and Westnes (2003)	Subjective measures of intellectual capital based on Bontis (1998) and *ICAP* methodology of evaluating intellectual capital specific for each organization;	**Organizational performance:** Degree of sick-leave and Working climate; **Financial performance:** Gross Operating Profit (*GOP*) percent, Revenue per available room, Occupancy percent, Rooms profit, *F&B* profit (comparing cost of food sold with food sales), Personnel cost;	-----------------------------------	Static analysis / 13 Hotels in the Radisson SAS chain in Norway	Weak relationship between *ICAP* and *GOP;* No relationship between *ICAP* and total climate; Relationship between human capital and total sick-leave and personnel cost; Relation between structural capital, rooms profit and *F&B* profit; Relationship between customer capital and occupancy rate; Relationship between human capital and structural capital;

Table 7 – continued

Firer and Williams (2003)	Value Added Intellectual Coefficient (*VAIC*^{TM});	**Profitability**: Return on assets (*ROA);* **Productivity**: *ATO* (total revenue / total book value of assets); **Market Valuation**: *MB* (total market capitalization / book value of net assets);	Size of the firm (natural log of total market capitalization); Leverage (total debt divided by book value of total assets); Return on equity (*ROE*); Industry type;	Static analysis / 75 Publicly traded African companies from sectors extensively reliant on intellectual capital	Moderately positive association between structural capital and profitability; Negative association between human resources and profitability and market valuation; Positive association between physical capital and market valuation; Control variables contribute very little to performance;
López (2003)	Indicators of company reputation, product reputation, human capital, and organizational culture assessed on 7-point Likert scale;	Return on assets (*ROA*);	Size of the firm (total employment);	Static analysis / 72 Spanish manufacturing firms holding *ISO* certificate	Company reputation, human capital and organizational culture have a positive impact on performance; Relationship between product reputation and performance do not found to be significant;
Riahi-Belkaoui (2003)	Relative measure of trademarks;	Net Value Added over Total Assets (*VATA*);	Relative prior years´ performance (relative value added / total assets); Size; Leverage; Multinationality (foreign sales over total sales);	Static analysis / Forbes magazine's most international 100 American manufacturing and service firms	Intellectual capital is associated with future firm performance;
SubbaNara-simha and Ahmad (2003)	Efficiency in utilizing of technological knowledge assessed by *DEA;*	-----------------------------------	-----------------------------------	Static analysis / 29 pharmaceutical firms in the USA	Some firms are more efficient than others in utilizing their breadth and depth of technological knowledge;
Roberts and Dowling (2002)	Overall reputation obtained from ratings on different items like community and environmental friendliness or ability to develop and keep key people;	Persistence of profitability (*ROA*);	Market to book value; Size (total sales);	1998-1999 / 540 *FORTUNE* 1000 firms	Firms with good reputation are better able to sustain superior profit over time;

Table 7 – continued

Carmeli (2001)	The list of 22 intangible resources based on previous studies;	Net income (ratio between profits after taxes and revenues); *ROE* (ratio between profits after taxes and stakeholders equity);	------------------------------------	Static analysis / 10 Public firms in Israel	The core intangible resources of high-performance firms: managerial competence, ability to manage changes, know-how, human capital and organizational strategy; Low performance firms: product/service reputation, know-how, intellectual property, human capital and ability to raise funds;
Delios and Beamish (2001)	Expenditures on *R&D* / Total sales; Expenditures on advertising / Total sales;	**Profitability**: managerial assessment between three categories: loss, breakeven and gain; **Survival:** dummy indicating if firm failed or not;	Experience abroad; Size; Age;	1987-1996 / 641 Japanese multinational firms	Positive relationship between intangible assets and survival; Technological assets are positively related with profitability; Not significant relationship between advertising assets and profitability;
Bontis, Keow and Richardson (2000)	As Bontis (1998);	As Bontis (1998)	Industry type: service and non-service industry;	Static analysis / 107 *MBA* students in Malaysia	Human capital is positively related to customer capital regardless industry and to structural capital only in in non-service industries; Customer capital is positively related to structural capital regardless industry sector; Structural capital is positively related to business performance regardless industry;
Bontis (1998)	Indicators of human, structural and customer capital taken from the literature assessed on 7-point Likert scale;	Industry leadership, Future outlook, Profit, Profit growth, Sales growth, After-tax return on assets, After-tax return on sales, Overall response to competition, Success rate in product launch, Overall business performance assessed on 7-point Likert scale;	------------------------------------	Static analysis / 64 *MBA* students in Canada	Intellectual capital has a significant impact on performance; Human capital is useless without supportive structure of structural capital; There must exist constant interplay between human, structural and customer capital;

Source: own elaboration

The first thing to notice from Table 7 is that only very recently (as for 1998) researchers started asking questions about intangible assets' contribution to firm performance and competitive advantage by measuring both concepts and linking them formally. Bontis (1998) in his exploratory pilot study shows a valid, reliable, significant and substantive causal link between intangibles and business performance. In particular, the results indicate that each of three elements of intellectual capital (human, structural and relational capital) is related individually to firm performance. Since his study the relevance of intangible assets for financial performance is getting more widely accepted in different sectors. Bontis, Keow and Richardson (2000) show the positive link between different dimensions of intangible assets and performance regardless industry sector. The recent study of Gleason and Klock (2006) reported intangible assets as significant determinants of firm performance. Among intangible assets that are found to contribute to superior performance are company reputation, human capital and organizational culture (López, 2003; Roberts and Dowling, 2002). The studies further emphasize the importance of the interactions between intangible elements as they tend to enhance organizational performance (Bollen, Vergauwen and Schnieders, 2005; Wang and Chang, 2005; Carmeli and Tishler, 2004; Engström, Westnes and Westnes, 2003; Bontis, 1998).

It is interesting to notice that studies lack of uniform criteria to assess firm performance outcomes. Generally speaking, the measures used can be classified into: 1) objective, treating firm financial or market information and computing different kind of ratios; and 2) subjective, self-reported indicators of performance, which usually ask responders to assess different dimensions of firm performance on the Likert scale with varying number of items[12]. In fact, 19% of studies identified (4 out of 21) utilize subjective indicators. Different dimensions of firm current and future performance are considered, like operating and market performance using, for example, market to book value, market return or Return on assets (Chen, Cheng and Hwang, 2005; Juma and Payne, 2004), firm's specific profits and profitability utilizing firm profits and return on assets (Villalonga, 2004), or profitability and survival applying subjective assessment of firm profitability and dummy indicating company failure (Delios and Beamish, 2001). Nevertheless, we can summarize that the majority of papers focus on the relationship

[12] Likert scale is a scale commonly used in the questionnaires in which respondent specifiy their attitudes and preferentes towards some statements, for example ranking from strongly disagree to strongly agree.

between intangibles and *Tobin's Q* (Gleason and Klock, 2006; Youndt, Subramaniam and Snell, 2004) or such profitability ratios as Return on assets (*ROA*), Return on equity (*ROE*) or Return on investment (*ROI*) (Chen, Cheng and Hwang, 2005; Youndt, Subramaniam and Snell, 2004; López, 2003). It is worth pointing out, however, that those indexes, while having the advantage of being easy to compute, suffer from well known conceptual limitations: 1) they are not able to reflect effectively the multidimensional character of performance, which is a prevalent characteristic of many industrial sectors; 2) their interpretation is problematic due to the fact that firm earnings tend to be artificially modified by managers under different external circumstances like, for example, the import relief with quota reductions that favour lower incomes (Jones, 1991); and 3) they are too aggregated to show the impact of different strategic factors (Banker, Chang and Majumdar, 1996).

Regarding the measurement of intangibles, the most commonly applied is a range of subjective indicators of intangible assets (Bollen, Vergauwen and Schnieders, 2005; Wang and Chang, 2005; Carmeli, Tishler, 2004; López, 2003; Bontis, 1998), or Value Added Intellectual Coefficient ($VAIC^{TM}$) (Chen, Cheng and Hwang, 2005; Firer and Williams, 2003). Further, many studies use measures referring to *R&D* and marketing expenditures of the firm (Gleason and Klock, 2006; Delios and Beamish, 2001). Some recent papers apply the methodologies adapted from efficiency literature by measuring intangibles using Data Envelopment Analysis (*DEA*) or Malmquist index (Wu et al., 2006; SubbaNarasimha and Ahmad, 2003). However, those methods are used in order to assess the efficiency of utilizing and managing intangibles, but not to measure firm performance and to link it with intangibles indicators, what we aim to do in this dissertation.

In addition, it is worth to observe that the sectors analysed in the studies include mostly high-tech industries. To ensure the occurrence of relationships, the empirical settings of investigations are mostly chosen from sectors believed to be extensively reliant on intangible assets such as pharmaceutical, chemical and information technology industries.

Within this dissertation we aim to further extend the research on the relationship between intangibles and firm performance. Our work differs from earlier contributions by measuring performance through technical efficiency. Assessing firm performance in such way may filter out the effects of price change or stock market volatility and show the true operating results of the firm. At the same time, it permits to account for multidimensionality of performance as it makes simultaneous use of multiple inputs to transform them into multiple outputs. While there is a research measuring intangibles using methods from efficiency literature and applying *Tobin's Q* as an indicator of performance, to our knowledge, none of the studies used efficiency as a measure of performance, simultaneously approaching intangibles by *Tobin's Q*. In addition, the analysis of traditionally less knowledge-intensive sector, that is the textile and clothing industry, is another contribution to this stream of research.

In hypercompetitive environment, which is a prevailed characteristic of nowadays markets, not only knowledge-based firms tend to increasingly depend on intangible assets. Also more labour-intensive textile and apparel companies face the challenges of international market liberalization, development of new technologies and constant changes in customer demands, which force them to change a traditional way of doing a business and competing, and focus on products with more value added. Therefore, the companies start to invest in more invisible resources. However, so far literature on the relationship between intangible assets and performance has neglected this kind of sector and within this dissertation we try to fill in this gap in the literature.

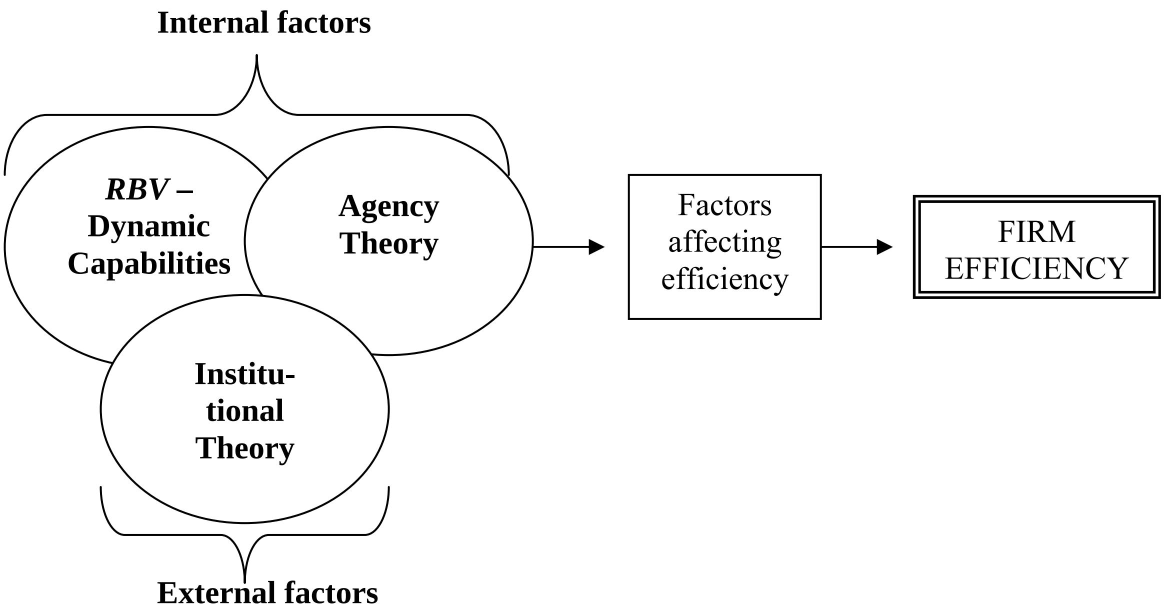
2.3 Theoretical frameworks

The complex problems as the one analyzed in this dissertation are likely to benefit and be explained by insights obtained from many different theoretical paradigms[13]. Taking our objective and conclusions of the literature review carried out, we think that the following theories are useful and adequate for the development of model of factors affecting firm efficiency: Resource-Based View of the Firm with its extension to dynamic environments in the form of Dynamic Capabilities Approach, Agency Theory and Institutional Theory (Figure 3). With those theoretical frameworks we cover the internal and external factors explaining efficiency of firms. Resource-

[13] Different view is presented in Johannisson et al. (2007) where we propose the usage of many different theoretical perspectives on the localized economic development, and see that every theory provide different image of the same phenomenon.

Based View considers internal factors as responsible for differences between firms. In particular, this theory has been used to analyze the link between intangible assets and firm performance. Dynamic Capabilities Approach adds to those resources distinctive processes and evolution path firm has adopted or inherited. Agency Theory is often used in efficiency research to analyze the impact of such internal factors as firm financing structure. Finally, external factors are best captured by Institutional Theory as it looks at how external environment impacts on firm performance. Premised on the arguments of those theories, we construct a conceptual framework that seeks to demonstrate how internal firm factors and country environmental context shape firm efficiency. These frameworks are adequate to analyze the factors affecting efficiency in the international context.

Figure 3 Theories incorporated in the dissertation and their implications



Hereafter, we develop those theories in more details analyzing the factors considered, we establish the conceptual model, and we link determinants with efficiency by the elaboration of hypotheses.

2.3.1 Resource-Based View of the Firm (RBV) and its dynamic extension

RBV gives an answer to the main research question of why firms in the same industry vary systematically in the performance over time. It states that “a firm’s ability to attain and keep profitable market positions depends on its ability to gain and defend advantageous positions in underlying resources important to production and distribution" (Conner, 1991, p. 121). Hence, the essence of company performance lies in the resources. The main assumptions underlying *RBV* are notations of resource heterogeneity and immobility across the competitors in the same industry (Barney, Wright and Ketchen, 2001; Barney, 1991). Based on these premises, the theory predicts that: 1) if a firm possesses resources that are both valuable and rare, it will attain a competitive advantage; 2) if these resources are also inimitable and non-substitutable, the firm will sustain this advantage; and 3) if firm attains such advantages, it will be able to improve its performance (Newbert, 2008). The duration of firm competitive advantage and persistence of the rents generated are directly related to the strength of isolating mechanisms, including property rights (for example, patents), high learning and development costs, causal ambiguity or historical conditions (Dierickx and Cool, 1989).

Since the early eighties, *RBV* has become a very popular framework to explain firm competitive advantage and superior performance. It has developed considerably in the theory and has been applied empirically to a large extent in different industrial and country settings linking heterogeneous disciplines of marketing, entrepreneurship, international business and human resources[14]. Although the *RBV* is a dominant paradigm explaining the interfirm performance differences, still it remains the area of additional study (Carmeli and Tishler, 2004). Many authors emphasize that its systematic empirical falsification is difficult (Newbert, 2007; Hoopes, Madsen and Walker, 2003). Newbert (2007), after an extensive review of *RBV* empirical studies, finds out that only 53% of tests support the theory. Therefore, more empirical studies investigating the basic insights and definitions of framework are needed.

Another issue to discuss is performance measurement in *RBV* research. While the theory is concerned with performance, surprisingly not enough attention has been paid on its measurement (Majumdar, 1998). Most of the studies use a single

[14] For the past contributions as well as forward-looking extensions of *RBV* see a special issue of *Journal of Management* edited by Barney, Wright and Ketchen (2001).

performance indicator, however, to account for multidimensionality of performance alternative methods should be considered.

It is also emphasized that the field lacks maturity, despite a large number of high-quality papers published in top academic journals. An argument in favour of such standing can be a fact that even fundamental concept of the theory such as resource misses a clear and agreed definition. As many theoretical contributions to the field exist, so many different approaches to firm resources are developed. In this dissertation we follow Wernerfelt (1984) and define firm resources as tangible and intangible assets that are tied semipermanently to the firm. They are all assets, capabilities, organizational processes, information, and knowledge, which enable the firm to implement strategies that improve its efficiency and effectiveness (Barney, 1991). Tangibles consist of physical items that firm possesses such as raw materials, equipment and machinery. On the other hand, intangibles comprise of all resources that are not seen in financial statements like organizational reputation and culture. They can be further classified into assets and skills (Hall, 1992).

While both tangible and intangible resources are considered as a source of heterogeneity of firm performance and above-normal returns, however, they are not of equal importance in terms of achieving competitive advantage and superior performance. Those differences are attributed mainly to how high the barriers of resource imitation are, or how durable resources are (Barney, 1991). Tangible assets are easy to duplicate by competitors and most *RBV* scholars claim that they are a relatively weak source of competitive advantage and economic benefit (Conner, 2002; Barney, 1991). On the contrary, intangible assets are considered to be a more important source of heterogeneity of performance than tangible assets because of relatively high barriers to duplication (Hall, 1992). In this way, *RBV* provides a theoretical explanation for intangibles as a source for firm exceptional performance.

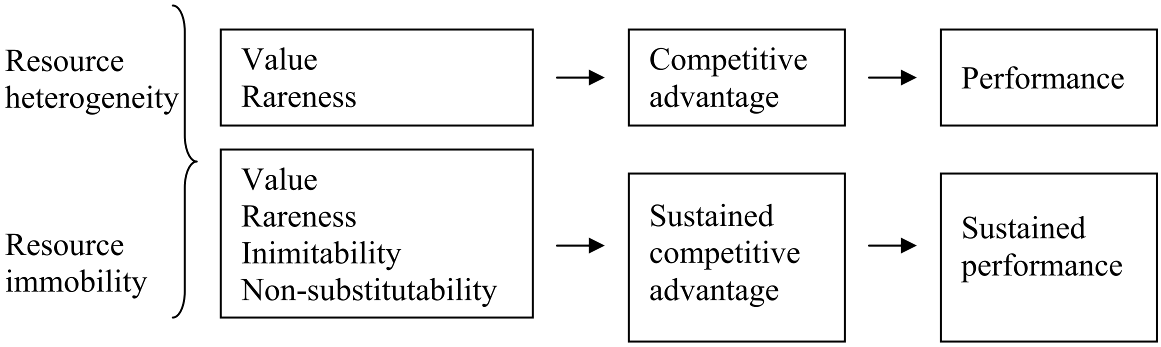
2.3.1.1 The most influential contributions

Edith Penrose book “The theory of the growth of the firm” is often seen as a precursor of *RBV* (Newbert, 2007; Wernerfelt, 1984). Penrose (1959) defines firms as a collection of resources that have been historically determined. In such way, in her view, the limits of firm growth are inside of the firm and not only outside. In particular, the optimal growth implies equilibrium between exploitation of existing and development of new resources. In addition, she distinguishes resources from services, arguing that it is never resources themselves that are inputs into the production process, but rather it is the services that these resources can cause. Although recently some of Penrose's contributions to *RBV* have been questioned (see, for example, Rugman and Verbeke, 2002; Foss, 1999), many of the most influential authors consider it as a seminal work where intellectual foundations for this theory can be found (Peteraf, 1993; Conner, 1991; Wernerfelt, 1984).

Acedo, Barroso and Galan (2006) indicate thirteen *RBV* documents that are the most cited in the management field. Among them two works are found to be the most influential: Wernerfelt's (1984)[15] which emphasizes resources and diversification, and Barney's (1991) that provides the most formalized depiction of firm-level Resource-Based View. Wernerfelt (1984, p. 171) coins the term Resource-Based View and begins the article with the statement: "For the firm, resources and products are two sides of the same coin", directing strategy schools toward resources as important antecedents to products. He further says that firm may enjoy above normal returns by identifying and acquiring resources critical to the development of products. In particular, he analyzes some situations in which firms could get high returns from individual resources, like for example companies enjoying resource position barriers (first mover advantages) or opportunities to trade non-marketable resources through mergers and acquisitions. Finally, by specifying a resource profile for a firm, it would be possible to find the optimal product-market activities. Barney (1991) provides the most influential framework of advantage-creating resource characteristics. Beginning with two fundamental assumptions of resource heterogeneity and immobility, he notes that firm's assets in order to be a source of sustained competitive advantage and performance, must be valuable, rare, imperfectly imitable and they cannot have any strategically equivalent substitute. While two first notations are necessary but not sufficient for sustained competitive advantage, only all four satisfied together give rise to sustainability (Figure 4).

[15] In 1994 this article was awarded the prize for the best article of *Strategic Management Journal*.

Figure 4 Resource-Based View model



Source: adapted from Barney (1991)

2.3.1.2 Recent developments

RBV has developed beyond its original Barney's (1991) formulation as a static approach into more dynamic conceptions. One important stream in the recent *RBV* analyzes how the firm develops processes for knowledge creation and is coined as the knowledge-based view (Kogut and Zander, 1992). This framework emphasizes that the central competitive dimension of the firm is to create and transfer knowledge efficiently. The main rationale for the firm existence is then the creation of conditions under which individuals can integrate their specialist knowledge (Grant, 1996). What is important is that knowledge is created and held by individuals, not organizations as a whole (Grant, 1996). Generally, knowledge is categorized into information and know-how based, and both types have the characteristics of an easy replication within organization and a difficult imitation by other firms. Knowledge as information means knowing what something means, while know-how is knowledge of how to do something (Kogut and Zander, 1992). Coordination of such knowledge is difficult and may involve a usage of many different mechanisms such as rules and directives or routines (Grant, 1996).

Acedo, Barroso and Galan (2006) point out another trend within *RBV* coined relational view by Dyer and Singh in 1998. The focus of this perspective is on interorganizational relations as competitive factors of firms. In particular four potential sources of advantage are identified: 1) relation-specific assets; 2) knowledge-sharing routines; 3) complementary resources; and 4) effective governance, which combined together give rise to relational rents (Dyer and Singh, 1998). This stream of research offers distinct, but complementary to *RBV* view of firm advantage with the main difference in the unit of analysis being network of firms.

Finally, the recent formulation of *RBV* applied to changing environments is called Dynamic Capabilities Approach (Winter, 2003; Eisenhardt and Martin, 2000; Teece, Pisano and Shuen, 1997). The roots of this framework come from questioning sustainability concept of *RBV* and its relevance in rapidly changing environments. Dynamic Capabilities Approach reflects a firm's ability to achieve new and innovative forms of competitive advantage – how new resource combinations lead to innovation and value creation. Proponents of this view assume dynamic process: strategy of accumulating valuable technology assets is often not enough to support a significant competitive advantage and companies need dynamic capabilities. Dynamic capabilities are defined as "the firm's ability to integrate, build and reconfigure internal and external competences to address rapidly changing environments" (Teece, Pisano and Shuen, 1997, p. 516). They are also included in the concept of organizational routines, in particular they are "a high-level routine (or collection of routines) that, together with its implementing input flows, confers upon an organization's management a set of decisions options for producing significant outputs of a particular type" (Winter, 2003, p. 991).

In addition, through dynamic capabilities firms achieve new resource configurations as market emerge, collide, split, evolve and die (Eisenhardt and Martin, 2000). Hence, the value of dynamic capabilities in creating competitive advantage and superior performance lies in resource configurations. Furthermore, Dynamic Capabilities Approach emphasizes the path dependence of firms' resources as their current state is affected by past history. Firms evolve along unique trajectories: each firm develops its resource base depending on its own experience. Therefore, the notion that history matters is a very important contention of Dynamic Capabilities Approach. Within research on this theoretical strand there is a discussion of the mechanisms and processes underlying the development of the firm's resources. Attention has been given to organizational learning through experience, which is considered to contribute to firm performance. Summarizing then, in Dynamic Capabilities Approach firm competitive advantage and performance outcomes are seen as resting on distinctive processes, shaped by firm resource positions and the evolution path the firm has experienced (Teece, Pisano and Shuen, 1997).

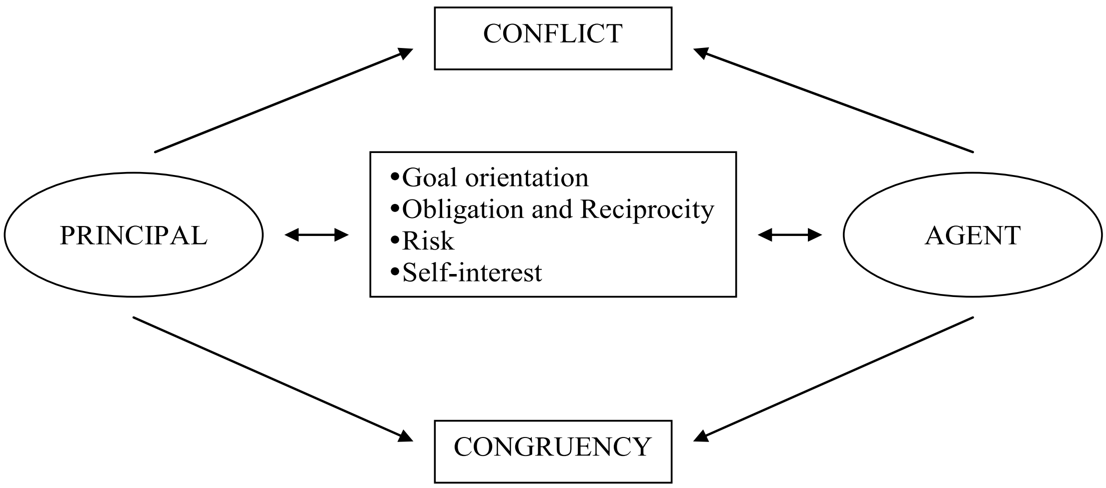
To sum up, *RBV* theory provides the arguments for intangibles as a basis for firm competitive advantage. Hence it is a potentially interesting framework to explain intangibles as a source of improved performance and efficiency of textile and clothing firms as the future of this industry is predicted in the development and deployment of these assets. However, intangible assets solely cannot explain performance differences in rapidly changing textile and clothing markets. Dynamic Capabilities Approach adds to those resources distinctive processes and evolution path firm has adopted or inherited. Firm intangible assets together with company learning through time and experience are further investigated in this dissertation.

2.3.2 Agency Theory

In the view of Agency Theory, the firm is an artificial construct under legal rules that links a set of contracting relationships between individuals (Jensen and Meckling, 1976). In the seminal paper of the theory, Jensen and Meckling (1976) defined a general agency relationship as a contract under which one person (principal) engages another person (agent) to perform some services on his or her behalf. Assuming the premise that both parties maximize their own utility, the agent will not always act in the best interest of principal. The potential conflicts which arise from the divergence of interests between agents and principals are the basis of Agency Theory and give rise to agency cost. The main focus of this framework is on contract that minimizes costs associated with agency relationship (Wright, Mukherji and Kroll, 2001).

Goal orientation, obligation and reciprocation, risk, and self-interest summarize the main components of Agency Theory (Figure 5). Principal and agent differ considering their attitude towards risk taking: principals are considered risk neutral as they are able to diversify their investment in contrast to agents whose employment is tied to one firm, hence they are risk averse. Those two parties have also different goals and different utility functions.

Figure 5 The relationship between principal and agent



Source: Wright, Mukherji and Kroll (2001)

In order to limit divergences of interest, principals need to monitor agents or make them cooperating by establishing appropriate incentive schemes. Agents are also paid in some situations (bonding costs) to ensure that they will not undertake some actions that would harm the principal. Those monitoring and bonding expenditures compose of agency costs. Jensen and Meckling (1976) add a third component of agency cost – residual loss – a remaining divergence between agent's decisions and decisions maximizing the welfare of principal. Furthermore, the theory argues that the agency contract is impacted by adverse selection and moral hazard problems. Adverse selection is the condition under which the principal cannot ascertain who the better agents are. Moral hazard refers to the fact that agents do not make all information available to principals and as a result the principal cannot be sure whether the agent has put forth maximal effort.

Jensen and Meckling (1976) identify two types of conflicts and two types of the relationships that fit the definition of agency relation. These are, on the one hand, conflicts between manager-owners and outside shareholders, and, on the other hand, conflicts between debtholders and manager-owner. Hence, three important organizational players appear in Agency Theory: manager-owner, outside shareholder and debtholder. Each of those conflicts gives rise to agency costs. Firstly, agency costs appear when owner-manager sells equity claims to outside shareholders and arise from conflicts between external shareholder and manager-owner. The theory states that the managers tend to usurp the part of firm resources for their own consumption. Secondly, the conflicts between manager-owner and debtholder are another source of agency costs. Within this view, managers have incentives to take actions for their own benefit at the expense of debtholders[16].

Summarizing, on the basis of conflicts between managers-owners, shareholders and debtholders, Agency Theory emphasizes the impact of firm financing structure on performance, a topic that has been analyzed by the previous literature, as we have seen in literature review section. Therefore, a central challenge for this perspective within textile and clothing firms concerns the need to understand the impact of firm financing on performance and efficiency. We analyze this issue further in this dissertation.

2.3.3 Institutional Theory

According to Institutional Theory, organizations that come into existence will reflect the opportunities provided by the institutional matrix (North, 1994). In particular, the framework focuses on the role of the political, social, and economic systems surrounding firms in shaping their behaviour (North, 1990, 1994).

Institutions are defined as constraints that structure human interaction (North, 1994). They consist of formal constraints (laws, constitutions, political and economic rules, and contracts), informal constraints (norms of behaviour, codes of conduct, attitudes, and conventions) and their enforcement characteristics. In this view, firms are embedded in institutional environment, where institutions are the rules of game and firms are players of this game. In addition, they provide resources for conducting transactional activities between economic actors and their main function in a society is to reduce uncertainty by establishing a stable structure for human interaction and exchange (North, 1990).

[16] It is worth observing that the agency theory can be applied to many different situations where two or more people need to cooperate, as Jensen and Meckling (1976, p. 309) pointed out: "agency costs arise in any situation involving cooperative effort".

Because institutions form the incentive structure of a society, the political and economic institutions, in consequence, are the underlying determinants of economic performance (North, 1994). Institutions represent important elements in influencing business strategies and business performance (Oliver, 1997). In accordance with North (1990) in this dissertation we develop the concept of institutions to refer to external, environmental factors that influence business performance.

Oliver (1997) suggests that Institutional Theory can be analyzed at individual, firm and inteorganizational level. At individual level institutions consist of managers' norms, habits and conformity to traditions, while firm level refers to corporate culture, belief system and political processes supporting given ways of managing structures and behaviours. Finally, interorganizational level treats pressures from governments, industry alliances and expectations of society regarding product quality or environmental management.

Drawing from the insights from Institutional Theory, in this dissertation we include external environment as impacting performance and efficiency of textile and clothing firms. In multicountry studies the relevance of external factors arises from the specificity of every region analyzed. Furthermore, in looking how the external environment moderates the relationship between internal factors and firm performance and efficiency, Institutional Theory can be an appropriate theoretical framework. We delimit ourselves to interorganizational level of this framework by analyzing the impact of country environment on firm performance. In particular we conceived of external environments as consisting of country development level and country economic integration. Because institutions define the choice set and therefore determine transaction and production costs and hence the profitability and feasibility of engaging in economic activity, one example of the institution might be integration initiatives undertaken all over the world. Furthermore, we focus on environmental differences between countries by analyzing the impact of economic development on firm performance and efficiency.

2.4 Hypotheses and model development

2.4.1 Main hypothesis – intangible assets and firm efficiency

Resource-Based View of the Firm views intangible assets as the main source of firm exceptional performance. Because intangibles are valuable, rare, mostly inimitable and non-substitutable, they are capable of generating sustainable competitive advantage and superior financial performance (Barney, 1991). In particular, those assets can be seen as the basis of firm efficiency outcomes. A number of important contributors considered Resource-Based View as a theory explaining the dispersion of firm efficiencies (Peteraf, 1993; Barney, 1991; Lippman and Rumelt, 1982), and emphasizing the building competitive advantage through rents stemming from fundamental firm-level efficiency advantages (Teece, Pisano and Shuen, 1997). In addition, Williamson (1991) coined *RBV* as a leading efficiency approach to business strategy.

According to *RBV* theory, some (efficient) firms do better than other (inefficient) firms because they are different and possess heterogeneous resources (Barney, 1991). In other words, efficiency is embedded in the creation of specialized resources and resource heterogeneity. Some authors go further on this argument explaining that uncertain imitability can particularly explain the origin and persistence of interfirm differences in efficiency (Lippman and Rumelt, 1982). The cause-effect relationship between resources and efficiency has two directions: the creation of specialized resources is based on operating efficiently, while firms with superior resources are able to produce more efficiently.

Peteraf (1993) suggested that different resources used by firms in the production process will lead to different outcomes. In particular, there will be efficiency differences across resources since some resources are superior to others. Therefore, firms with superior resources are able to produce more cost-effectively and achieve incomes. From efficiency literature perspective, González and Càrcaba (2004) argue that efficiency indicators can be interpreted through the theoretical concepts of *RBV*. They propose that technical efficiency arises from heterogeneity in resources and capabilities that are not included as inputs in efficiency computation. Those resources are connected with motivation, knowledge and use of superior inputs. Summarizing then, intangibles are positively related to firm performance outcomes from theoretical point of view, in particular they have a positive impact on firm efficiency.

In general, the large body of empirical research analyzing the impact of intangibles on performance proves this main contention of *RBV* (Chen, Cheng and Hwang, 2005; Li and Wu, 2004; Riahi-Belkaoui, 2003; Delios and Beamish, 2001; Bontis, Keow and Richardson, 2000; Bontis, 1998). Most of the studies report positive association between intangibles and different performance measures in heterogeneous industrial sectors. On the other hand, however, Villalonga (2004) indicated that the relation between intangibles and performance might vary between sectors and intangibility measurements as the negative associations for some subsamples and for some intangibles indicators were found. In this way the study suggests that intangibles can also lock firms into a kind of disadvantage. Furthermore, Firer and Williams (2003) show that the relationship between intellectual capital components and firm performance is limited in South African context. The findings suggest that still tangibles remain the most significant underlying resource of corporate performance. In addition, in the new ventures' context Juma and Payne (2004) show that although intangibles are related to performance, this relationship is varying and difficult to interpret. In particular, the study reported that the relationship between intangibles and performance is negative for some intangibles measurement (Economic Value Added *EVA*) and performance indicators (Return on assets *ROA*), while positive for others (Market to book value and Return on investment *ROI*).

Although the empirical research on the relationship between intangibles and performance is to some extent inconclusive, the context of the textile and clothing industry provides the arguments in favour of positive relationship. The companies in this sector struggle to survive and attempt to find a niche in international markets by investing in new technologies, developing new products and orienting themselves on the market and customer that is influencing on the broadly defined intangible assets (Stengg, 2001; Mittelhauser, 1999). Firms' owners are conscious that only through the development of intangibles the enterprises can improve performance outcomes. The example of Spanish clothing holding Inditex with the most known brand Zara confirms this contention by showing that firm success is conditioned on the capacity for continuous adaptation of products to customer needs with short-term adaptation to changing trends (Mazaira, González and Avendaño, 2003). Zara stores are stocked with new articles several times a week and it takes only three weeks for the company to make a new line from start to finish, while an industry average is nine months (Owen, 2001).

Hence, the first hypothesis is that intangible assets are positively associated with firm performance as measured by efficiency, and is posited as:

H_1: Intangible assets have a positive effect on efficiency of textile and clothing firms

2.4.2 Impact of other internal factors on firm efficiency

Leverage and efficiency

The early theorem of Modigliani and Miller (1958) suggested that the financial structure has no influence on the firm value. They demonstrated that in the absence of bankruptcy costs and tax subsidies on the payment of interest, the value of the firm is independent on its financial structure. The later theoretical works, however, shown that this theory is incomplete and provided arguments in favour of a non-neutral impact of financial structure on firm performance[17]. In particular, Agency Theory focuses on costs arising from conflicts between managers-owners and debtholders as well as between managers-owners and outside shareholders and predicts both negative and positive association between leverage and efficiency.

On the one hand, according to Agency Theory, the issuing of debt causes the agency costs, which in turn reduce firm value (Jensen and Meckling, 1976). The source of agency costs in this case are conflicts of interest between managers-owners and debtholders, which impact the value of the firm. Jensen and Meckling (1976) mention 3 major components of the agency costs of debt: 1) incentive effects associated with highly leverage firms; 2) monitoring and bonding costs; 3) bankruptcy costs. With debt issuing the manager will have a strong incentive to engage in riskier activities than

[17] For the review of the most important theories developed to explain firm financial structure it is useful to look at Myers (2001).

debtholders would prefer, which offer very high payoffs when successful, but also have a low probability of success. If investment goes well, the manager receives all gains, but if it goes badly, the debtholder will pay the consequences. The result of this overinvestment in risky projects is a reduced value of the firm.

On the other hand, Myers (1977) demonstrated that the existence of debt can weaken the firm incentives to undertake good future investments because they will benefit only debtholders, not shareholders. Again, this will cause the firm value to decrease. Furthermore, the costs of monitoring the debt that is of establishing debt provisions are incurred and transferred from debtholders to managers-owners. A consequence is, once again, the decrease in firm value.

Finally, the third element of agency cost of debt is bankruptcy cost which increases with rise in debt. That also makes the total value of the firm to fall. Higher agency costs will presumably have an adverse effect on efficiency of the firm. On the basis of Agency Theory then, highly indebted textile and clothing firms bear high costs from receiving credit, tend to under- or overinvest or have the higher possibility of liquidation, and as a consequence efficiency is reduced. That is the theoretical predictions of Agency Theory resulting from the conflicts between managers-owners and debtholders suggest that the relationship between leverage and efficiency is negative.

On the other hand, however, Agency Theory provides arguments in favour of positive relationship between leverage and efficiency as high leverage reduces the agency costs of outside equity. The conflicts of interest between managers-owners and outside shareholders give rise to agency costs. The theory states that the managers tend to minimize their effort as they have their own objectives. Debt issuing, however, puts a pressure on managers to perform better, as Jensen (1986, p. 324) paid attention to the "benefits of debt in motivating managers and their organizations to be efficient". Hence, debt encourages managers to act more in the interests of shareholders. Therefore, in this view debt has a positive effect on firm efficiency.

Summarizing then, Agency Theory gives contradictory views on the relationship between leverage and efficiency. As such the theory predicts that there might exist some optimum of leverage, where agency costs of outside equity and agency costs of debt are minimized. The theory suggests, therefore, that the relationship between leverage and efficiency might not be lineal. The empirical research, however, does not provide the consistent view in this matter. Pushner (1995) found a strong negative relationship between leverage and total factor productivity in Japan, while Majumdar and Chhibber (1999) revealed the same relation sign between leverage and profitability for Indian firms. Weill (2008) suggested the impact of institutional factors on the relationship between leverage and efficiency and found a significantly positive relation for some countries in the sample (Belgium, France, Germany and Norway), positive but not significant for one country (Portugal) and negative for other countries (Italy and Spain). On the other hand, Margaritis and Psillaki (2007) for an extensive sample of New Zealand firms found that higher leverage is associated with improved efficiency. Within the studies in the textile and clothing sector, in general the relationship between the usage of external funds and efficiency is found to be negative (Aras, 2006; Kim, 2003). All those inconclusive results leave the subject still open to academic debate.

The majority of studies, especially those conducted in the textile and clothing sector, have reported a negative relationship. Therefore, we hypothesize that:

H_2: Leverage has a negative impact on efficiency of textile and clothing firms

Learning by experience and efficiency

According to the Dynamic Capabilities scholars, firms do not only compete on their ability to exploit their existing intangibles, they also compete on their ability to renew and develop those resources (Teece, Pisano and Shuen, 1997). Intangible assets evolve through cumulative firm experience and learning by this experience[18] (Dierickx and Cool, 1989). That is the development of firm resources requires learning and experience. In other words, firm stock of intangible assets is influenced by the past choices. Dynamic Capabilities Approach emphasizes the role of path dependence that defines the possibilities which are open to the firm today, as well as it puts bounds for future activities (Teece, Pisano and Shuen, 1997). Company history in turn exerts

[18] Other terms that are used in literature include: learning by doing, learning by using, learning before doing.

significant influences on firms' growth strategies and organizational structure. Firm previous investments and routines constrain its future behaviour because opportunities for learning will be restricted by former activities.

Learning is defined as a process which enables tasks to be performed better and quicker through repetition and experimentation (Teece, Pisano and Shuen, 1997). In addition, firm learning allows identifying new production opportunities and creates knowledge residing in new patterns of firm activity, in its routines. Technically, learning by experience refers to the phenomenon when manufacturing costs fall as manufacturing experience increases (Hatch and Dyer, 2004). Learning is a dynamic concept (Bhatt and Grover, 2005). It builds on the past knowledge and experience which makes it path dependent (Stata, 1989). Learning which is properly managed occurs as a function of time (Stata, 1989). It involves accumulation, sharing and application of knowledge (Bhatt and Grover, 2005). At the same time, learning results are knowledge and expertise or competence.

System of learning constitutes dynamic capabilities (Teece, Pisano and Shuen, 1997). It is an example of dynamic capabilities, since these systems are fundamental to the ability of organizations to innovate and to adapt to changes in technology and markets, including the ability to learn from mistakes (Helfat and Raubitschek, 2000). Learning guides the evolution of dynamic capabilities and underlies the path dependencies (Eisenhardt and Martin, 2000). The processes involved in a firm's system of evolutionary learning can be classified into the categories of variation, selection, and retention which characterize any decision-making or problem-solving activity (Teece, Pisano and Shuen, 1997).

Firm performance improves over time as companies gain experience and learn by this experience. Because learning is heterogeneous across firms, thereby it is a source of competitive advantage in the present global environment. The learning organizations should have an advantage in enacting their environments as well as responding and adapting to external environmental change (Senge, 1990). Learning contributes to the effectiveness of firms resources for their competitiveness. It is considered to increase a firm's problem-solving capacity and to improve performance. Nevertheless, there are two sides of the same coin, as learning can act both as a source of superior performance and as a constraint. In the case of a radical change, already accumulated knowledge and the path dependence of learning can “lock in” the firm to an unfortunate future (Dosi and Teece, 1993). There is no guarantee that cumulative past experience and learning will fit to solve new problems. Firms might get “stuck” in their past and fail to solve new problems.

From empirical point of view, performance impact of organizational learning has supporting findings from a number of studies. Pisano (1994) found that learning by doing was advantageous in pharmaceutical industry. Singh and Zollo’s (1998) research illustrates the role of repeated practice. The authors found that it led to increased performance of bank acquisitions. Furthermore, Jiang and Li (2008) suggest a strong, positive relationship between organizational learning and financial performance in the context of strategic alliances. In the same setting, Emden, Yaprak and Cavusgil (2005) confirmed that learning from past experiences is an important factor enhancing firm performance. Haleblian and Finkelstein (1999) explored the relationships between acquisition experience and acquisition performance. The study reported that managers with extensive experience were able to notice similarities and differences between current and previous acquisitions, and so apply their acquisition skills in a more discriminatory manner that was associated with superior performance. In contrast, managers with moderate experience had less refined acquisition capabilities. Bontis, Crossan and Hulland (2002) found the support for the premise that there is a positive relationship between the stocks of learning and business performance at individual, group and organizational level.

At the same time, however, some empirical studies conclude that learning itself does not cause differential firm performance. Zott (2003) in his simulation study confirmed the direct and indirect effect of learning on the emergence of differential intraindustry firm performance. Learning affects performance indirectly by determining the magnitude of the cost of resource deployment. The study also revealed that path dependencies associated with the learning of resource deployment foster the emergence of differential firm performance, but they do not always obtain. Bhatt and Grover (2005) failed to support that higher level of the intensity of organizational learning alone would have a positive effect on competitive advantage and performance of the firm. The study concluded that knowledge itself may not directly affect the competitiveness of the firm unless this knowledge is assimilated with existing knowledge. That is only through path specific knowledge can learning lead to competitive advantage. Learning is found to impact competitive advantage through its manifestation in the form of firm capabilities.

Summarizing, learning is found to be responsible for positive performance outcomes. In particular, basing on Dynamic Capabilities Approach, learning leads to efficiency differences between firms (Teece, Pisano and Shuen, 1997). Learning by experience effects make firms more efficient as a result of their growing stock of experience. Therefore, we predict a positive relationship between learning and efficiency, and third hypothesis is conjectured as:

H_3: Learning by experience has a positive impact on efficiency of textile and clothing firms

2.4.3 Influence of external factors on firm efficiency

Economic development and efficiency

Economic development is concerned with the levels and rates of growth in living standards in rich and poor countries (Jacobs, Kalai and Kamien, 1998; Lucas, 1988). Elaborating on that, the widely accepted definition of economic development emphasizes the process whereby the real per capita income of a country increases over a long period of time assuming that the number of people below the poverty line does not increase, and that the distribution of income does not become more unequal (Meier, 1995). Therefore, the main goal of economic development is the increase in the real income per capita of countries. However, the multidimensionality of economic development should be recognized and its subgoals such as: alleviation of poverty, diminution of inequality, improvement in standard of living or development of human capabilities (Meier, 1995). *World Bank* defines economic development as a qualitative change and restructuring in a country's economy connected with technological and social progress. According to this definition the main indicator of economic development is increasing *GDP* per capita, which reflects an increase in the economic productivity and average material wellbeing of population.

In recent years economic development has become a fruitful area of research in macroeconomics. Many studies have focused on identifying the determinants of economic growth and development, considering efficiency of different sectors as a contributing factor, mostly banking efficiency (Botrić and Slijepčević, 2008; Harrison, Sussman and Zeira, 1999). From efficiency literature perspective, however, reverse causality is also postulated that is economic growth as a factor enhancing efficiency of firms. Efficiency generally improves with economic growth and development. Hence, economic development has a positive impact on enterprises that is in more developed countries, companies experiencing better conditions tend to perform better. Economic development is positively correlated with the level of infrastructure and human capital, which in turn positively affect the efficient use of resources in firms. Micro performance depends on macro performance of economies, and many studies concluded that the ability of a country to improve the standard of living affects the efficiency performance of its firms. For example, Afonso and Aubyn (2006) found that higher *GDP* per capita results in more efficiency in secondary education. Guran and Tosun (2008) study concluded that there is a positive relationship between efficiency of public sector and the level of country economic development. Likewise, Stavárek (2006) for banking sector found that a higher degree of economic development goes hand in hand with higher efficiency.

In total, we hypothesize that:

H_4: Economic development has a positive impact on efficiency of textile and clothing firms

Economic integration and efficiency

Economic integration is defined as an institutional combination of separate national economies into larger economic blocks or communities (Robson, 1998). It is also seen as a gradual elimination of economic frontiers between independent states; as a result the economies of those states function as one entity (Molle, 1994). Economic integration can take the variety of forms: customs unions, free trade areas, common markets, monetary unions and economic and monetary unions. Over the last decades formal barriers to trade and capital flows between countries were substantially reduced and many different integration initiatives were undertaken. The most important bloc of economic integration nowadays is European Union (*EU*). It rests on a common market with a common external tariff and trade policy and freedom for movement for labour and capital. Recently, it has been introduced the monetary union between some members of the block. Another very important contemporary initiative is a free trade agreement between the USA, Canada and Mexico (*NAFTA*).

The textile and clothing firms in countries integrated economically are impacted by integration initiatives as, for example, they are faced with necessities to adapt to technical requirements aimed at protecting environment or customer. In general economic integration is concerned with efficiency gains in resource use on a regional basis (Robson, 1998). Those gains are achieved by encouraging specialization amongst the member countries on the basis of competitive advantage. The countries can make better use of their resources and benefit from economies of scale. In economics it is believed that international economic integration tends to increase the long-run rate of growth (Rivera-Batiz and Romer, 1991) and efficiency within the economy (Fujita and Thisse, 2003). For example, *EU* integration benefits by combined effects of better market entry and increased competition, more innovation, learning and economies of scale amounted to about 6% of *GDP* (Molle, 1994). At the same time, however, it is often argued that the integration might be accompanied by the appearance of core regions whose wealth is obtained at the expense of peripheral regions (Fujita and Thisse, 2003). Moreover, the elimination of trade barriers between member countries often involves the occurrence of obstacles against the rest of world (Maudos, Pastor and Seranno, 1999). That is the positive effect of integration reveals when domestic production is replaced by imports from another more efficient country, and the negative impact when a third country is replaced by a less efficient member country.

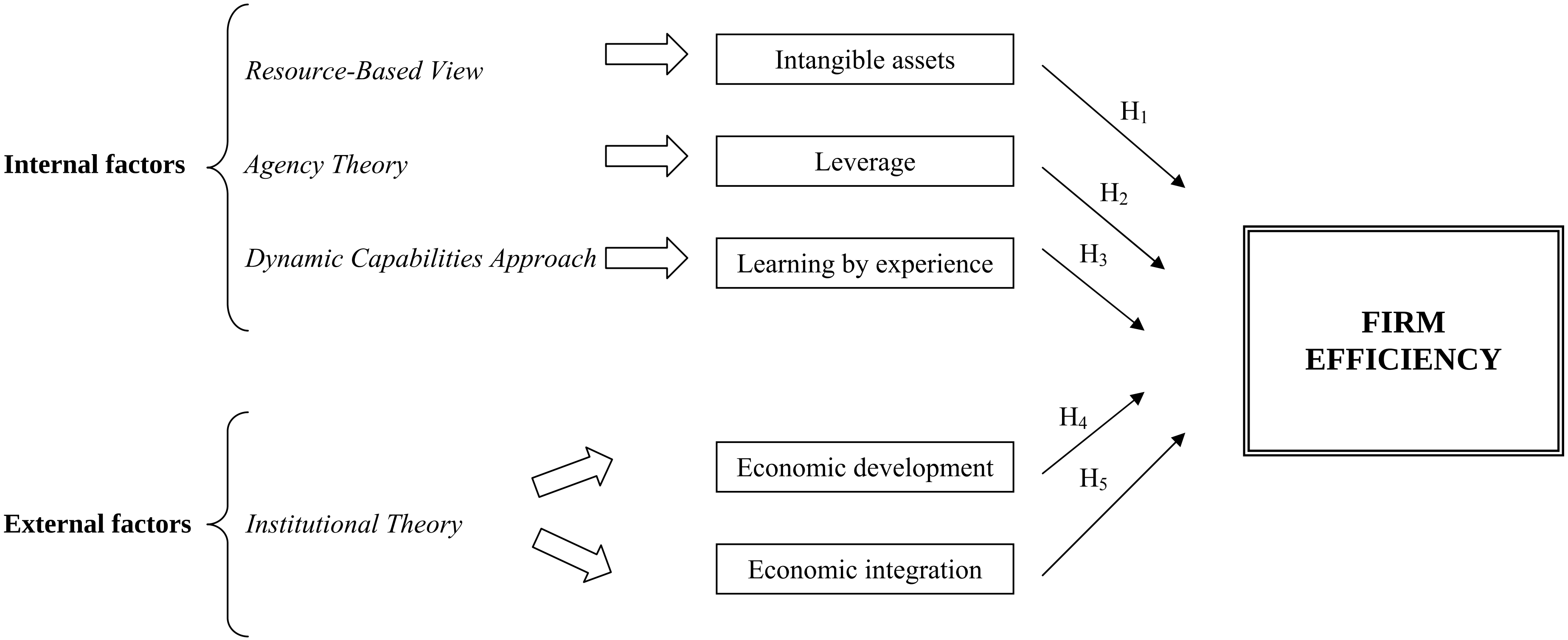
Empirical research on the impact of economic integration on efficiency of firms in general reports a positive relationship. Stavárek (2006) concluded a positive impact of *EU* integration on banking efficiency. The results of Maudos, Pastor and Seranno (1999) indicated that phases of *EU* integration until 1990 were beneficial for all participants that is the countries experienced gains in efficiency and a positive growth of total factor productivity. De Hoyos and Iacovone (2008) shown that *NAFTA* contributed to cumulative increase of 8% in labour productivity in Mexico, while Ramirez-Urquidy and Mungaray (2003) found efficiency improvements in north regions of Mexico, mainly in the manufacturing sector and the service industries. On the other hand, Kasman and Yildrim (2006) did not find strong and consistent efficiency gains in banking sector of Central and Eastern European countries after integration with *EU*. Also experience of *NAFTA* is sometimes challenged, especially with regard to benefits of Mexico. Within this line Feils and Rahman (2008) found that the benefits of *NAFTA* can be attributed only to the USA and Canada. All those results leave the subject still open to academic debate.

The majority of studies have reported a positive relationship between economic integration and efficiency. The hypothesis is thus as below:

H_5: Economic integration has a positive impact on efficiency of textile and clothing firms

The following figure summarizes the hypotheses developed.

Figure 6 A model of relationships among intangible assets, other internal factors, external variables and efficiency: Hypotheses.



CHAPTER 3

Methodology

3 Methodology

In this chapter we elaborate on the methodological aspects of this dissertation. First of all, we explain in details the construction of the database of firms in the textile and apparel industry. We describe the sources of the data, the type of information derived, the modifications undertaken in order to make the data comparable between countries and years, and finally we outline the structure of the database. Then we explain the methods used in the empirical part of present work: static analysis of efficiency, productivity and efficiency evolution over time, and regression. We illustrate the ideas behind efficiency valuation by using simple graphs and mathematical concepts. Finally, we present the operationalization of variables applied in all parts of empirical investigations.

3.1 Database

3.1.1 Sources of information

The dissertation is based on the original database of firms in the textile and apparel industry worldwide. The following sources were linked together in order to create it:

1) *COMPUSTAT* - a database covering publicly traded companies in more than 80 countries, representing over 90% of the world's market capitalization, elaborated by Standard & Poor company;

2) *DATASTREAM* - a dataset containing a vast number of economic, company and financial data from both developed and emerging markets, supplied by various sources both nationally and internationally, like *OECD*, *EUROSTAT* or national stock exchanges;

3) *OSIRIS* - a comprehensive database of listed companies, banks and insurance companies around the world, containing the information on over 46000 firms in more than 190 countries.

The harmonization of these three data sources required the definition of some identification criteria. As all databases reveal the identification of firms in the form of codes recognized internationally, we use them as linking variables. Therefore, *DATASTREAM* and *OSIRIS* were combined using *ISIN* code[19], while *COMPUSTAT* and *OSIRIS* using *SEDOL* code[20]. Only *DATASTREAM* and *COMPUSTAT* were matched comparing the company name as identification codes do not repeat in both databases. If the firm appeared in two databases, we included in the sample the company from a database which provided more information on the variables of interest.

Further, firms were divided into two representations of textile and apparel branches. *COMPUSTAT* and *OSIRIS* already split the companies into those categories: *COMPUSTAT* uses the classification similar to *SIC* code[21], while *OSIRIS* is based on *NACE* Rev. 1.1 code[22]. The more problematic case represent *DATASTREAM* which puts all firms into one general category "Clothing and accessories" following *ICB* classification[23], and division by industry was obtained using: 1) the extended business description provided by this database to find out from which branch firm obtains the greatest revenues; or 2) firms' webpages.

The main criterion to choose firms was the availability of data for the variables required for the analysis. Basically, three types of information for ten-year period 1995-2004 were extracted from those databases:

- Accounting data that is each individual firm financial statements (balance sheets and profit and loss accounts);
- Data from the stock exchange that is market value of each individual firm;
- Firm-specific information that is a number of employees and a year of company establishment.

[19] *ISIN* (International Securities Identifying Number) is a 12-character alpha-numerical code used for the identification of securities.

[20] *SEDOL* (Stock Exchange Daily Official List) is a 7 digit number used to identify listed firms.

[21] *SIC* (Standard Industrial Classification) is a 4-digit number that identify a company's primary business that is industry from which the company derives its greatest revenue. In *COMPUSTAT* number 2290 represents "Apparel and Accessories", while number 2500 refers to "Textiles".

[22] *NACE* Rev. 1.1 is a classification of economic activities used by *EUROSTAT* and published in 2002. It is an extension of *ISIC* Rev. 3 activity representation created by the United Nations. According to this classification number 17 represents "Manufacture of textiles", while number 18 refers to "Manufacture of wearing apparel, dressing and dyeing of fur".

[23] *ICB* (Industry Classification Benchmark) is a classification standard for trading and investment decisions created by Dow Jones Indexes and FTSE. The category of "Clothing and accessories" (3763) falls under Consumer Goods (3000) – Personal and Household goods (3700) – Personal goods (3760).

Because the databases did not provide the complete information on a company's year of establishment, in some cases we needed to search this variable from firms' webpages. Final task was to match together those variables between different databases, for which purpose we use the variables descriptions provided by the sources.
To sum up, the usage of multiple sources implied a considerable amount of work devoted to harmonize data.

3.1.2 Purchasing power parity versus exchange rate

The data originally extracted from databases was expressed in thousands of national current prices. To make the information comparable across countries and time the challenge was to modify it to obtain the common currency (the USA dollar) and the constant prices measures.

In principle the literature provides two different methods for obtaining the data in common currency. International comparisons of productivity have used either market exchange rates or purchasing power parity (*PPP*). Former studies translated local currencies to a common currency using exchange rates as of the end of each year (Pastor, Pérez and Quesada, 1997; Allen and Rai, 1996). However, nowadays the traditional approach of using exchange rates is well known to be unsatisfactory for a number of reasons. Firstly, exchange rates do not indicate the comparative value of currencies in the production of all services. In principle, they refer only to goods or services that are tradeable. Moreover, exchange rates are a subject to a substantial short term fluctuations and capital movements. As a result they may be substantially misleading when used to convert output to a common currency (Van Ark, Monnikhof and Mulder, 1999).

Recent evidence suggests that purchasing power parity (*PPP*) is a better basis for comparison than exchange rates and contemporary studies apply these indexes for comparison of productivity between countries (Yeaple and Golub, 2007; Ball et al., 2001; O'Mahony and Oulton, 2000; Van Ark, Monnikhof and Mulder, 1999; Jorgenson, 1995). *PPP* represents the number of currency units required to buy the goods equivalent to what can be bought with one unit of the currency of another country. For example, purchasing power parity of Polish zloty to the USA dollar for a specific output in the industry is the number of zloty required in Poland to buy an amount of the industrial output that would cost 1 dollar in the USA. As opposite to market exchange rates, purchasing power parities reflect prices of goods and services that make this output. Because of this characteristic, we can talk about the consensus that the statistical problems connected with using *PPP* when making international comparisons are much smaller than those associated with using exchange rate. Therefore, for our data we applied *PPP* of local currency to the USA dollar. The source for *PPP's* was *World Bank*.

PPP obtained was expressed in current prices and in this form was applied only for variables used to obtain *DEA* efficiency coefficients. For the rest of variables (including input-output specification for Malmquist), *PPP* was further modified in order to get constant measures. Constant *PPP's* for 1995-2004 period taking as a reference a year 1995 were computed using following formulas:

$$\begin{aligned}
&PPP_{CONSTANT\,1995} = PPP_{CURRENT\,1995} \\
&PPP_{CONSTANT\,1996} = PPP_{CURRENT\,1996} \cdot \frac{I_{COUNTRY\ X\ 1996}}{I_{USA\,1996}} \\
&PPP_{CONSTANT\,1997} = PPP_{CURRENT\,1997} \cdot \frac{I_{COUNTRY\ X\ 1997}}{I_{USA\,1997}} \\
&\vdots \\
&PPP_{CONSTANT\,2004} = PPP_{CURRENT\,2004} \cdot \frac{I_{COUNTRY\ X\ 2004}}{I_{USA\,2004}}
\end{aligned} \qquad \textbf{(33)}$$

where: I – price index of country under consideration in analyzed year.

The following hierarchy of price indexes was used:

1° the producer price index (all countries except China, France, Jordan, Portugal, Turkey and the USA), obtained from International Monetary Fund (*IMF*);

2° the producer price index for manufacturing (France, Portugal, Turkey and the USA), supplied by *OECD*;

3° the *GDP* deflator if none of the previous indexes was available (the case of China and Jordan), taken from *World Bank*.

The special cases in our database present Bermuda, Cayman Islands and Taiwan. Because for those countries *PPP* was not available, we have followed the traditional procedure of first applying price index deflators (*GDP* deflators) and then exchange rates of local currency to the USA dollar. The data for price indexes and exchange rates was taken from Taiwan Directorate General of Budget, Accounting and Statistics (http://eng.dgbas.gov.tw), Cayman Islands Economics and Statistics Office (http://www.eso.ky) and Bermuda Government site (http://www.gov.bm).

Current and constant Purchasing Power Parities from 1995 to 2004 per country are reported in Appendices 1 and 2. Price indexes from 1995 to 2004 per country are presented in Appendix 3.

3.1.3 Outliers detection and final database

In the next step, the database was modified to control for outliers. It is common knowledge that analyses of efficiency with *DEA* are very sensitive to the presence of outliers in the sample. This is because the extreme points that determine the efficiency frontier could affect the marginal rates of the rest of firms. Wilson (1993) names outliers as atypical observations, which result from recording or measurement error. Outliers should be corrected, if possible, or deleted from the data. Barnett and Lewis (1984) define an outlier in a set of data as an observation or subset of observations which appear to be inconsistent with the reminder of that set of data. In other words, whether we declare an observation to be an outlier depends on how it appears in relation to the postulated distribution of all observations in the sample. Grubbs (1969, p.1) pointed that “an outlying observation, or outlier, is one that appears to deviate markedly from other members of the sample in which it occurs”. Barnett and Lewis (1984) mention two reasons for outliers’ occurrence. Firstly, they may have arisen for a deterministic reason that is as a result of human error and ignoring (a reading, recording or calculating error in the data). If such situation is present, the only one remedy is to remove those values from the sample or replace them by corrected values when the method of correction is unambiguous.

The second situation is when the outlier is of random or inexplicable nature. As such it has to be assessed in relation to the variation properties of any random sample generated by assumed probability model. In other words, processing with outliers in such case depends on the assumed underlying distribution and is a matter of statistical analysis. Taking those two reasons outliers may be categorized as from identifiable and no identifiable source.

We assume that the distribution of the observations in our sample is normal and we detect outliers by cutting in the tails of this distribution. For this purpose we use the median and the lower and upper quartiles to construct the intervals for outlier detection. If the lower quartile is *Q1* and the upper quartile is *Q3*, then the difference *(Q3 - Q1)* is called the interquartile range or *IQ*. The median is an estimator of location, while the interquartile range is a measure of distribution dispersion. The following quantities are needed for identifying extreme values in the tails of normal distribution[24]:

*Median -3*IQ*

*Median +3*IQ*

All observations beyond the quantities on both sides are considered as outliers. Note that median and interquartile range are computed for ratios output/input of *DEA* and Malmquist, separately for every year studied. The detailed measurement of *DEA* inputs and outputs is explained later on.

In total, for the entire period between 1995 and 2004 the data availability and the outlier detection allow to obtain 5477 and 4982 observations for *DEA* and regression, and Malmquist analysis, respectively. All firms are listed on the stock exchange and the resulting panel is unbalanced. The distribution of firms between textile and apparel industry and geographical coverage is presented in Tables 8-11. The detailed distribution of the sample between countries for *DEA*, regression and Malmquist analysis is presented in Appendix 4 and 5.

[24] Such method of identifying outliers is widely used by statistical offices, for example by the Basque Statistics Office.

Table 8 Sample for *DEA* and regression analysis – sectoral distribution

Sector	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	TOTAL 1995-2004
Total Textile	128	135	147	163	206	272	317	402	442	464	**2676**
Total Clothing	144	149	175	189	220	317	351	394	421	441	**2801**
TOTAL	**272**	**284**	**322**	**352**	**426**	**589**	**668**	**796**	**863**	**905**	**5477**

Table 9 Sample for *DEA* and regression analysis – regional distribution

Region	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	TOTAL 1995-2004
Asia	113	112	127	141	201	264	325	421	474	503	**2681**
Europe	84	92	100	103	108	180	183	199	195	197	**1441**
North America	66	72	81	96	99	121	134	138	145	145	**1097**
Middle and South America	7	5	11	9	15	18	18	30	40	48	**201**
Rest of world	2	3	3	3	3	6	8	8	9	12	**57**
TOTAL	**272**	**284**	**322**	**352**	**426**	**589**	**668**	**796**	**863**	**905**	**5477**

Table 10 Sample for Malmquist analysis – sectoral distribution

Sector	1995/1996	1996/1997	1997/1998	1998/1999	1999/2000	2000/2001	2001/2002	2002/2003	2003/2004	TOTAL 1995-2004
Total Textile	152	167	185	192	249	287	310	411	448	**2401**
Total Clothing	170	185	212	232	269	331	355	402	425	**2581**
TOTAL	**322**	**352**	**397**	**424**	**518**	**618**	**665**	**813**	**873**	**4982**

Table 11 Sample for Malmquist analysis – regional distribution

Region	1995/1996	1996/1997	1997/1998	1998/1999	1999/2000	2000/2001	2001/2002	2002/2003	2003/2004	TOTAL 1995-2004
Asia	120	132	144	154	224	295	350	448	498	**2365**
Europe	120	131	137	138	155	172	165	190	185	**1393**
North America	73	79	102	117	123	133	130	133	143	**1033**
Middle and South America	7	7	9	10	12	14	13	30	38	**140**
Rest of world	2	3	5	5	4	4	7	12	9	**51**
TOTAL	**322**	**352**	**397**	**424**	**518**	**618**	**665**	**813**	**873**	**4982**

We see from tables that our sample is equally distributed between textile and clothing firms. That is 51% out of all observations for the entire period for *DEA*, regression and Malmquist analysis represent clothing industry, the rest being textile firms. The majority of firms come from the USA, Japan, China and Korea (see Appendix 1 and 2). The regions mostly represented in our database are Asia, North America and Europe. It is worth pointing out that the geographical distribution of our sample presented in Table 9 and 11 represents the real population as the majority of world production in textiles and clothing comes firstly from Asia, then from Americas and Europe (Stengg, 2001). Hence, our sample is representative at the world level.

3.2 Methods of data analysis

In order to reach our research objectives, our methods of analysis involve three separate sections: computation of static efficiency indicators for each firm in the sample, regression of those measures on the set of explanatory variables to test the hypotheses, and computation of dynamic notion of productivity to assess performance changes over time. Each of those steps involves application of some estimation methods which are described hereafter.

3.2.1 Benchmarking firm efficiency in static terms

Efficiency can be represented by distance function. In order to introduce mathematical notations of this function, we begin by defining the production technology of the firm. The mathematical formulations that follow are based on Fried, Lovell and Schmidt (2008) and Shepard (1970).

Consider the case where we have the production unit that uses n inputs $x = (x_1,...,x_n) \in R_+^n$ to produce m outputs $y = (y_1,...,y_m) \in R_+^m$. Shepard (1970) has proven that production technology can be represented by the production set:

$$T = \{(\mathbf{y},\mathbf{x}) : \mathbf{x}\ can\ produce\ \mathbf{y}\} \qquad \textbf{(1)}$$

as well as by the inputs sets:

$$L(\mathbf{y}) = \{\mathbf{x} : (\mathbf{y}, \mathbf{x}) \text{ is feasible}\} \quad \textbf{(2)}$$

For every $\mathbf{y} \in R_+^M$ the production technology has an isoquant:

$$IsoqL(\mathbf{y}) = \{\mathbf{x} : \mathbf{x} \in L(\mathbf{y}), \omega\mathbf{x} \notin L(\mathbf{y}), \omega \in [0,1)\} \quad \textbf{(3)}$$

and an input efficient subset:

$$EffL(\mathbf{y}) = \{\mathbf{x} : \mathbf{x} \in L(\mathbf{y}), \mathbf{x}' \notin L(\mathbf{y}), \mathbf{x}' \leq \mathbf{x}\} \quad \textbf{(4)}$$

The sets (2), (3) and (4) satisfy: $EffL(\mathbf{y}) \subseteq IsoqL(\mathbf{y}) \subseteq L(\mathbf{y})$.

Regarding the properties satisfied by the technology *T*, it is assumed that it is a convex, closed set and that inputs and outputs are freely disposable[25].

Shepard (1970) introduced the input distance function measure defined as follows:

$$D_I(\mathbf{y}, \mathbf{x}) = \max\{\lambda : (\mathbf{x}/\lambda) \in L(\mathbf{y})\} \quad \textbf{(5)}$$

where λ is a value of the input distance function.

The input distance function considers by how much the input vector may be reduced with the output vector held fixed. For all input vectors ***x*** which are the elements of the feasible production set *L(**y**)*, the value of the input distance function is greater than or equal to unity, that is $D_I(\mathbf{y}, \mathbf{x}) \geq 1$ if $\mathbf{x} \in L(\mathbf{y})$. For all ***x*** located on the isoquant $IsoqL(\mathbf{y})$ the input distance function takes the value of unity, that is if $\mathbf{x} \in IsoqL(\mathbf{y})$ then $D_I(\mathbf{y}, \mathbf{x}) = 1$, and the point *(**x,y**)* is said to be an input-efficient.

The Debreu-Farrell input-oriented measure of technical efficiency is described by:

$$TE_I(\mathbf{y}, \mathbf{x}) = \min\{\theta : \theta\mathbf{x} \in L(\mathbf{y})\} \quad \textbf{(6)}$$

[25] For the detailed list of assumptions regarding production technology see Shepard (1970, p. 14)

where θ is the value of input-oriented technical efficiency.

The input-oriented technical efficiency gives the maximum proportional reduction of inputs given the observed output level. The value of this index is always equal or smaller than unity, $TE_I(\mathbf{y},\mathbf{x}) \leq 1$. From (5) and (6) we can conclude that the input-oriented technical efficiency θ is the reciprocal of the input-oriented distance function λ:

$$TE_I(\mathbf{y},\mathbf{x}) = \frac{1}{D_I(\mathbf{y},\mathbf{x})} \quad \textbf{(7)}$$

Let's replicate the above logic for the output-oriented efficiency measurement.
Production technology can be represented by the output set:

$$P(\mathbf{x}) = \{\mathbf{y} : (\mathbf{x},\mathbf{y}) \ is \ \ feasible\} \quad \textbf{(8)}$$

and its isoquant as:

$$IsoqP(\mathbf{x}) = \{\mathbf{y} : \mathbf{y} \in P(\mathbf{x}),\ \mu\mathbf{y} \notin P(\mathbf{x}),\ \mu > 1\} \quad \textbf{(9)}$$

While an output efficient subset:

$$EffP(\mathbf{x}) = \{\mathbf{y} : \mathbf{y} \in P(\mathbf{x}),\ \mathbf{y}' \notin P(\mathbf{x}),\ \mathbf{y}' \geq \mathbf{y}\} \quad \textbf{(10)}$$

Therefore, the output distance function is defined as:

$$D_O(\mathbf{x},\mathbf{y}) = \min\{\psi : (\mathbf{y}/\psi) \in P(\mathbf{x})\} \quad \textbf{(11)}$$

where ψ is a value of the output distance function.

The output distance function looks at how the output vector many be proportionally augmented with the input vector held fixed. The output distance function takes the maximum value of unity if and only if $\mathbf{y} \in IsoqP(\mathbf{x})$, and unit ***(x,y)*** is said to be output-efficient. Otherwise, its value is smaller than unity for every $\mathbf{y} \in P(\mathbf{x})$.

The Debreu-Farrell output-oriented technical efficiency is a reciprocal of output distance function and is defined as:

$$TE_O(\mathbf{x},\mathbf{y}) = \max\{\phi : \phi\mathbf{y} \in P(\mathbf{x})\} \qquad \textbf{(12)}$$

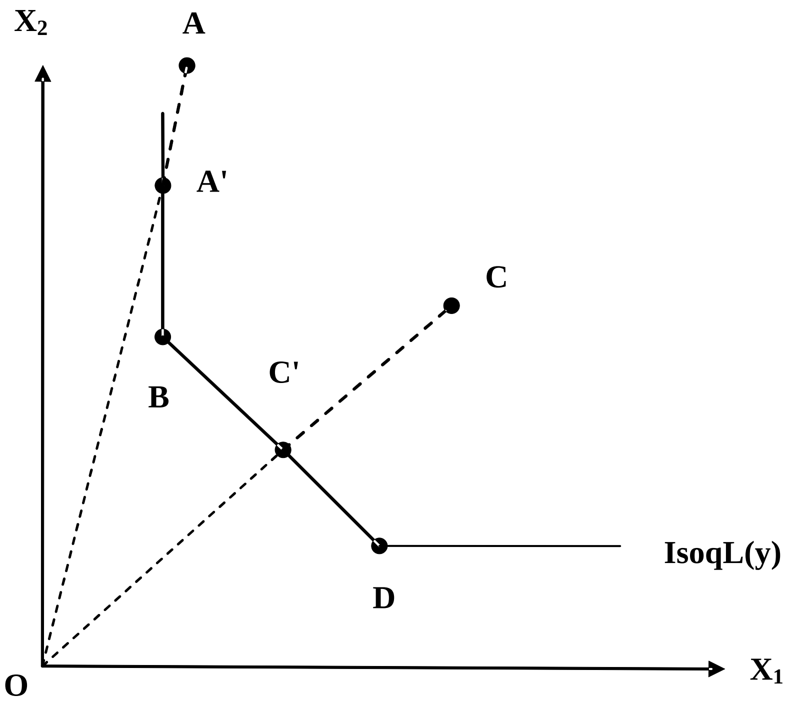
where ϕ is a value of output-oriented technical efficiency.

The output-oriented technical efficiency measures the maximum proportional augmentation of outputs given the observed input level. Obviously, $\phi \geq 1$.
Note that it is also possible to combine both directions of efficiency measurement by simultaneously contracting inputs and expanding outputs[26].
Further, it is worth pointing out that under constant returns to scale, the input distance function is equal to the inverse of the output distance function: $D_I(\mathbf{y},\mathbf{x}) = \dfrac{1}{D_O(\mathbf{x},\mathbf{y})}$.

To explain all concepts graphically, we consider two examples: 1) firms that produce one output y using two inputs x_1 and x_2,; 2) firms which use one input x to produce two outputs y_1 and y_2 (Figure 7 and 8).

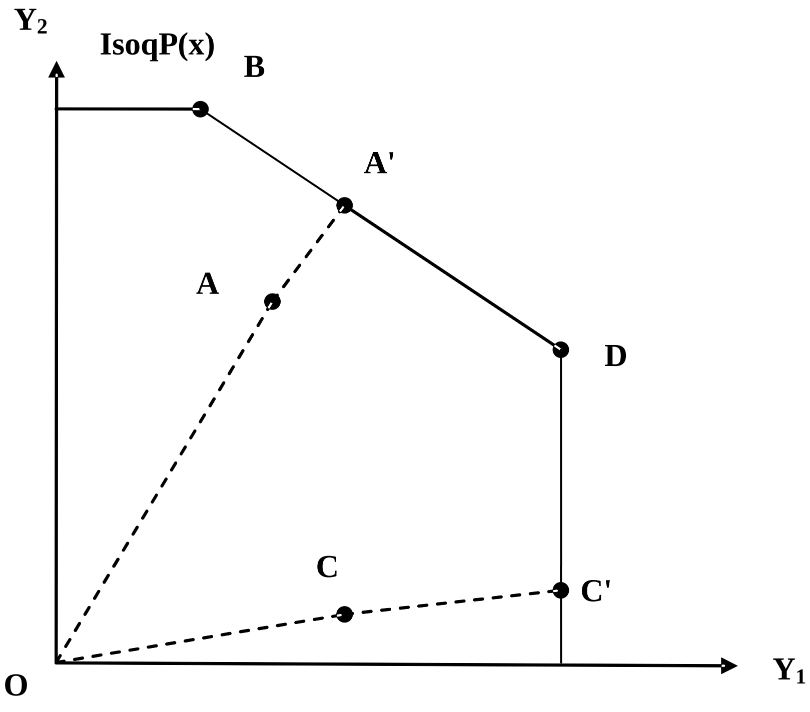
[26] There is a considerable amount of research regarding the non-oriented efficiency models. One stream is represented by the directional distance function literature (see, for example: Chambers, Chung and Färe (1998) or Färe and Grosskopf (2000)). Others include: hyperbolic measure of efficiency which is due to Färe, Grosskopf and Lovell (1985), and additive models due to Charnes et al. (1985).

Figure 7 Input-oriented distance function and Debreu-Farrell technical efficiency



Source: adapted from Fried, Lovell and Schmidt (2008)

Figure 8 Output-oriented distance function and Debreu-Farrell technical efficiency



Source: adapted from Fried, Lovell and Schmidt (2008)

The input combinations x_1 and x_2 of points A and C can be reduced radially and still remain capable of producing output vector $\mathbf{y}$. Because points B and D are located on the isoquant, the input combinations of those points cannot be contracted radially and still be able to produce the same output. Therefore, $D_I(\mathbf{y}, x_B) = TE_I(\mathbf{y}, x_B) = D_I(\mathbf{y}, x_D) = TE_I(\mathbf{y}, x_D) = 1$. For point A, the ratio $\frac{OA}{OA'}$ is the input distance function measure ($D_I(\mathbf{y}, x_A) > 1$), while its reciprocal $\frac{OA'}{OA}$ is the Debreu-Farrell measure of technical efficiency ($TE_I(\mathbf{y}, x_A) < 1$) (Figure 7).

Similarly, for output-oriented case, points B and D are efficient given input usage, while points A and C are not. For point C, the distance function is represented by the ratio $\frac{OC}{OC'}$ ($D_O(y_C, \mathbf{x}) < 1$) and the Debreu-Farrell measure is its inverse, that is $\frac{OC'}{OC}$ ($TE_O(y_C, \mathbf{x}) > 1$) (Figure 8).

3.2.2 Estimation methods of efficiency - Data Envelopment Analysis (DEA)

Two main approaches to a calculation of production frontier and resulting efficiency scores can be distinguished: econometric and mathematical programming techniques (Fried, Lovell and Schmidt, 2008; Coelli, 1995). Other authors categorized those methods as parametric and nonparametric (Coelli and Perelman, 1999; Drake and Simper, 2003; Murillo-Zamorano and Vega-Cervera, 2001). Econometric models are due to Aigner, Lovell and Schmidt (1977) and their general idea is to estimate a stochastic frontier production function. As such they distinguish the effect of noise and inefficiency providing the basis for statistical inference. On the other hand, however, the main problem of those methods is that they assume a priori the functional form of the technology, which does not always result in appropriate specification. Mathematical programming approach coined as Data Envelopment Analysis (*DEA*) comes from Charnes, Cooper and Rhodes (1978). It simultaneously constructs frontier technology from data and calculates the distance to that frontier for individual production units. The frontier consists of linear combinations of observed best-practice units. The biggest advantage of this method is their flexibility as it does not impose specific functional forms on the technology (nonparametric method). On the other hand, the shortcomings are emphasized frequently and they include: the no inclusion of the error as resulting frontier is nonstochastic, and the sensitivity to outliers (Färe, Grosskopf and Lovell, 1994). Nevertheless, recently the disadvantages of both approaches has been relaxed as newly developed tools allow for the statistical inference of mathematical programming methods, while applications of flexible functional forms have moved the econometric approaches from their parametric nature (Fried, Lovell and Schmidt, 2008).

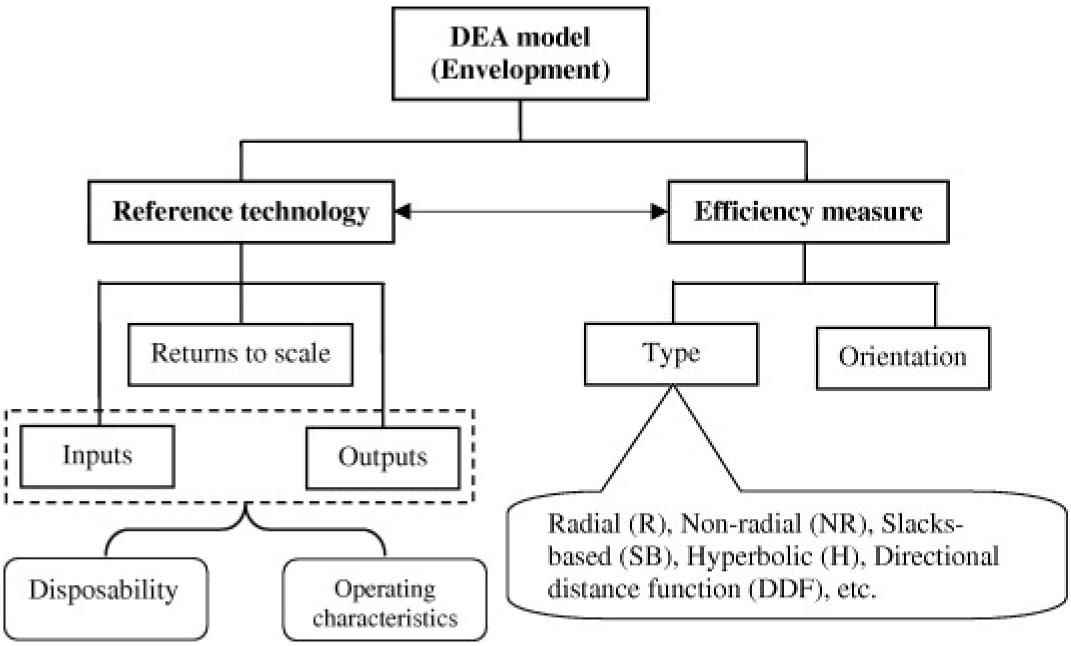
Regarding distance functions, Coelli and Perelman (1999) point out three most commonly used methods to estimate multi-input, multi-output distance functions, two of them are parametric: 1) construction of a parametric frontier using linear programming methods (*PLP* method): specification of a parametric frontier and use of linear programming methods to construct the frontier and measure efficiency relative to it; 2) construction of a parametric frontier using corrected ordinary least squares (*COLS* method), and one which is non-parametric: 3) construction of a non-parametric frontier using a linear programming method of Data Envelopment Analysis (*DEA*). Each of those methods has its own supporters and possible advantages and limitations. Coelli, Rao and Battese (2005) suggest that the selection of the appropriate method should be made on a pragmatic basis. *DEA* is preferred in this research due to the fact that it does not assume a particular functional form which characterizes technology. As it was mentioned before, using parametric frontiers, efficiency scores obtained are partially dependent on the accuracy of the functional form chosen. Further, although *DEA* has been criticized for its deterministic nature, recent developments of bootstrap methods allow for statistical inference. Hereafter, we focus on this approach.

In Data Envelopment Analysis *(DEA)* each production unit to be evaluated is referred to as a Decision Making Unit (*DMU*). The performance of each *DMU* is characterized by a production process that uses multiple inputs to produce multiple outputs. In short, *DEA* involves the application of the linear programming techniques to observed inputs consumed and outputs produced by firms to obtain efficiency measures. Next *DEA* constructs an efficient production frontier based on the best practices. Each firm's efficiency is then measured relative to this frontier either in input or output, or non-oriented orientation. This relative efficiency is calculated by obtaining the ratio of the weighted sum of all outputs and the weighted sum of all inputs.

Since the seminal work by Charnes, Cooper and Rhodes (1978)[27], *DEA* has rapidly grown both in models development and applications, linking the investigators from operations research and management science, economists and experts from various areas of application. The method has been used to evaluate efficiency of different organizations in public and private sectors such as banks, schools, hospitals, armed services, shops, tourism as well as manufacturing firms. As for 2001 *DEA* literature consists of over 1800 articles in referred journals in addition to many books, conference proceedings and different monographs (Gattoufi, Oral and Reisman, 2004).

During thirty years of *DEA* history there has been an extensive methodological growth of the field giving rise to the development of many different models. Figure 9 presents the classification of *DEA* formulations, which takes into account two criteria: efficiency measure as well as assumptions about reference technology.

Figure 9 Classification of *DEA* models



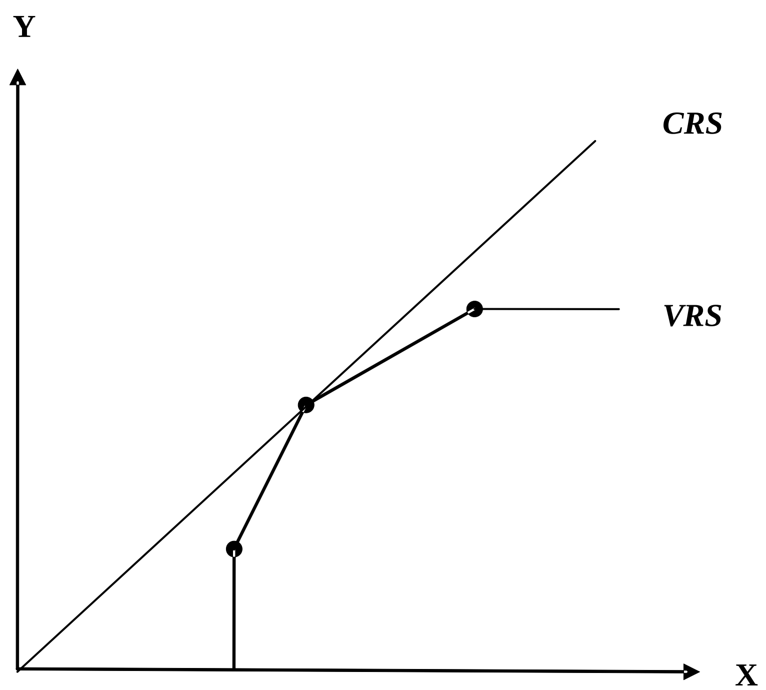
Source: Zhou, Ang and Poh (2008)

From efficiency measure point of view, input-, output- and non-oriented models can be distinguished. At the same time, radial, non-radial, slacks-based, hyperbolic and directional distance function indicators are developed, when we consider the type of

[27] Per 2008 this paper has over 2000 citations in the Social Sciences Citation Index.

measurement. Furthermore, *DEA* models invoke different assumptions about the technology. The main characteristic here is the type of returns to scale. The original *DEA* model proposed by Charnes, Cooper and Rhodes (1978) assumes constant returns to scale *(CRS)*, while variable returns to scale model *(VRS)* was developed by Banker, Charnes and Cooper (1984). Returns to scale measure the change in output levels due to the changes in input levels and concerns the verification of the assumption of proportionality between inputs and outputs. Constant returns to scale imply that an increase in input levels results in a proportional increase in output levels. On the other hand, variable returns imply that an increase in the input levels does not necessarily result in a proportional increase in output levels, that is the output levels can increase (increasing returns to scale) or decrease (decreasing returns to scale) by a different proportion than the input increment[28]. The difference between *VRS* and *CRS* is illustrated in Figure 10.

Figure 10 Returns to scale: *CRS* versus *VRS*



In the case of *CRS* the relationship between inputs and outputs is lineal. For *VRS* this curve is replaced by one with a changing slope. In *VRS* only convex combinations of

[28] Podinovski (2004) developed the hybrid returns to scale technology (*HRS*) that combines the assumption of *CRS* to selected inputs and outputs, while preserving *VRS* for the remaining units.

efficient producers form the best-practice frontier, and this production technology envelops the data more tightly than *CRS*. As can be seen on the graph, any *DMU* efficient in *CRS* is also efficient in *VRS*, and the efficiency scores in *VRS* are greater than or equal to those obtained using *CRS* assumption. In addition, the convexity of *VRS* makes firms to be compared with those of similar size (Coelli, Rao and Battese, 2005).
Finally, the disposability and operating characteristics of inputs and outputs are other criteria to categorize *DEA* models. Many different methods have been developed to incorporate undesirable outputs and inputs, and non-discretionary, categorical or environmental variables. A detailed review of majority of existing models can be found in Cook and Seiford (2009) and Zhou, Ang and Poh (2008).

3.2.2.1 DEA estimation of input distance function

We have two issues to decide in *DEA* formulation: model orientation and reference technology. Textile industry worldwide nowadays acts in the competitive and severe market environments, where outputs are defined by demand and limited only by resources and capacities. The firms in order to survive do not rely on mass production anymore and cannot assume to expand their market share in a significant way due to this increasing competition. So, the outputs expansion cannot be the unique way to achieve efficiency. Instead firms change to the type of products based on knowledge and intangible assets directed to niche markets, subcontract the parts of manufacturing, reduce the size of factories as well as decrease the employment. For example GANT, a clothing brand from the USA, bought by Swedish investors, with a centre of operation by a company Pyramid Sportswear AB, is an imaginary organization that has eight employees and the brand name. It finds designers, identifies trends, contracts out production and cultivates a retailer network using catalogues, advertising, image creating activities and sales support. GANT illustrates that a firm with limited resources can build around an idea and outsource most of the firm's activities, linking them in an intensive network (Hedberg et al., 2000). Such evidence is a clear orientation towards the input reduction, not orientation towards the new markets. Hence, for the aforementioned reasons, it is more realistic and suitable to apply the model in input orientation. The technology chosen is *VRS* due to heterogeneity of our sample (our dataset includes numeric values with a large difference in magnitudes).

Let us add more notations and assume that now we have *k DMUs*, each of which consumes varying amounts of *N* different inputs to produce *M* different outputs. The model evaluates the efficiency score of each observed *DMU* called DMU_o relative to other DMU_S. The linear programming problem of *DEA* used to calculate efficiency for the input-oriented distance function (λ) defined by **(5)** relative to variable returns to scale technology (*VRS*) is following:

$$\begin{aligned} & Max\ \lambda, \\ & subject\ to \quad -y_{m0} + \sum_{i=1}^{k} z_i y_{mi} \geq 0, \quad m = 1,\dots,M \\ & \qquad x_{n0}/\lambda - \sum_{i=1}^{k} z_i x_{ni} \geq 0, \quad n = 1,\dots,N \\ & \qquad \sum_{i=1}^{k} z_i = 1, \\ & \qquad z_i \geq 0. \end{aligned} \tag{13}$$

where:

λ is the input-oriented distance function,

x_{ni} stands for quantity of input *n* consumed by DMU_i,

y_{mi} stands for quantity of output *m* produced by DMU_i,

x_{no} represents quantity of input *n* consumed by the observed unit under analysis DMU_o,

y_{mo} represents quantity of output *m* produced by the observed unit under analysis DMU_o,

z_i symbolises the activity levels associated with inputs and outputs of DMU_i.

Note that the restriction $\sum_{i=1}^{k} z_i = 1$ corresponds to *VRS* model. This additional constraint makes a firm to be compared with those of similar size. Constant returns to scale (*CRS*) *DEA* is conducted by removing this convexity constraint, and *DMU* may be benchmarked against DMU_S that are substantially larger (smaller) than it.

The computation of efficiency scores involves solving one linear program for each *DMU*. As with input distance function, the values of efficiency derived by this model are equal or greater than unity.

3.2.2.2 Formulation of DEA bootstrap

The idea of bootstrapping of *DEA* efficiency scores arose as the answer to the criticism of nonparametric efficiency measures for lacking of statistical basis and not accounting for the presence of stochastic noise in the data generation process. In other words, basic *DEA* assumes that the distance between the observation and the efficient boundary reflects only inefficiency. However, this distance reflects both inefficiency and noise arising as the input-output levels could be a subject to measurement error or some input-output variables might be omitted. The bootstrapping recognizes that the data is a subject to a random noise allowing to correct *DEA* estimators for a bias and to estimate the confidence intervals for them. In its sense bootstrap estimates the sampling variation of the efficiency estimators.

The bootstrap method was first introduced to econometric research by Efron (1979) and it was used to perform inference when the sampling distribution of the estimator was unknown or difficult to obtain analytically. Simar and Wilson (1998) proposed to use bootstrapping in *DEA* research. It is assumed that the probability distribution of observed *DEA* efficiencies mimics the true but unknown parent population of *DEA* efficiencies, therefore, if we draw with replacement a sample from the observed *DEA* efficiencies, it will be like drawing a sample from a population itself. Technically speaking bootstrapping could be defined as a repeated simulation of the data-generating process through resampling and applying the original estimator to each simulated sample so that resulting estimates imitate the original unknown sampling distribution of the estimators of interest (Simar and Wilson, 1998, 2000a, 2000b).

Let us now introduce the bootstrap procedure mathematically. Taking all notations from previous sections, we further denote $\chi = \{(\mathbf{x}_i, \mathbf{y}_i), i = 1,...,k\}$ as an original sample of *k* decision making units for which bootstrap should be estimated. The bootstrap algorithm can be summarized in the following steps (Simar and Wilson, 1998, 2000a, 2000b):

1) the computation the efficiency scores $\hat{\delta}_i$ for each decision making units $i = 1,...,k$ by solving the linear programming model described by **(13)**,

2) using kernel density estimation and reflection method (smooth bootstrap[29]), the generation of the random sample of size n from $\{\hat{\delta}_i, i = 1,...,k\}$, resulting in $\{\delta^*_{ib}, i = 1,...,k\}$,
3) the generation of the pseudo sample $\chi^* = \{(\mathbf{x}^*_i, \mathbf{y}^*_i), i = 1,...,n\}$ to form the reference bootstrap technology,
4) the computation of the bootstrap estimation of efficiency $\hat{\delta}^*_{ib}$ of $\hat{\delta}_i$ for each $i = 1,...,k$,
5) the repetition of steps 2-4 B times in order to obtain a set of estimates $\{\hat{\delta}^*_{ib}, b = 1,...,B\}$.

Having the bootstrap values computed, we can obtain the following measures:

- the estimation of bootstrap bias values for the original estimator $\hat{\delta}_i$ from the following equation:

$$bia\hat{s}_B(\hat{\delta}_i) = B^{-1}\sum_{b=1}^{B}\hat{\delta}^*_{ib} - \hat{\delta}_i \tag{14}$$

- the computation of bias-corrected estimator of δ as:

$$\hat{\hat{\delta}}_i = \hat{\delta}_i - bia\hat{s}_B(\hat{\delta}_i) = 2\hat{\delta}_i - B^{-1}\sum_{b=1}^{B}\hat{\delta}^*_{ib} \tag{15}$$

- the construction of confidence intervals for efficiency scores of each decision making unit, which involves following steps:

- sort the values $(\hat{\delta}^*_{ib} - \hat{\delta}_i)$ for $b = 1,...,B$ and delete $(\frac{\alpha}{2}\times 100)$- percent of the elements at either end of this sorted array,
- set $-\hat{b}^*_\alpha$ and $-\hat{a}^*_\alpha$ $(\hat{a}^*_\alpha \leq \hat{b}^*_\alpha)$, equal to the endpoints of the resulting array, then the estimated $(1-\alpha)$- percent confidence interval is formulated as below:

$$\hat{\delta}_i + a^*_\alpha \leq \delta_i \leq \hat{\delta}_i + b^*_\alpha \tag{16}$$

[29] Resampling directly from the original data that is applying naive bootstrap will provide a poor estimate of data generating process. Using kernel smoothing and reflection methods yields consistent estimators of the underlying distributions. For details see: Simar and Wilson (1998).

In this dissertation *DEA* efficiency estimators of firms are computed from 2000 bootstrap replications. For this purpose we use *FEAR* 1.1 package[30]. Those indicators are calculated separately for each year of analysis, while we decide to compute the common frontier for textile and clothing sub-sectors, and later in the second stage regression analysis we attempt to disentangle the industry specific by adding industrial activity as a control variable. The main reason for such treatment was the availability of data. Performing the international analysis of textile and clothing firms we wanted to keep as many firms, countries and regions as possible in our database to make our sample representative at the world level. With separation of textile and clothing branches we would reduce our sample significantly as well as loose some regions for our analysis. Moreover, the separation into textile and clothing was not so obvious as some database (*DATASTREAM*) did not provide such division and, as it was mentioned before, we needed to use the extended description of the business activity or companies' webpages for this purpose. On the other hand, not adequate split into textile and clothing could result in the significant modifications of the frontiers. Therefore, pooling the data over industries gives us more confidence in the precision of *DEA* estimation.

3.2.3 Productivity evolution over time - Malmquist index

DEA allows evaluating of efficiency for a specific time period and the variations of efficiency over time are not known. In order to conduct efficiency comparisons over time, the time-series approximations have been introduced, among them the most widely used in efficiency research is the so-called Malmquist productivity index[31]. Because the principal role of distance functions described previously is to measure technical efficiency, they can be also used to construct Malmquist. As in *DEA*, to compute Malmquist indexes we need the information on inputs and outputs to firm production process. The definition of Malmquist follows.

[30] *FEAR* is a software package for frontier efficiency analysis with *R*, which allows to compute many different estimates of efficiency, among them *DEA* and Malmquist together with bootstrap. It is written by Wilson (2007, 2008). The software is freely available from: http://www.clemson.edu/economics/faculty/wilson/Software/FEAR/fear.html

[31] The index was named after the Swedish statistician Sten Malmquist, who used the distance function in 1953 to define input quantity indexes in the consumption framework (Malmquist, 1953). However, he did not propose Malmquist index to measure productivity change. It was done later, first as theoretical index by Caves, Christensen and Diewert (1982), and then as applied using linear programming techniques by Färe et al. (1992).

3.2.3.1 Malmquist and its decomposition

To be consistent with *DEA* analysis, we formulate Malmquist in input orientation[32]. To define input-oriented Malmquist index we use the general formulation of input distance function as described by **(5)**. Now we consider two periods of time: t and $t+1$. In period t firm produces output y^t using input x^t, while in period $t+1$, y^{t+1} utilizing x^{t+1}. Inputs sets for t can be defined as:

$$L(\mathbf{y}^t) = \{\mathbf{x}^t : (\mathbf{y}^t, \mathbf{x}^t)\ is\ \ feasible\} \qquad \textbf{(17)}$$

Then formulation **(5)** can be redefined adding time dimension. For t:

$$D_I^t(\mathbf{y}^t, \mathbf{x}^t) = \max\{\lambda : (\mathbf{x}^t / \lambda) \in L(\mathbf{y}^t)\} \qquad \textbf{(18)}$$

While for $t+1$ it gives following equation:

$$D_I^{t+1}(\mathbf{y}^{t+1}, \mathbf{x}^{t+1}) = \max\{\lambda : (\mathbf{x}^{t+1} / \lambda) \in L(\mathbf{y}^{t+1})\} \qquad \textbf{(19)}$$

In addition to those two distance functions for period t and $t+1$, the computation of Malmquist requires the formulation of two additional distance functions. One concerns the firm at time $t+1$ in relation to the technology at t:

$$D_I^t(\mathbf{y}^{t+1}, \mathbf{x}^{t+1}) = \max\{\lambda : (\mathbf{x}^{t+1} / \lambda) \in L(\mathbf{y}^t)\} \qquad \textbf{(20)}$$

The second refers to the firm at time t in relation to the technology at $t+1$:

$$D_I^{t+1}(\mathbf{y}^t, \mathbf{x}^t) = \max\{\lambda : (\mathbf{x}^t / \lambda) \in L(\mathbf{y}^{t+1})\} \qquad \textbf{(21)}$$

Färe et al. (1992) defined an input-oriented Malmquist index between time period t and $t+1$ as a geometric mean of the indices proposed by Caves, Christensen and Diewert (1982):

[32] Of course Malmquist index can be also formulated in output orientation using the definition of output distance function (11).

$$M_I(\mathbf{y}^{t+1},\mathbf{x}^{t+1},\mathbf{y}^t,\mathbf{x}^t)=\left[\frac{D_I^t(\mathbf{y}^{t+1},\mathbf{x}^{t+1})}{D_I^t(\mathbf{y}^t,\mathbf{x}^t)}\cdot\frac{D_I^{t+1}(\mathbf{y}^{t+1},\mathbf{x}^{t+1})}{D_I^{t+1}(\mathbf{y}^t,\mathbf{x}^t)}\right]^{\frac{1}{2}} \quad \textbf{(22)}$$

Values of Malmquist index less than 1 indicate improvements in productivity between t and $t+1$, values greater than 1 show decreases in productivity from t to $t+1$, while Malmquist index with value equal to 1 would indicate no change in productivity between periods considered.

Färe et al. (1992) break down Malmquist index $M_I(\mathbf{x}^{t+1}, \mathbf{y}^{t+1}, \mathbf{x}^t, \mathbf{y}^t)$ into two sources of productivity change[33]:

- efficiency change or so called "catching up effect" ($E_I(\mathbf{x}^{t+1}, \mathbf{y}^{t+1}, \mathbf{x}^t, \mathbf{y}^t)$), which shows how much closer or further away a firm goes to the frontier of best practices between two periods of time t and $t+1$; assuming input orientation, this component is smaller than 1 when technical efficiency improves, equal to 1 when there have been no changes in efficiency, and more than 1 when efficiency reduces between analyzed periods;
- technical change or "frontier-shift effect" ($T_I(\mathbf{x}^{t+1}, \mathbf{y}^{t+1}, \mathbf{x}^t, \mathbf{y}^t)$), which measures the shifts of the frontier of best practices, that is it shows if the units belonging to the frontier improved or worsened between two periods of time t and $t+1$; similarly to efficiency change component, technical change less than 1 indicates technological progress, equal to 1 shows no technological changes (no shift in the frontier), while larger than 1 technological regress.

Thus, the Malmquist index **(22)** can be written in an equivalent way:

$$\begin{aligned} M_I(\mathbf{y}^{t+1},\mathbf{x}^{t+1},\mathbf{y}^t,\mathbf{x}^t) &= E_I(\mathbf{y}^{t+1},\mathbf{x}^{t+1},\mathbf{y}^t,\mathbf{x}^t)\cdot T_I(\mathbf{y}^{t+1},\mathbf{x}^{t+1},\mathbf{y}^t,\mathbf{x}^t) = \\ &= \underbrace{\frac{D_I^{t+1}(\mathbf{y}^{t+1},\mathbf{x}^{t+1})}{D_I^t(\mathbf{y}^t,\mathbf{x}^t)}}_{\textit{efficiency change}}\cdot\underbrace{\left[\frac{D_I^t(\mathbf{y}^{t+1},\mathbf{x}^{t+1})}{D_I^{t+1}(\mathbf{y}^{t+1},\mathbf{x}^{t+1})}\cdot\frac{D_I^t(\mathbf{y}^t,\mathbf{x}^t)}{D_I^{t+1}(\mathbf{y}^t,\mathbf{x}^t)}\right]^{\frac{1}{2}}}_{\textit{technical change}} \end{aligned} \quad \textbf{(23)}$$

[33] A number of other decompositions have been developed, and there is no consensus which one best measures different components of productivity change. For survey of all decompositions see Grosskopf (2003) and Lovell (2003).

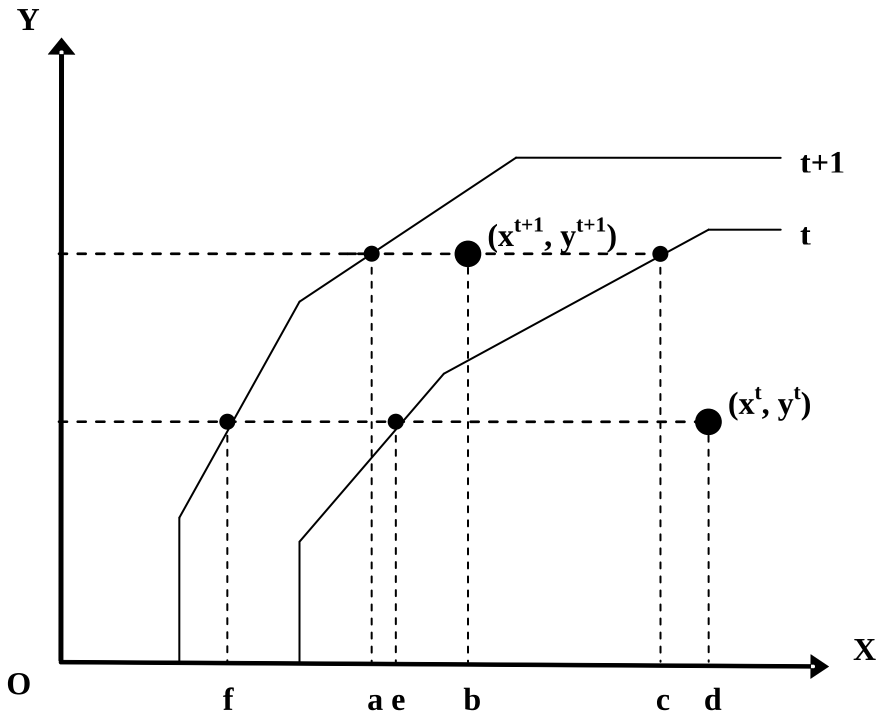
Efficiency change (the first ratio on the right-hand side) is the distance function efficiency measure for year *t* relative to that for year *t+1*.
Technical change (the second term) is the geometric mean of two distance functions and it measures technological change at two time periods. In particular, the first ratio inside the bracket evaluates the shift in the frontier at the data observed in period *t+1*, while the second captures that shift at the data in period *t*.

To be consistent with *DEA* analysis we apply Malmquist in *VRS* technology. This choice again is motivated by the fact that our dataset consists of firms heterogeneous in size, input and output level.

Figure 11 illustrates the calculation of input-oriented Malmquist index with its decomposition in *VRS* technology. It can be expressed as follows:

$$M_I(\mathbf{y}^{t+1},\mathbf{x}^{t+1},\mathbf{y}^t,\mathbf{x}^t)=\frac{0b/0a}{0d/0e}\left[\frac{0b/0c}{0b/0a}\frac{0d/0e}{0d/0f}\right]^{\frac{1}{2}}=\frac{0b/0a}{0d/0e}\left[\frac{0a}{0c}\frac{0f}{0e}\right]^{\frac{1}{2}}$$

Figure 11 Input-oriented Malmquist index in *VRS*



Source: adapted from Färe et al. (1992)

The situation presented in Figure 11 shows improvement in all indexes. Malmquist index $M_I(\mathbf{x}^{t+1}, \mathbf{y}^{t+1}, \mathbf{x}^t, \mathbf{y}^t)$ is smaller than 1 which indicates a positive change in productivity. Its decomposition shows a positive efficiency change $E_I(\mathbf{x}^{t+1}, \mathbf{y}^{t+1}, \mathbf{x}^t, \mathbf{y}^t)$ as x^{t+1} is nearer to the frontier than x^t. At the same time technical change $T_I(\mathbf{x}^{t+1}, \mathbf{y}^{t+1}, \mathbf{x}^t, \mathbf{y}^t)$ is positive as frontier corresponding to period $t+1$ has better productivity than that connected with period t.

The estimation of the distances, which make the equation **(23)**, can be done by the methods used to compute static efficiency which were already introduced before. In particular, here we follow the linear programming technique of Data Envelopment Analysis due to its advantages already mentioned. We investigate the statistical significance of computed indexes through the introduction of bootstrap. Contrary to *DEA*, the Malmquist decomposition requires the solving of four linear programmes for each *DMU*. Let us assume that we have *k DMUs*, each of which consumes varying amounts of *N* different inputs to produce *M* different outputs. The programme to estimate the input distance function for period t $D_I^t(\mathbf{y}^t, \mathbf{x}^t)$ is following:

$$
\begin{aligned}
& Max\ \lambda, \\
& subject\ to \quad -y_{m0}^t + \sum_{i=1}^{k} z_i y_{mi}^t \geq 0, \quad m = 1,\dots,M \\
& \qquad x_{n0}^t / \lambda - \sum_{i=1}^{k} z_i x_{ni}^t \geq 0, \quad n = 1,\dots,N \\
& \qquad \sum_{i=1}^{k} z_i = 1, \\
& \qquad z_i \geq 0.
\end{aligned} \tag{24}
$$

where:

λ is the input-oriented distance function,

x^t_{ni} stands for quantity of input n consumed by DMU_i in period t,

y^t_{mi} stands for quantity of output m produced by DMU_i in period t,

x^t_{no} represents quantity of input n consumed by the observed unit under analysis DMU_o in period t,

y^t_{mo} represents quantity of output m produced by the observed unit under analysis DMU_o in period t,

z_i symbolises the activity levels associated with inputs and outputs of DMU_i.

Based on the model above, the formulation of the programme for period *t+1* is following:

$$D_I^{t+1}(\mathbf{y}^{t+1},\mathbf{x}^{t+1})$$

$$\begin{aligned}
&\textit{Max } \lambda, \\
&\textit{subject to} \quad -y_{m0}^{t+1}+\sum_{i=1}^{k} z_i y_{m\,i}^{t+1} \geq 0, \quad m=1,\ldots,M \\
&x_{n0}^{t+1}/\lambda-\sum_{i=1}^{k} z_i x_{n\,i}^{t+1} \geq 0, \quad n=1,\ldots,N \\
&\sum_{i=1}^{k} z_i = 1, \\
&z_i \geq 0.
\end{aligned} \tag{25}$$

Finally, the formulations for mixed-period cases **(20)** and **(21)** are following:

$$D_I^{t}(\mathbf{y}^{t+1},\mathbf{x}^{t+1})$$

$$\begin{aligned}
&\textit{Max } \lambda, \\
&\textit{subject to} \quad -y_{m0}^{t+1}+\sum_{i=1}^{k} z_i y_{m\,i}^{t} \geq 0, \quad m=1,\ldots,M \\
&x_{n0}^{t+1}/\lambda-\sum_{i=1}^{k} z_i x_{n\,i}^{t} \geq 0, \quad n=1,\ldots,N \\
&\sum_{i=1}^{k} z_i = 1, \\
&z_i \geq 0.
\end{aligned} \tag{26}$$

$$D_I^{t+1}(\mathbf{y}^{t},\mathbf{x}^{t})$$

$$\begin{aligned}
&\textit{Max } \lambda, \\
&\textit{subject to} \quad -y_{m0}^{t}+\sum_{i=1}^{k} z_i y_{m\,i}^{t+1} \geq 0, \quad m=1,\ldots,M \\
&x_{n0}^{t}/\lambda-\sum_{i=1}^{k} z_i x_{n\,i}^{t+1} \geq 0, \quad n=1,\ldots,N \\
&\sum_{i=1}^{k} z_i = 1, \\
&z_i \geq 0.
\end{aligned} \tag{27}$$

3.2.3.2 Bootstrapping of Malmquist index

As in *DEA*, statistical interpretation can be given to Malmquist index in order to interpret if changes in productivity, efficiency and technology are significant that is whether the result indicates a real change in productivity or it is a result of sampling noise (Simar and Wilson, 1999). In particular, the methodology of bootstrapping of *DEA* distance functions can be easily adapted and extended to bootstrapping of Malmquist, except that time-dependence structure of the data must be taken into account. The procedure can be summarized in following steps (Simar and Wilson, 1999):

1) the computation of Malmquist index $\hat{M}_i(t,t+1)$ for each *DMU* $i=1,...,k$ by solving the linear programming models **(24)-(27)**,
2) using bivariate kernel density estimation and univariate reflection method[34] the generation of pseudo data set $\{(\mathbf{x}^*_{it}, \mathbf{y}^*_{it}, i=1,...,k,\ t=1,2\}$,
3) the computation of bootstrap estimate of Malmquist index for each *DMU* $\hat{M}^*_{ib}(t,t+1)$ by applying the original estimators to pseudo data set derived from step 2,
4) the repetition of steps 2 and 3 B times in order to obtain a set of estimates $\{\hat{M}^*_{i1}(t,t+1),...,\hat{M}^*_{iB}(t,t+1)\}$.

As in *DEA*, once Malmquist bootstrap values are computed one can obtain following indicators:

- bootstrap bias:

$$bi\hat{a}s_B(\hat{M}_i(t,t+1)) = B^{-1}\sum_{b=1}^{B}\hat{M}^*_{ib}(t,t+1) - \hat{M}_i(t,t+1) \quad \textbf{(28)}$$

- bias-corrected estimate of Malmquist:

$$\hat{\hat{M}}_i(t,t+1) = \hat{M}_i(t,t+1) - bi\hat{a}s_B(\hat{M}_i(t,t+1)) = 2\hat{M}_i(t,t+1) - B^{-1}\sum_{b=1}^{B}\hat{M}^*_{ib}(t,t+1) \quad \textbf{(29)}$$

[34] Applying bivariate kernel density estimation and univariate reflection method allows to account for possible temporal correlation arising from the panel data characteristic. For details, see: Simar and Wilson (1999).

- confidence intervals by sorting the values $\hat{M}^*_{ib}(t,t+1)-\hat{M}_i(t,t+1)$ for $b=1,...,B$ and deleting $(\frac{\alpha}{2}\times 100)$ - percent of the elements at either end of this sorted array; then setting $-\hat{b}^*_\alpha$ and $-\hat{a}^*_\alpha$ $(\hat{a}^*_\alpha \le \hat{b}^*_\alpha)$, equal to the endpoints of the resulting array; as a result the estimated $(1-\alpha)$ - percent confidence interval is formulated as below:

$$\hat{M}_i(t,t+1)+a^*_\alpha \le M_i(t,t+1) \le \hat{M}_i(t,t+1)+b^*_\alpha \quad \textbf{(30)}$$

All the procedures described here can be repeated to obtain bootstrap estimates for efficiency change $E_I(\mathbf{x}^{t+1}, \mathbf{y}^{t+1}, \mathbf{x}^t, \mathbf{y}^t)$ and technical change $T_I(\mathbf{x}^{t+1}, \mathbf{y}^{t+1}, \mathbf{x}^t, \mathbf{y}^t)$.

In this dissertation we perform a statistical inference on Malmquist through the development of confidence intervals. As in *DEA*, the indexes are computed from 2000 bootstrap replications using *FEAR* 1.1 package. Malmquist indexes are calculated between two consecutive years integrating the textile and clothing sub-sectors for the same reasons as outlined in *DEA*.

It is worth pointing out that bootstrap techniques with regard to both Malmquist and *DEA*, have been increasingly used recently to analysis of efficiency of farms in Central Europe (Balcombe, Davidova and Latruffe, 2008; Latruffe, Davidova and Balcombe, 2008), Bangladesh rice farming (Balcombe et al., 2008), banking industry in Spain (Tortosa-Ausina et al., 2008) or industrial firms in Ukraine (Zelenyuk and Zheka, 2006). We contribute to this growing body of empirical literature adding another industrial perspective as, to the best of our knowledge, the evidence regarding the textile and clothing industry has not appeared yet.

3.2.4 Truncated regression of the DEA efficiency on the explanatory factors to test the hypotheses

The main aim of the second stage is to investigate the dependency of the technical efficiency on the factors which were hypothesized before to influence efficiency as well as on some control variables. As we possess a panel data which encompass of ten consecutive years (1995-2004), the model we want to estimate is following:

$$\hat{\delta}_{it} = \varphi_i + F_{it}\beta + \varepsilon_{it}, \quad i = 1,...,k, \quad t = 1,...,l \qquad \textbf{(31)}$$

where i stands for individual (firm) and t for time (year) dimension. In particular, $\hat{\delta}_{it}$ is the efficiency score in the form of an input distance function resulting from the first stage that is by solving the equation **(13)**, φ_i is a specific constant for each firm, F_{it} is a vector of factors hypothesized to impact efficiency together with control factors for firm k, β is a vector of coefficients to be estimated associated with those factors, and ε_{it} is a statistical noise.

Until recently a common practice to analyze such relationship was to employ the Tobit regression. Tobit is an example of censored model, which is the case when all (y_i, x_i) are observed and it is just that when y_i passes the certain point, y_i is recorded as that certain point (Franses and Paap, 2001). In other words the values of dependent variable in a certain range are all reported as a single value[35]. Recently, Simar and Wilson (2007) have shown that *DEA* efficiency coefficients are biased and serially correlated in a complicated, unknown way, and they demonstrated in Monte Carlo experiments that Tobit estimator "results in catastrophe" in terms of coverage of estimated confidence intervals (Simar and Wilson, 2007, p. 46). Instead they propose to use truncated regression with bootstrap and show its good performance in Monte Carlo experiments. Here we follow this approach. Truncated regression is a case when (y_i, x_i) is observed only when y_i>a (left truncation) or y_i>b (right truncation), or when c<y_i>d (double truncation) (Franses and Paap, 2001). That is the values of dependent and independent variables are observed in only some of the ranges and outside these ranges are totally lost[36]. In our case, only firms with efficiency greater or equal to 1 are observed that is our dependent variable is left truncated by 1.

Because we possess a panel data, basically we have two possibilities for running the regression:

- we can omit individual and time effect, and run a pooled regression;

or

- we can control for those effects using a panel data regression.

[35] For a survey of different types of Tobit models see Amemyia (1984).

[36] Truncation is a characteristic of the population under study, while censoring is a feature of the data-gathering mechanism. For more details, see: Greene (2003).

Panel data refers to any data set with repeated observations over time for the same individuals (Arellano, 2003). Baltagi and Song (2006) outline several benefits from using panel data, which include: the ability to control for individual heterogeneity, a much larger data set with more variability and less collinearity, and the possibility to identify and measure effects that are not detectable in pure cross-section or pure time-series data. As a consequence, with panel data one can get more reliable estimates. To check which model gives more consistent results, pooled or panel, we perform Wald test to find out the significance of dummies indicating each firm and year of analysis[37]. The results of this test are shown in table below.

Table 12 Test for significance of firm and year dummies

(1)	[eq1]_Inum_2 = 0
(2)	[eq1]_Inum_3 = 0
(3)	[eq1]_Inum_4 = 0
(4)	[eq1]_Inum_5 = 0
(5)	[eq1]_Inum_6 = 0
....	....
(1043)	[eq1]_Inum_1051 = 0
(1044)	[eq1]_Inum_1052 = 0
(1045)	[eq1]year2 = 0
(1046)	[eq1]year3 = 0
(1047)	[eq1]year4 = 0
(1048)	[eq1]year5 = 0
(1049)	[eq1]year6 = 0
(1050)	[eq1]year7 = 0
(1051)	[eq1]year8 = 0
(1052)	[eq1]year9 = 0
(1053)	[eq1]year10 = 0
chi2(1052) =14750.480 Prob > chi2 = 0.000	

We see from Table 12 that with 99% of confidence we can reject the null hypothesis that the coefficients of dummies are equal to 0. That is dummies for company as well as for year are truly important and should be included in the model. In other words, panel data model is preferred to pooled regression. Because none of the statistical software which was available for us has the possibility to conduct truncated regression for panel data[38], we decide to use a sort of handmade procedure with *STATA* 10.0 to control for individual and time dimension. For this purpose in the normal truncated regression we

[37] Note that for ordinary least squares regression the statistical tests exist that allow for finding the most relevant model: random effects or pooled regression (Breusch and Pagan *Test of the Multiplier of Lagrange for Random Effects*), fixed effects or pooled regression (*F* test). In the case of truncated regression it resulted impossible to run one of those well known tests.

[38] In fact, the software *LIMDEP* has the possibility of conducting a panel data truncated regression, however it was not available for us.

introduce dummies for each year of analysis (time series) and for each firm in the sample (cross-sectional) obtaining a panel data model. What we estimate here then is a panel data with two-way fixed effects[39]. Model **(31)** can be finally specified as:

$$\hat{\delta}_{it} = \nu_i + \eta_t + F_{it}\beta + \varepsilon_{it}, \quad i = 1,...,k, \quad t = 1,...,l \qquad \textbf{(32)}$$

where ν_i is a vector of dummy variables for individual effect and η_t represents a vector of dummy variables for every year. Note that $\hat{\delta}_{it} \geq 1$ and $\varepsilon_{it} \to N(0,\sigma^2)$.

Simar and Wilson (2007) proposed two algorithms within truncated regression: Algorithm 1 that uses original efficiency estimators and then regress them in the second stage on the set of independent variables in the truncated regression using bootstrap (single bootstrap), and Algorithm 2 that applies bias-corrected efficiency in the truncated regression model with bootstrap (double bootstrap). In more details, Algorithm 1 involves following steps:

1) the computation of efficiency scores $\hat{\delta}_i$ for all decision making units $i = 1,...,k$;
2) the estimation of $\hat{\beta}$ and $\hat{\sigma}_\varepsilon$ using the maximum likelihood in the truncated regression of $\hat{\delta}_i$ on F_i;
3) the computation of L bootstrap estimates for β and σ_ε in the following way:

- for $i = 1,...,k$ draw ε_i from a normal distribution with variance $\hat{\sigma}_\varepsilon^2$ and left truncation at $(1 - F_i\hat{\beta})$,
- for $i = 1,...,k$ compute $\delta_i^* = F_i\hat{\beta} + \varepsilon_i$,
- using maximum likelihood estimate the truncated regression of δ_i^* on F_i, yielding estimates $(\hat{\beta}^*, \hat{\sigma}_\varepsilon^*)$,

[39] Literature mentions one problem that might occur when estimating fixed effect model of truncated regression - so called incidental parameter problem. It refers to the inconsistency of estimated parameters which introduce a bias. Greene (2006) analyzes this problem using Monte Carlo method and concludes that although the problem should be reckoned with, it is not as dangerous as one might think. Observed bias diminishes when number of groups (years of analysis) increases, and with a number of groups equal or more than 10, the results of estimations are consistent. In this context, fixed effect model estimated with our panel comprising of 10 years should give consistent results. Moreover, because our panel is unbalanced we decided to conduct an additional analysis by running fixed effects truncated regression with only those firms for which we possess the information on 10 years (balanced panel) for robustness checks. The results were very much comparable to those reported later on in this dissertation (the same sign of coefficients estimated), which further confirms the adequacy of methods applied.

4) the estimation of confidence intervals for each element of β and for σ_ε.

Algorithm 2 includes two bootstrap procedures: in the first stage problem when bias-corrected efficiency scores are constructed, and in the second stage when those scores are applied in the truncated regression model with bootstrap, as in Algorithm 1. Procedure of Algorithm 2 can be summarized in following steps:

1) the computation of efficiency scores $\hat{\delta}_i$ for all decision making units $i = 1,...,k$;
2) the estimation of $\hat{\beta}$ and $\hat{\sigma}_\varepsilon$ using the maximum likelihood in the truncated regression of $\hat{\delta}_i$ on F_i;
3) the computation of L_1 bootstrap estimates for δ_i in the following way:

- for $i = 1,...,k$ draw ε_i from a normal distribution with variance $\hat{\sigma}^2_\varepsilon$ and left truncation at $(1 - F_i\hat{\beta})$,
- for $i = 1,...,k$ compute $\delta^*_i = F_i\hat{\beta} + \varepsilon_i$,
- for $i = 1,...,k$ set $x^*_i = x_i$ and $y^*_i = y_i\hat{\delta}_i / \delta^*_i$,
- compute new efficiency estimate on the set of data (x^*_i, y^*_i), where x_i and y_i are replaced in **(8)** with $x^*_i, i = 1,...,k$ and $y^*_i, i = 1,...,k$;

4) the computation of bias-corrected score $\hat{\hat{\delta}}_i = \hat{\delta}_i - bia\hat{s}_B(\hat{\delta}_i)$, where $bia\hat{s}_B(\hat{\delta}_i) = (B^{-1}\sum_{b=1}^{B}\hat{\delta}^*_{i,b}) - \hat{\delta}_i$.

When bias-corrected scores are computed, algorithm 2 follows algorithm 1 from step 2 onwards by replacing $\hat{\delta}_i$ with $\hat{\hat{\delta}}_i$.

Because it was not possible in version of *STATA* 10.0 that was available for us to apply bootstrap inside of panel data truncated regression, we run it without bootstrap. In order to assess what is gained by the usage of bootstrap we apply both original and bias-corrected efficiency estimators, although of course more importance is given to bias-corrected indicators. In such way we perform sort of algorithm 1 and 2 but without bootstrapping the regression.

3.3 Variables and measures

3.3.1 Input-output specification for DEA and Malmquist

The definition of *DEA* and Malmquist inputs and outputs which we use in this dissertation is based on the idea of Smith (1990) to utilize the input-output data derived from financial statements of for-profit organizations. Although there exist a number of potential problems with accounting data, in the efficiency literature there are many papers applying this strategy to analyze industrial sectors (Destefanis and Sena, 2007; Zheka, 2005; Zhang, Zhang and Zhao, 2001; Piesse and Thirtle, 2000; Thore, Kozmetsky and Phillips, 1994). Prior (2002) gives a comprehensive review of the most frequently used accounting variables in the analysis of frontier efficiency until 2001. The variables used, extended of the latest studies, are listed in Table 13.

Table 13 Accounting variables

OUTPUTS	Destefanis and Sena (2007)	Zheka (2005)	Battese, Rao and O´Donell (2004)	Sena (2004, 2006)	Zhang, Zhang and Zhao (2001)	Piesse and Thirtle (2000)	Zhu (2000) A[xxx] / B[xxxx]		Bowlin (1999)	Ahuja and Majumdar (1998)	Worth-ington (1998)	Athanass-opoulos and Ballantine (1995)	Huang Liu (1994)	Thore, Kozmetsky, Phillips (1994) A[x] / B[xx]		Hill and Kalirajan (1993)	Smith (1990)
Sales		+	+		+		+			+	+	+	+	+	+		
Turnover						+										+	
Value added	+			+					+								
Profit before tax							+				+			+	+		
Market capitalization of enterprise								+			+				+		
ROI								+									
ROE								+									
Operating profit										+							
Operating cash flow										+							
Profit after tax																	+
Financial cost																	+
Tax																	+

x static production function
xx intertemporal production function
xxx first phase of evaluation: profitability
xxxx second phase of evaluation: marketability

Table 13 - continued

INPUTS	Destefanis and Sena (2007)	Zheka (2005)	Battese, Rao and O´Donell (2004)	Sena (2004, 2006)	Zhang, Zhang and Zhao (2001)	Piesse and Thirtle (2000)	Zhu (2000) A[xxx] / B[xxxx]		Bowlin (1999)	Ahuja and Majumdar (1998)	Worth-ington (1998)	Athanass-opoulos and Ballantine (1995)	Huang and Liu (1994)	Thore, Kozmetsky Phillips (1994) A[x] / B[xx]		Hill and Kalirajan (1993)	Smith (1990)
Total cost											+						
Operating cost			+			+			+					+	+		
Material cost		+	+		+								+			+	
Employee cost		+											+			+	
Depreciation		+															
Financial cost															+		
Current assets											+						
Fixed assets	+			+	+	+				+	+	+	+	+	+		
Total assets							+		+								
Investments			+													+	
Number of employees	+		+	+	+		+			+		+		+	+		
Equity							+					+					+
Debt												+					+
Sales								+									
Profit before tax								+									
Educational attainment of employees	+																
R&D activities	+																

Source: derived from Prior (2002) and extended for latest publications

Among output variables the most frequently applied in the studies are sales revenues (Zheka, 2005; Zhang and Zhao, 2001; Athanassopoulos and Ballantine, 1995; Huang and Liu, 1994). Usually this variable is used in conjunction with other. For example, Worthington (1998), analyzing efficiency of gold production and exploration in Australia, and Thore, Kozmetsky and Phillips (1994), investigating computer industry, besides sales revenues use profit before tax and market capitalization of enterprise. However, it is believed that profits are not a good approximation of outputs, because they can be strongly influenced by environmental conditions (Al-Shammari, 1999). Furthermore, investigations of a firm level efficiency conducted by Piesse and Thirtle (2000) in the context of transition in Hungary and Hill and Kalirajan (1993) in small firms in clothing industry, apply single aggregate output, namely gross value of production (turnover). Zhu (2000) analyzing performance of the Fortune 500 companies, works with multiple outputs like return on investments and return on equity. Finally, value added is commonly used to capture firm level output because it considers both production and profit-generating relationship between inputs and outputs (Destefanis and Sena, 2007; Sena, 2004, 2006; Ahuja and Majumdar, 1998).

On the other hand, the inputs used in the studies present a huge differentiation too. Hill and Kalirajan (1993) work with three inputs, namely cost of employees, material cost and value of investments. Piesse and Thirtle (2000) use operating cost and fixed assets. In addition to those two variables, Thore, Kozmetsky and Phillips (1994) apply number of employees. Worthington (1998) works with total costs, fixed assets, and current assets. Ahuja and Majumdar (1998) and recently Sena (2004, 2006) operates with fixed assets and number of employees.

Thanassoulis (2001: 92) makes the following conclusions about the choice of variables when applying *DEA*:

- The input-output variables should be chosen according to the type of efficiency being assessed;
- The input-output variables should confirm exclusivity, exhaustiveness and exogenity principles;
- The input-output variables should be as few as possible;

- The more units being assessed, the more input-output variables which can be tolerated (without loosing on discriminatory power of efficiencies).

Following those recommendations, in our study we aim at assessing efficiency from technological perspective where sales are judged against real inputs (assets, costs and employees). To accomplish with minimization of input-output set we use only one output together with three inputs. Consistent with prior studies (Piesse and Thirtle, 2000; Thore, Kozmetsky and Phillips, 1994), we apply the following variables:

Inputs	***Output***
a. Costs of goods sold (operating cost)	a. Revenues
b. Tangible fixed assets	
c. Number of employees	

Our proxy for output are Revenues, which are the closest approximation of real output in physical units. Revenues are extracted from firms' profit and loss account and they include total sales and other operating revenues.

Regarding the inputs, costs of goods sold is another item from the profit and loss account. They involve all costs directly allocated to production including material consumption, wages and salaries relating to the production process, and other related production expenses such as rents. Tangible fixed assets represent the total amount of property, plant and equipment in monetary terms net of depreciation. Number of employees shows a yearly average of full-time workers. Choosing costs of goods sold and number of employees as inputs we are aware that to some extent the duplication of labour costs occurs as costs of goods sold include labour costs related with production process (that is the multiplication of number of employees and wages). However, even if that has place there are no negative influences for efficiency measurement because: 1) when all elements of costs of goods sold are non zero, then there is no significant correlation between costs of goods sold and number of employees; 2) even if all elements of costs of goods sold except for labour costs are equal to zero, then the efficiency scores obtained do not change. On the other hand, of course it would be much safer to use other operating costs that is operating costs net of labour costs as an input, but this data was available only for a limited number of companies, therefore choosing this strategy we would loose a considerable amount of firms for analysis.

Tables below present the descriptive statistics for *DEA* and Malmquist variables with regard to the entire period and total industry. Detailed descriptive statistics for every year and industrial branch are included as Appendix 6 and 7.

Table 14 Input-output specification for *DEA* used in the regression (descriptive statistics for the pooled sample, 1995-2004)

Statistic / Variable	Mean	Std. dev.	Min	Max	25th percentile	75th percentile
INPUT						
Costs of goods sold	240274.7	581037.2	5.7	1.52e+07	38405.8	245029.4
Tangible fixed assets	125525.4	282981.2	0.5	4673960	13378.6	119289.3
Number of employees	2871	6458	2	121636	390	2786
OUTPUT						
Revenues	343973.5	761564.6	8.1	1.70e+07	54287.1	338796.6
Number of observations: 5477						

All variables, except for number of employees are expressed in thousand of the USA dollars, calculated by purchasing power parity PPP.

Table 15 Input-output specification for Malmquist analysis (descriptive statistics for the pooled sample, 1995-2004)

Statistic / Variable	Mean	Std. dev.	Min	Max	25th percentile	75th percentile
INPUT						
Costs of goods sold	241289.9	597039.8	10.5	1.44e+07	34066	238405.6
Tangible fixed assets	116918.8	276526	5.9	4971454	11542.5	111327
Number of employees	2882	6638	2	121636	377	2787
OUTPUT						
Revenues	346245.3	780521	8.09	1.57e+07	47588.4	327824.3
Number of observations: 4982						

All variables, except for number of employees are expressed in thousand of the USA dollars, calculated by purchasing power parity PPP, constant prices from 1995.

We observe that the mean textile and clothing company in our sample is very big with 2871 (*DEA*) and 2882 (Malmquist) employees, suggesting that our database is biased towards large companies. On the other hand, the standard deviation is relatively high showing that our sample is very heterogeneous with very small and very big firms. The similar conclusions can be made by looking at the mean values of tangibles and revenues.

3.3.2 Variables used in the regression

As outlined before, our dependent variables for the second stage analysis are original and bias-corrected efficiency estimator (Simar and Wilson, 1998, 2000a, 2000b). Based on the hypotheses developed, we need to operationalize the following independent variables: intangible assets, leverage, learning by experience, economic development and economic integration. We also add some control factors that are often applied both in intangibles and efficiency literature: industry branch, geographical location and firm size. The justification and details on every measurement are described below.

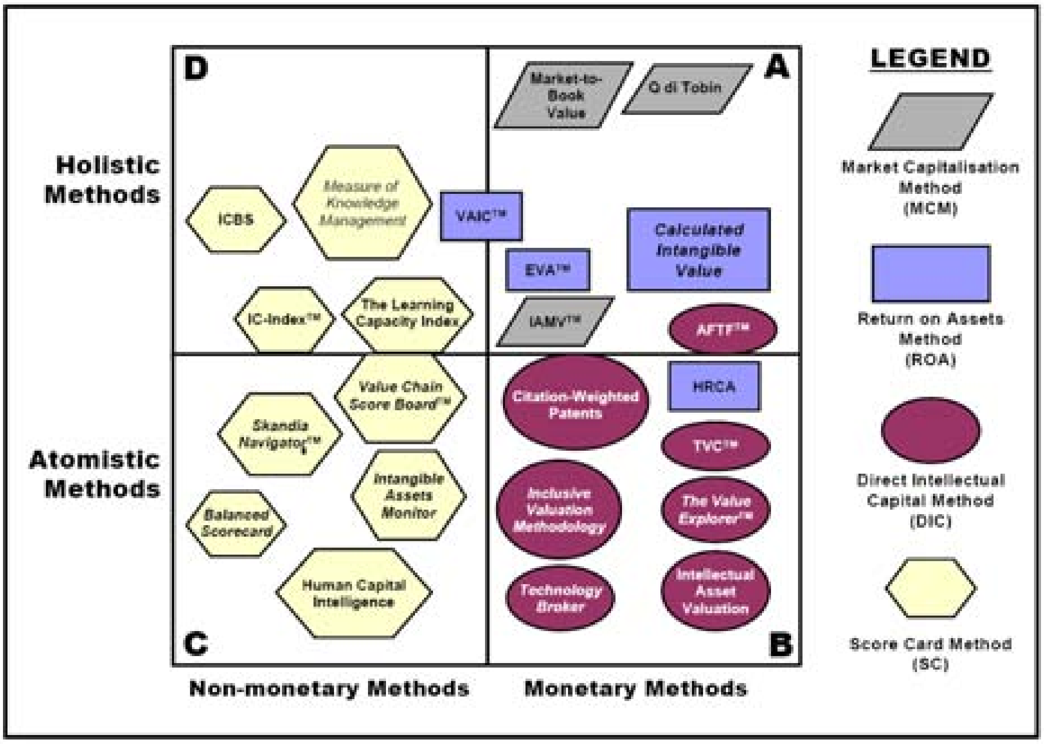
3.3.2.1 A review of available methods for intangible assets' measurement

There exists a vast of methods of intangibles measurement and valuation in the relevant literature. Sveiby (2001) distinguished between four groups of methods: 1) direct intellectual capital methods (estimation of value of intangible assets by identifying and evaluating its various components, for example Technology Broker method); 2) market capitalization methods (calculation of the difference between a company market capitalization and its stockholders equity, for example Market to Book Value or *Tobin's Q*); 3) return on assets methods (comparison of company return on assets with industry average, the multiplication of the difference by the company average tangible assets to obtain average annual earnings from intangibles, then division of the above-average earnings by the company average costs of capital or an interest rate, obtaining the value of intangible assets, for example Economic Value Added *EVA*^{TM}); and 4) scorecard methods (generation of indices of various components of intangible assets and reporting them in scorecards or as graphs, for example Intangible Asset Monitor).

On the other hand, Mavridis (2004) classified all methodologies into two groups: process- and value-oriented. The first group focuses on the cost or expenses and captures intangible assets through the difference between market and book value, while the second asks for the profit or investment returns and its drivers.

We think that the most comprehensive and complete classification of methods is provided in the European Commission work "Study on the measurement of intangible assets and associated reporting practices"[40]. This review, basing on Sveiby (2001), categorized all methods taking into account four characteristics: Atomistic / Holistic methods, and Monetary / Non-monetary methods (Figure 12).

Figure 12 Models for measuring intangible assets



Source: publication of the European Commission "Study on the measurement of intangible assets and associated reporting practices"

Atomistic / Holistic dimension refers to the attitude of the model to address the measurement of an individual intangible asset or of all intangibles, respectively. On the other hand, the Monetary / Non-monetary dimension distinguishes between financial (accounting) and non-financial measurements of intangibles. Crossing all categories, in total four groups of models exists: 1) models using financial methods to provide the

[40] For more details on all methods as well as for other classifications, see Andriessen (2004), Bontis (2001) or Sveiby (2001).

general representation of company intangibles (category A); 2) models applying monetary methods to individual intangible assets (category B); 3) models of non-monetary methods for individual intangible assets (category C); and 4) non-monetary methods applied for all intangible assets, which so far is addressed by literature to a lesser extent (category D).

The most representative of group A is Market to Book Value. The assumption behind this method is that intangible assets are contained in the difference between the firm's market value and its accounting value. Hence, to calculate this indicator we divide market value (from the stock market) by accounting value (from financial statements). The higher is this ratio, the greater is the proportion of a firm's asset base that is of intangible character.

With regard to group B, worth reviewing in more details is Technology Broker. This model is attributed to Brooking (1996). To some extent the objective of Technology Broker is to provide the guide to make the audits of intangibles in firms. In short, in this method the value of intangible assets is assessed based on the analysis of a firm's response to twenty questions, which cover four major components of intangibles: market assets, human-centred assets, intellectual property assets and infrastructure asset. Further each block is examined through a number of questionnaires which compromise of questions specific for that intangible category. In total, the Technology Broker contains 178 questions. When all questions are answered, three methods of calculating value for intangible assets are proposed (Bontis, 2001): 1) cost approach that is an assessment of replacement cost of the asset; 2) market approach applying market comparables in order to assess value; and 3) income approach which measures the capability of asset to produce income.

Intangible Assets Monitor is representative for Category C. This model is indebted to Sveiby (1997). It distinguishes between three groups of intangible assets: employee's competence, internal and external structure. For each of those dimensions three aspects of intangibles' value creation are assessed: 1) growth and renewal; 2) efficiency; and 3) stability. Then for each intangible dimension and for each indicator of value creation, there is a list of indicative variables. The manager of the firm is recommended to choose one or two of those variables for each indicator. The choice should be made depending on the company strategy. Therefore, this method can be essentially interpreted as a strategic tool. In addition, it is worth pointing out, that Intangible Assets Monitor is a widely shared point of a reference for the development of intangible assets reporting in practice, and many companies adopted it in their intangibles statements.

Regarding group D, Intellectual Capital Index *(IC-Index*^{TM}) attempts to consolidate all individual indicators of intangibles into a single index and then relate the changes in intangible assets with changes in the market valuation. This index was developed by Roos et al. (1997). The following distinct features of the index can be distinguished (Bontis, 2001): - it is an idiosyncratic measure; - it focuses on the monitoring of the dynamics of intangibles; - it is capable of taking into account performance from prior periods; - it sheds light on a company different from an external view typically based on the examination of tangible assets; and - it is a self-correcting index that is if the index does not reflect changes of the market value of the firm, then the choice of capital forms is flawed. Above all, this index is context-specific as it measures the company intangibles dimensions basing on the company strategy, characteristics of the particular business and its day-to-day operations.

Worth mentioning is also Value Added Intellectual Coefficient ($VAIC^{TM}$) which belongs to both categories A and D. This measure provides the information about the value creation efficiency of tangible and intangible assets within a company and was proposed by Pulic (2004). $VAIC^{TM}$ can be computed in following steps:

1) Computation of value added for the company (*VA*)

$VA = OUTPUT - INPUT$

where: *OUTPUT* = total sales,

INPUT = cost of bought-in materials, components and services.

It can be calculated from company accounts as follows:

VA = *OP* (operating profit) + *EC* (employee costs) + *D* (depreciation) + *A* (amortization).

2) Computation of human capital efficiency (*HCE*)

$HCE = VA / HC$,

where: *HC* = total salaries and wages for a company.

3) Computation of structural capital efficiency (*SCE*)

$SCE = SC / VA,$

where: SC = structural capital = $VA – HC$.

3) Computation of intellectual capital efficiency (*ICE*)

$ICE = HCE + SCE.$

4) Computation of capital employed efficiency (*CEE*)

$CEE = VA / CE,$

where: CE = book value of net assets for a company.

5) Computation of Value Added Intellectual Capital Coefficient ($VAIC^{TM}$)

$VAIC^{TM} = ICE + CEE.$

Each of the methods described by Figure 12 has its advantages and disadvantages and more appropriate context of application. Because the monetary methods are useful in the case of comparison of companies in the same industry[41] and most of all due to the data availability, we decide to use one of the methods from this group. In particular, we measure intangible assets through *Tobin's Q* ratio. We also bear in mind the observation made by Juma an Payne (2004) who concluded that future studies of intangibles need to test various more prominent measurement models, among them *Tobin's Q*. *Tobin's Q*[42] can be defined as the market value of the firm's financial claims to the replacement cost of the firm's assets (Chung and Pruitt, 1994; Lindenberg and Ross, 1981). The measurement of intangibles is in this case based on the assumption that a firm's equilibrium market value must be equal to the replacement value of its assets, giving the value of *Tobin's Q* close to unity. The deviations from this relationship when *Tobin's Q* is greater than unity are interpreted as unmeasured source of value attributed to intangible assets. There are practical problems associated with implementing this definition because the variables indicated are not observable. Therefore, *Tobin's Q* is normally approximated following Chung and Pruitt (1994) as:

$Tobin's\ Q = (MV + DEBT) / TA$

where: MV = Market value

$DEBT$ = Short term liabilities + Long term liabilities

TA = Book value of total assets.

[41] According to the European Commission work "Study on the measurement of intangible assets and associated reporting practices".

[42] The development of *Tobin's Q* is due to the Nobel Prize winner James Tobin. For detailed development of the measure see Tobin (1969).

Total assets is an item derived from firms' balance sheet and they consist of a sum of tangible fixed assets, intangible assets, investments, other assets, total stocks and work in progress, total debtors and equivalent, and cash and cash equivalents. Debt is also a balance sheet item encompassing the total of long and short term borrowings. These accounting magnitudes composing of *Tobin's Q* are calculated by constant purchasing power parities of each currency relative to the USA dollar.
In such definition we see, therefore, that *Tobin's Q* differs from Market to Book ratio by incorporating the value of debt and all assets, not just equity.

3.3.2.2 Measurement of other internal factors

Learning by experience

In the literature learning is assessed in different ways. It is considered as an outcome of engineering activities, experimentation, process innovation management, quality improvement and workforce training. Bhatt and Grover (2005) measure organizational learning through a number of indicators subjectively assessed by firm managers: the ability of firm to search and acquire new and relevant knowledge, the ability of the firm to assimilate and apply relevant knowledge, and the extent of concerted efforts for the exploitation of existing competences and exploration of new knowledge. Hatch and Dyer (2004) assess learning by density of defects in manufacturing as all defects are the result of some lack of knowledge.

We are unable to measure firm learning in one of the ways explained, given our data set. We treat learning as an outcome of firm experience. The critical source of experience is an organizational aging. And firm experience is usually assessed in the literature as firm age (Delios and Beamish, 2001). We therefore include the firm age as a proxy for firm learning by experience. Age, on the other hand, is measured following the widely applied approach both in intangibles and efficiency research as a number of years since establishment to the date of observation (Balcombe et al., 2008; Wadud, 2004; Youndt, Subramaniam and Snell, 2004; Delios and Beamish, 2001; Majumdar and Chhibber, 1999; Hill and Kalirajan, 1993).

Leverage

Leverage is measured as a firm indebtedness relative to the size of its asset base. It is a ratio of accounting value of debt to accounting value of total assets. This definition and assessment is frequently adopted in the literature on the relationship between leverage and efficiency (Weill, 2008; Margaritis and Psillaki, 2007; Pushner, 1995). These accounting magnitudes are calculated by constant purchasing power parities of each currency relative to the USA dollar.

3.3.2.3 Operationalization of external factors

Economic development

Because the main aim of economic development is increase in the real per capita income, we measure it by Gross Domestic Product (*GDP*) per capita[43] of each country where our firms were established and have their headquarters localized (nationality of firms). It is worth pointing out that organizations such as *World Bank* or International Monetary Fund (*IMF*) for the purpose of categorizing countries into developed or developing use a criterion of *GDP* per capita. *GDP* is the value of all goods and services produced within a country. *GDP* per capita, on the other hand, gives a rough guide to average income per person in the country. In general, countries with higher *GDP* per capita are more economically developed than those with low *GDP* per capita. Although *GDP* per capita might underestimate economic development as official statistics do not include black market, we choose this measure as it satisfies the primary goal of economic development that is the increase in the real per capita income. *GDP* per capita is calculated by purchasing power parity of each currency relative to the USA dollar[44]. Therefore, we compensate for the weaknesses of local currencies in the world markets and consequently, the differences between countries turn to be smaller than it would occur by using exchange rates. Moreover, we use constant purchasing power parity that is we adjust it by inflation taking into account the change in the prices (our reference year is 1995).

[43] The source for *GDP* per capita was *World Bank*.

[44] Due to lack of data for Taiwan, *GDP* per capita of this country is adjusted by exchange rate and price index.

Economic integration

As it was outlined before, two important integration initiatives can be distinguished nowadays: European Union (*EU*) and North American Free Trade Agreement (*NAFTA*)[45]. Therefore, here we measure the economic integration by the country membership to either *EU* or *NAFTA*. For this purpose we introduce two dummy variables for each firm, defined as follows:

1) variable capturing *EU* membership: value of 0 – a firm from the country not participating in the *EU*, value of 1 – a firm from the country participating in the EU;

2) variable capturing *NAFTA* membership defined in a similar manner that is 0 – not belonging to *NAFTA*, 1 – belonging to *NAFTA*.

3.3.2.4 Control factors

Industry

Although in the analysis of *DEA* efficiency we integrated textile and clothing branches together, now we include industry as a control variable to disentangle industry characteristics. We introduce a dummy variable denoted as 0 – textile firm, 1 – clothing firm. Due to the fact that according to the information provided by some databases (*DATASTREAM*) sometimes firms could be classified as both textile and clothing, the variable indicates the branch from which firm obtains the greatest revenues.

Geographical location

Additionally, as we analyze textile and clothing firms in different regions in the world, efficiency outcomes might vary between geographical locations of firms. We classify the textile and apparel companies into 6 geographical locations: Asia, Europe, North America, Middle and South America, Australia and Oceania and Africa. Each of these categories is represented by a dummy variable (Asia, Eur, Nam, Msam, Aus, Afr) with region of Europe used as a reference. We make this distinction taking into account the headquarters localization, not plant localization as globalized firms might have their factories in different countries and regions.

[45] There are many other initiatives in the world, like for example in Asia exists Association of Southeast Asian Nations (*ASEAN*) compromising of ten countries: Brunei, Cambodia, Indonesia, Lao, Malaysia, Myanmar, Philippines, Singapore, Thailand and Vietnam. Because they represent a very small degree of integration, we omit them in this research.

Size

Because our sample is very heterogeneous, consisting of very small and very large firms, we also control for a company size. Size is a widely applied control variable in intangibles literature as well as is a recurrent issue in the efficiency research. However, the sign of the relationship between size and efficiency is not clear. On the one hand, efficiency can decline with an increase in firm size due to replacement of gains of the labour division with costs as routines cause boredom and diminish creativity, reduced speed and flexibility of decision making, and increased cost of coordination (Downs, 1967; Robinson, 1962[46]). On the other hand, size is considered to enhance a firm's ability to sustain a competitive advantage when economies of scale, economies of scope, market power or learning effects are presented, and greater differentiation is possible (Jovanovic, 1982; Prescott and Visher, 1980; Penrose, 1959). Large firms may benefit also from pecuniary economies of scale that is from cost savings resulting for example, from buying of raw material in large quantities at lower prices than their smaller rivals (Scitovsky, 1954).

One possible method of measuring size applied frequently in intangibles and efficiency literature is a number of full time employees (Youndt, Subramaniam and Snell, 2004; Mini and Rodriguez, 2000), but we use this variable already in the first stage of our analysis that is for computing efficiency coefficients. Another one utilized very often are revenues and sales (Roberts and Dowling, 2002; Ahuja and Majumdar, 1998), but once again firm revenues was taken as a proxy for output in the computation of efficiency. Finally, another standard practice is to use total assets (Li and Wu, 2004; Riahi-Belkaoui, 2003) and here we follow this approach. In particular we take logarithm of total assets as this transformation was necessary to normalize this data. The value of total assets is calculated by constant purchasing power parities of each currency relative to the USA dollar.

The table below presents the descriptive statistics of all variables for the pooled sample[47]. Detailed descriptive statistics (for every year and industrial branch) are reported in Appendix 8.

[46] As cited by Färe, Grosskopf and Lovell (1985).

[47] Note that the means for efficiency coefficient (input distance function) are presented and discussed in the chapter that deals with results.

Table 16 Explanatory variables used in the regression (descriptive statistics for the pooled sample, 1995-2004)

Statistic / Variable	Mean	Std. dev.	Min	Max	25th percentile	75th percentile
Intangibles (*Tobin's Q*)	1.176	1.093	0	8.883	0.598	1.285
Leverage (ratio)	0.427	0.355	0	6.924	0.225	0.568
Learning (age)	20	27	0	258	7	23
Development	22.466	11.666	1.790	70.283	13.606	29.082
EU	0.233	0.423	0	1	0	0
NAFTA	0.189	0.392	0	1	0	0
Industry	0.511	0.450	0	1	0	1
Size	378551.8	803739.9	54.430	1.36e+07	47369.340	366084.9
Asia	0.490	0.500	0	1	0	1
Eur	0.263	0.440	0	1	0	1
Nam	0.200	0.400	0	1	0	0
Msam	0.037	0.188	0	1	0	0
Aus	0.007	0.084	0	1	0	0
Afr	0.003	0.057	0	1	0	0
Number of observations: 5477						

Notes: 1) monetary values, except where indicated and for age, are presented in thousand of the USA dollars, calculated by purchasing power parity PPP, constant prices from 1995; 2) for dummy variables (EU, NAFTA, Industry, Asia, Eur, Nam, Msam, Aus, Afr), the mean value gives the proportions of observations exhibiting value 1.

What is interesting to note from Table 16 is that the sample average *Tobin's Q* ratio is 1.176, which says that textile and clothing firms on average possess intangible assets. The mean company is relatively young that is it has 20 years (with relatively high standard deviation), and is large what was already outlined in Tables 14 and 15. Regarding country development as measured by *GDP* per capita on average firms in our sample are from countries with very high *GDP* per capita (22466 USA dollars). The minimum value of 1790 USA dollars is the case of India, while maximum of 70283 USA dollars is represented by Bermuda. 23% of firms in our sample are from countries which are members of *EU*, while 18% belong to *NAFTA*. The sample is distributed almost equally between textile and clothing firms, what was already outlined before. Finally to note is that Asian, European and North American firms are mostly represented (49%, 26% and 20% of total sample, respectively).

CHAPTER 4

Analysis and Interpretations of Results

4 Analysis and Interpretations of Results

In this chapter the results of analysis are presented. Firstly, we show and discuss *DEA* efficiency of firms in the sample. We perform the sensitivity analysis by application of bootstrap. The results are compared between different regions and branches of the textile and clothing industry. Then we move on to the time-series investigations to assess the productivity and efficiency change over time. In order to reach this aim we discuss the results of Malmquist index and its decomposition into technical and efficiency change. We assess the statistical significance of the results by analyzing the confidence intervals of computed indexes. We point out to the differences between regions and branches of the textile and clothing sector. Finally, we proceed with analyzing the results of truncated regression with respect to the hypotheses developed. Here we compare findings between two models: the application of bias-corrected and original input distance functions estimation as dependent variables.

4.1 Static efficiency – results of *DEA* bias-corrected input distance function

4.1.1 General trends in the industry

As a result of applying the Simar and Wilson (1998, 2000a, 2000b) bootstrap algorithm with *FEAR*, we obtain four main measures: 1) original input distance estimates, that is without bootstrap ($\hat{\delta}_i$); 2) bootstrap bias ($bi\hat{a}s_B$); 3) bias-corrected input distance function ($\hat{\hat{\delta}}_i$); and 4) upper and lower bounds for 95% confidence intervals for the input distance function. Means of those measures for the entire period as well as for every year of analysis are shown in Table 17. It is worth observing that because the values of these efficiency indicators fall into the interval between 1 and infinity, implying that 1 means a 100% efficient firm, in fact, what we measure with input distance function is the level of firm inefficiency (in other words - inefficiency coefficient).

Table 17 Mean efficiency results with bootstrap

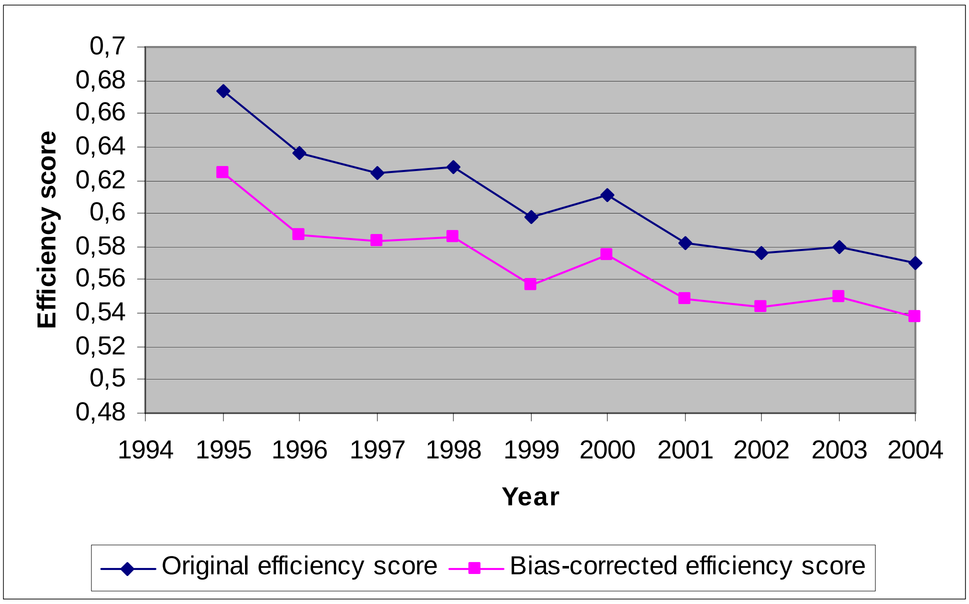
Year	Number of firms	Original input distance function $\hat{\delta}_i$	Bootstrap bias $bia\hat{s}_B$	Bias-corrected input distance function $\hat{\hat{\delta}}_i$	Confidence interval	
					Lower bound	Upper bound
1995	272	1.485 (9.191)	-0.116	1.602	1.530	1.740
1996	284	1.571 (9.155)	-0.127	1.702	1.575	1.804
1997	322	1.602 (6.832)	-0.112	1.713	1.616	1.825
1998	352	1.592 (8.807)	-0.116	1.708	1.614	1.827
1999	426	1.672 (5.164)	-0.123	1.797	1.682	1.904
2000	589	1.636 (5.772)	-0.107	1.741	1.666	1.851
2001	668	1.717 (5.224)	-0.098	1.824	1.717	1.925
2002	796	1.734 (5.772)	-0.105	1.839	1.753	1.936
2003	863	1.725 (4.745)	-0.097	1.821	1.749	1.917
2004	905	1.755 (4.967)	-0.102	1.858	1.761	1.940
1995-2004	5477	1.681 (5.965)	-0.107	1.789	1.697	1.891

The values presented in the brackets show the percentage of firms with original input distance function of unity

The first thing to note from Table 17 is that during the period of investigation on average textile and clothing firms in our sample are inefficient in 68%, that is they could have reduce their inputs by 68% maintaining the same output level. Only less than 6% of firms in the sample are efficient that is with an input distance function of unity. When taking bias-corrected estimates, mean inefficiency in the sample increases to 78%. Analyzing the changes between 1995 and 2004 we observe a decrease in efficiency, also with respect to a number of firms with input distance function of unity (approximately 9% in 1995 compared to less than 5% in 2004). In 1995 both the mean input distance function and corrected by bias reach their lowest values (1.485 and 1.602, respectively), hence the lowest level of inefficiency is observed. Only between 1997 and 1998, 1999 and 2000, and 2002 and 2003 we note a slight improvement when looking at both original input distance function estimation and corrected by bias.

The graph below shows the mean original efficiency scores and bias-corrected estimations (we take the reciprocal of both original and bias-corrected input distance functions in order to show the value of efficiency coefficient).

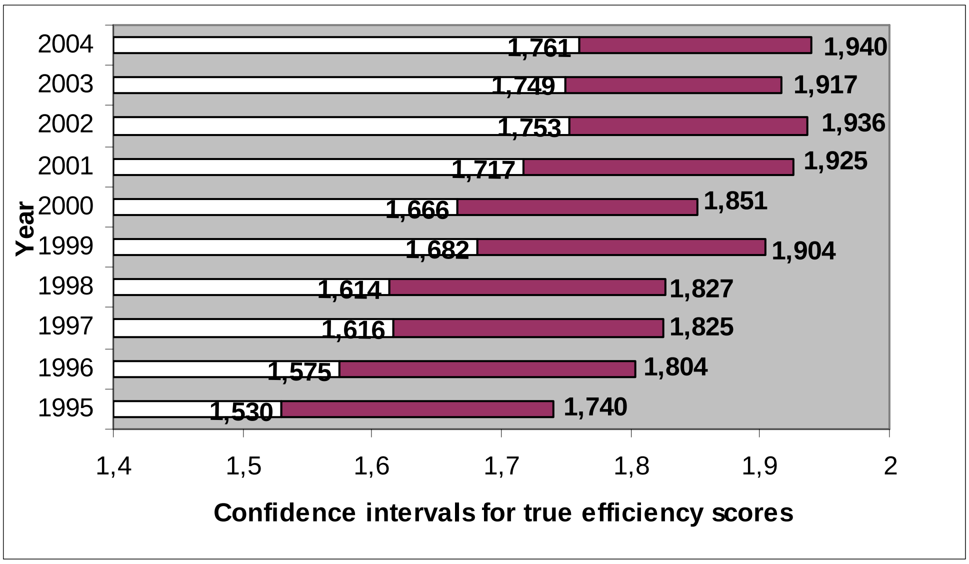
Figure 13 Efficiency trend for 1995-2004



We see on the graph that the general trend is negative showing that efficiency declines between 1995 and 2004, both when we take original and bias-corrected efficiency score. We see only small fluctuation and increase in 1998, 2000 and 2003. Finally, we can also observe that bias-corrected efficiency scores are always lower than original measures.

To more properly interpret the means of input distance functions and differences between 1995 and 2004, we have to analyze the information on confidence intervals as they show the statistical location of true input distance functions (Figure 14).

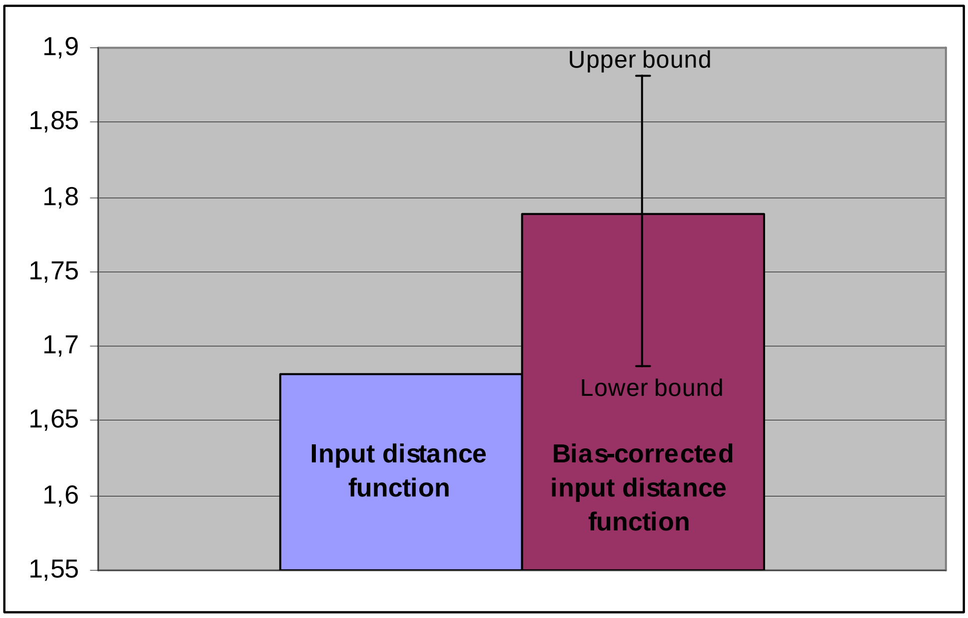
Figure 14 Confidence intervals for true efficiency scores (input distance function)



The real values of input distance function lie inside of the second column marked with colour. We see on the graph that the mean upper bound in 1995 is strictly less than the mean lower bound in 2004; hence the confidence intervals do not overlap. Therefore, truly efficiency of textile and apparel firms decreases between those two years.

To sum up, on average, the bias-corrected input distance functions are lower than the original ones (indicating higher level of inefficiency) and the values of real input distance functions are contained in the interval between 1.697 and 1.891 (Figure 15).

Figure 15 Input distance function and bias-corrected estimation together with confidence intervals

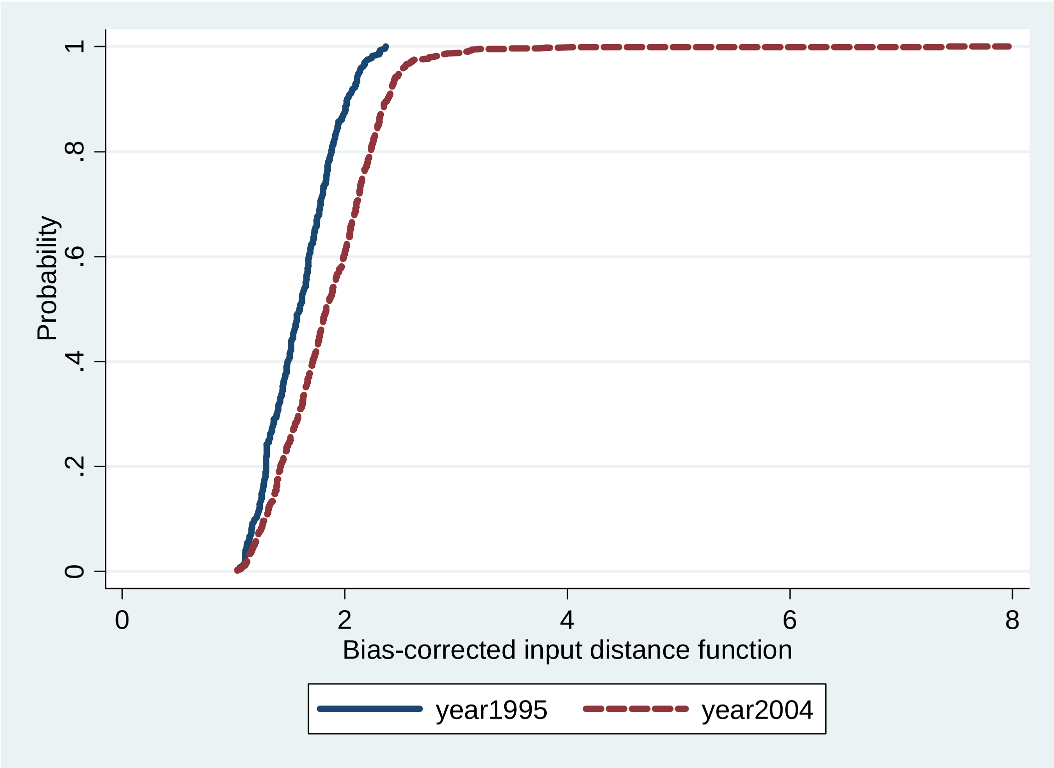


Furthermore, we perform a test of stochastic dominance to evaluate if distributions of bias-corrected input distance function in initial and final year of analysis are different (1995 versus 2004). Stochastic dominance refers to the differences that may hold between a pair of distributions, which are characterized by their cumulative distribution functions[48]. Formally, let us suppose that we have two distributions A and B with cumulative distribution functions F and G, respectively. First order stochastic dominance of A relative to B is defined by: $F(x) - G(x) \leq 0$ for any argument $x \in R$ (Delgado, Fariñas and Ruano, 2002). We need to test the following hypothesis: $H_0 : F(x) = G(x)$ *for all* $x \in R$ versus $H_1 : F(x) \neq G(x)$ *for at least one value of* x. To test this hypothesis the Kolmogorov-Smirnov two-sided test is used which allows to determine if both distributions are identical or not (Conover, 1971).

Figure 16 reports the differences between the bias-corrected input distance functions distributions in 1995 and 2004.

[48] Tests of stochastic dominance are more general than the Wilcoxon tests as they test if the entire distribution is different.

Figure 16 Differences in bias-corrected input distance functions: 1995 versus 2004 (smooth sample distribution function)



It can be seen on the graph that the position of the distribution for 1995 with respect to 2004 indicates higher levels of efficiency for 1995 versus 2004 (that is lower levels of inefficiency as represented by input distance function). All quartiles of bias-corrected input distance function are higher for 2004 relative to 1995. It suggests that the distribution of bias-corrected input distance function in 1995 stochastically dominates the distribution of 2004.

Kolmogorov-Smirnov test results are presented in table below.

Table 18 Differences between 1995 and 2004 – Kolmogorov-Smirnov test statistics

Number of observations		Equality of distributions	
1995	**2004**	**Statistic**	**P-value**
272	905	0.2882	0.000

The test in Table 18 suggest that the null hypothesis of equality between distributions in 1995 and 2004 can be rejected at 0.01 level of confidence.

It is worth pointing out that the figures of efficiency reported here, while being relatively low, are broadly comparable with other studies using the data from the textile and clothing industry in different countries. However, the study for a direct comparison does not exist as all papers identified use the database consisting of firms from exclusively one country and here we treat many different countries. Nevertheless, the general negative situation of textile and clothing firms with regard to efficiency found in this dissertation imitates the one shown in other studies. In particular, our results coincide with those of Wadud (2004) who reported low efficiency scores of firms in this industry in Australia ranging between 42% and 51% (between 58% and 49% of inefficiency). They also go in line with Jaforullah (1999), who found 59% inefficiency in the textile industry in Bangladesh, and with Margono and Sharma (2006) and Battese, Rao and O'Donnell (2004), who reported for textile and clothing firms in Indonesia approximately 53% of inefficiency. A little lower levels were demonstrated by Hill and Kalirajan (1993) in Indonesian apparel industry, by Goaïed and Ayed-Mouelhi (2000) for Tunisian textile, clothing and leather industries, and by Deraniyagala (2001) for this industry in Sri Lanka, reporting respectively 38%, 34% and 40% of inefficiency. The average efficiency found here is almost identical as obtained by Goncharuk (2007) who shows 73% of inefficiency in the textile industry in Ukraine in 2004, and by Chapelle and Plane (2005a,b) reporting 67% of inefficiency in Ivorian textile and clothing firms. Finally, similar conclusions were made by Chandra et al. (1998) who show that the majority of the textile companies in Canada do not perform well with efficiency level reaching 69%, with a few firms being efficient and the rest very poor performers.

4.1.2 Regional analysis[49]

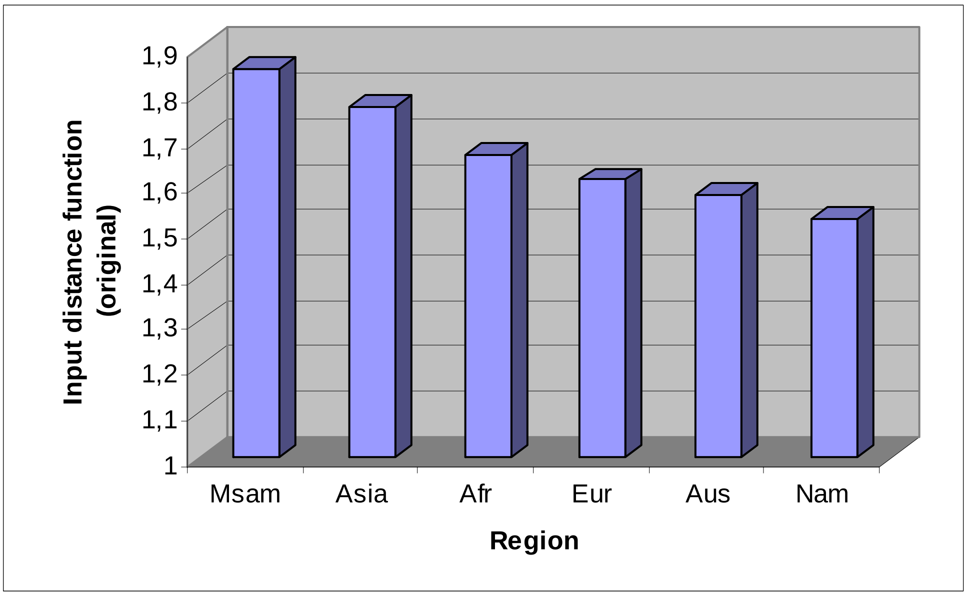
Table 19 lists the average measures of original and bias-corrected input distance functions, bootstrap bias and confidence intervals for 1995-2004 time-period according to the regional distribution of firms. Original input distance functions of different regions are presented on Figure 17. Note that regions on the graph are ordered according to the decreasing values of inefficiency.

[49] Similar analysis but with different database encompassing textile and clothing firms in two countries of Poland and Spain we conduct in Kapelko and Rialp-Criado (2009).

Table 19 Mean efficiency results with bootstrap for regions, 1995-2004

Region	**Number of firms**	**Original input distance function** $\hat{\delta}_i$	**Bootstrap bias** $bia\hat{s}_B$	**Bias-corrected input distance function** $\hat{\hat{\delta}}_i$	**Confidence interval**	
					Lower bound	Upper bound
Asia	2681	1.771	-0.092	1.866	1.785	1.959
Europe (Eur)	1441	1.611	-0.107	1.717	1.628	1.819
North America (Nam)	1097	1.524	-0.148	1.674	1.547	1.804
Middle and South America (Msam)	201	1.854	-0.069	1.923	1.863	1.995
Rest of world:	57	1.607	-0.124	1.730	1.623	1.843
Australia and Oceania (Aus)	39	1.580	-0.114	1.693	1.592	1.791
Africa (Afr)	18	1.664	-0.145	1.810	1.690	1.956

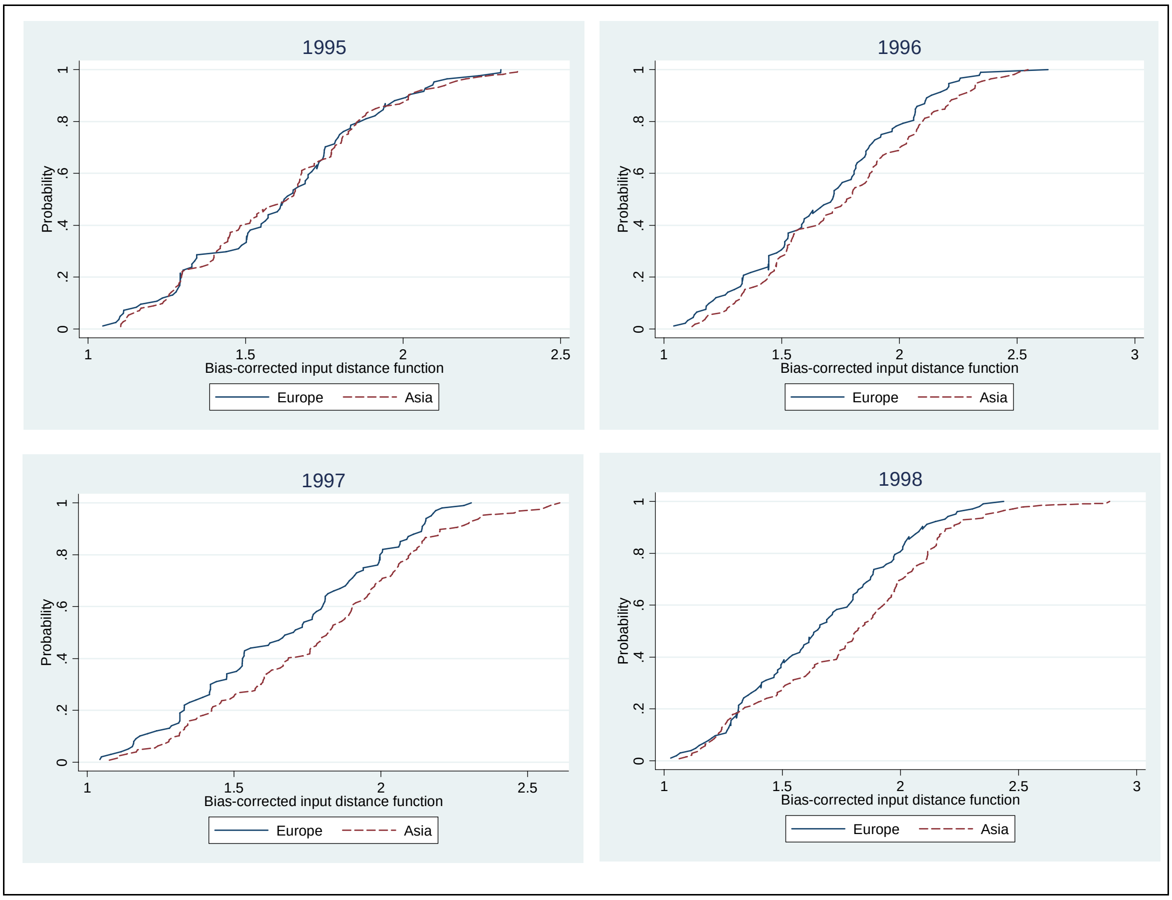
Figure 17 Efficiency of regions, 1995-2004

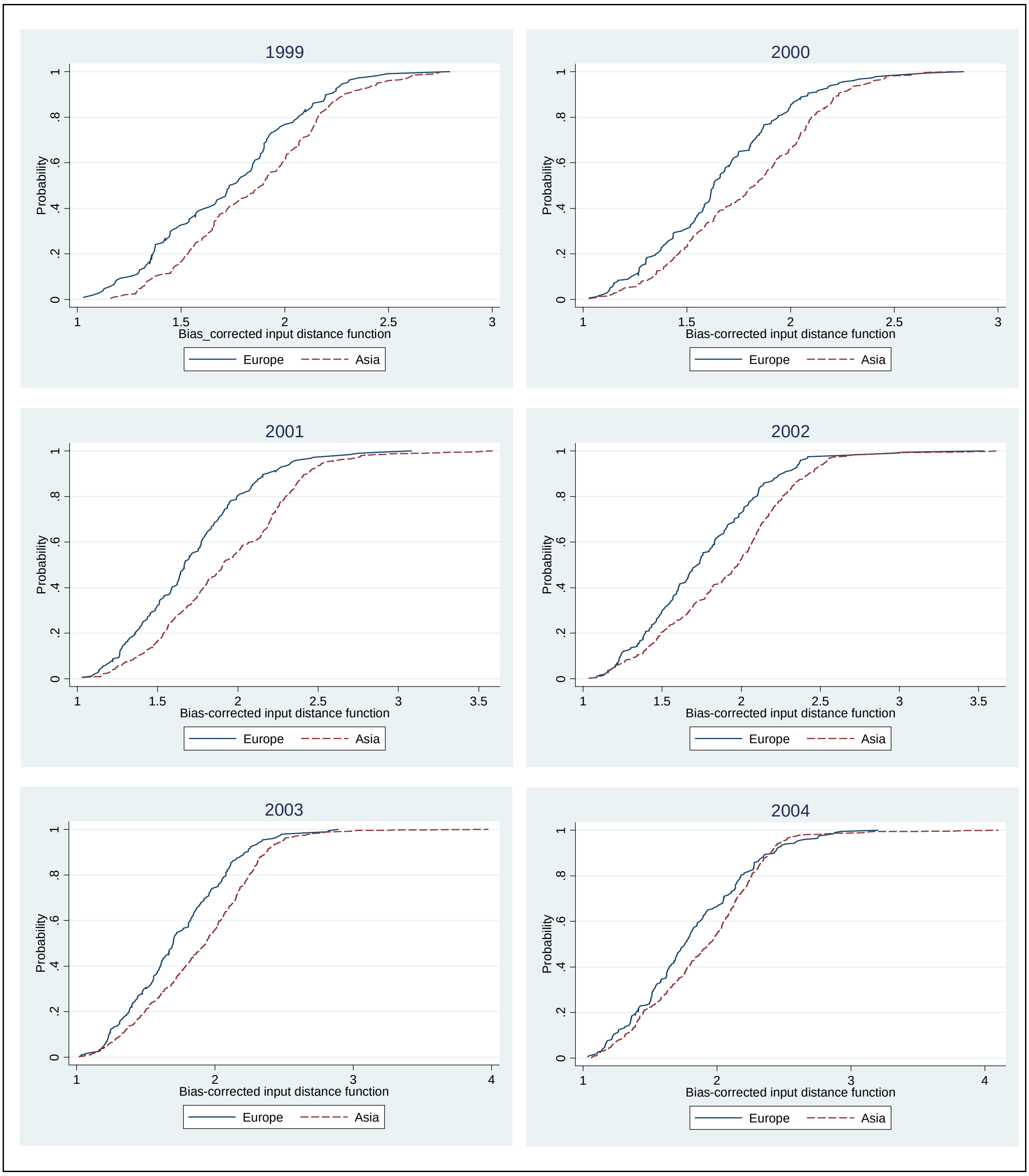


The values of efficiency observed in regions are relatively low with Middle and South America hitting the lowest level of 85% of inefficiency. According to the findings the most efficient region is North America and firms are inefficient in 52% assuming the original efficiency score, and 67% when the bias-corrected estimation is taken into account. In the middle place themselves firms from Asia, Europe and the Rest of world (Australia and Oceania, and Africa) with original efficiency scores ranging from 1.607 to 1.611. It is interesting to note that the region of the Rest of world hits before Europe with regard to the original efficiency score, but is efficiently worse when the bias-corrected efficiency is analyzed. In this context, the results of bias-corrected input distance function are of more importance.

We further analyze two regions: Europe and Asia as in general they represent two different levels of development. We use the test of stochastic dominance described before to assess the differences between distributions of bias-corrected input distance function for those regions. Because the application of Kolmogorov-Smirnov test requires independence of observations (Conover, 1971), and as we possess panel data of ten years, we calculate the statistic separately for each time period. The figure below presents the differences of distributions for bias-corrected input distance function between Europe and Asia for each year of 1995-2004 time-period.

Figure 18 Differences in bias-corrected input distance functions: Europe versus Asia (smooth sample distribution function)





It can be observed on the graph that for all years, except for 1995 and 1996, the position of distribution of Asian firms is below the distribution of European firms, which indicates higher levels of input distance function for Asian firms with respect to European firms, that is lower levels of efficiency. This finding can be interpreted as follows. In Europe a higher degree of economic development goes in line with higher efficiency of textile and clothing firms. Hence, in more economically developed region firms meet better conditions, have more opportunities for growth and gain higher efficiency results.

The results of Kolmogorov-Smirnov test are presented in the table below.

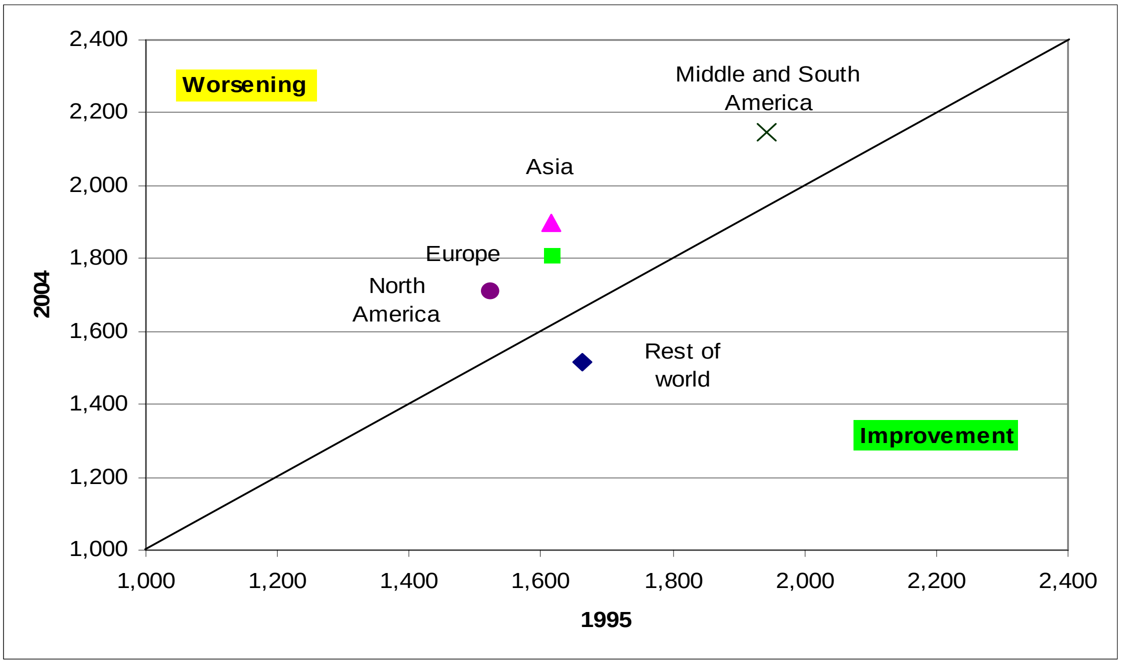
Table 20 Differences between Europe and Asia – Kolmogorov-Smirnov test statistics

Year	Number of observations		Equality of distributions	
	Europe	**Asia**	**Statistic**	**P-value**
1995	84	113	0.0887	0.843
1996	92	112	0.1223	0.437
1997	100	127	0.1723	0.072
1998	103	141	0.1925	0.024
1999	108	201	0.1868	0.015
2000	180	264	0.2250	0.000
2001	193	325	0.2639	0.000
2002	199	421	0.2279	0.000
2003	195	474	0.2072	0.000
2004	197	503	0.1575	0.002

P-values in the Table 20 indicate that for all years except for 1995 and 1996 the null hypothesis of equality of distributions of European versus Asian firms can be rejected (at 0.1 level in 1997, at 0.05 level in 1998 and 1999, and at 0.01 level in the rest of years). Only for 1995 and 1996 we cannot reject this hypothesis.

We perform also a comparison between the mean bias-corrected input distance function for 1995 and 2004 for regions under analysis in order to assess how efficiency changes over time. The results are presented in Figure 19.

Figure 19 Efficiency of regions: 1995 versus 2004



We can easily observe that most of the regions experience reductions in efficiency between 1995 and 2004 (all the regions located above and to the left of the diagonal line). Only the textile and apparel industry in the Rest of world that is in Australia and Oceania and Africa saw their efficiency increase in 2004 compared to 1995. However, given that technical efficiency scores are affected both by the movement relative to the frontier and the movement of the frontier itself, we need to elaborate on these findings by the analysis of Malmquist index, what is done later on in this dissertation.

4.1.3 Sectoral analysis

Finally, we are interested in differences in efficiency between textile and clothing firms. Table 21 reports the average values of original and bias-corrected input distance function estimators, bootstrap bias and confidence intervals for 1995-2004 time-period separately for textile and clothing firms.

Table 21 Mean efficiency results year by year

Year	Industry	Original input distance function $\hat{\delta}_i$	Bootstrap bias $bi\hat{a}s_B$	Bias-corrected input distance function $\hat{\hat{\delta}}_i$	Confidence interval	
					Lower bound	Upper bound
1995	Textile Clothing	1.605 1.379	-0.114 -0.118	1.717 1.500	1.636 1.436	1.841 1.651
1996	Textile Clothing	1.686 1.467	-0.125 -0.130	1.814 1.601	1.691 1.472	1.913 1.705
1997	Textile Clothing	1.732 1.494	-0.104 -0.118	1.833 1.612	1.743 1.510	1.937 1.731
1998	Textile Clothing	1.715 1.486	-0.105 -0.127	1.816 1.614	1.727 1.516	1.920 1.747
1999	Textile Clothing	1.792 1.559	-0.106 -0.138	1.899 1.702	1.789 1.583	1.988 1.825
2000	Textile Clothing	1.758 1.531	-0.094 -0.119	1.849 1.648	1.782 1.566	1.948 1.769
2001	Textile Clothing	1.866 1.583	-0.100 -0.096	1.966 1.696	1.866 1.582	2.065 1.799
2002	Textile Clothing	1.859 1.605	-0.098 -0.113	1.957 1.718	1.880 1.622	2.051 1.818
2003	Textile Clothing	1.856 1.586	-0.095 -0.099	1.951 1.685	1.877 1.614	2.042 1.786
2004	Textile Clothing	1.888 1.615	-0.095 -0.110	1.985 1.725	1.895 1.621	2.065 1.809
1995-2004	Textile Clothing	1.812 1.555	-0.100 -0.113	1.912 1.671	1.825 1.574	2.007 1.780

We can conclude from the table that on average clothing firms are more efficient than textile for 1995-2004 time-period, both when the original and the bias-corrected input distance function is considered. The similar conclusion can be made when looking at the particular years. However, when analyzing confidence intervals, which show the location of the true efficiency scores, not in all years the differences are significant as sometimes confidence intervals overlap (the case of years 1995, 1996, 1998 and 1999).

4.2 Productivity evolution over time - Malmquist with bootstrap results

4.2.1 General decomposition of Malmquist

Applying Simar and Wilson (1999) bootstrap algorithm with *FEAR* we obtain the values of Malmquist index $\hat{M}_i(t,t+1)$ and its decomposition into efficiency change $\hat{E}_i(t,t+1)$ and technical change $\hat{T}_i(t,t+1)$ together with 90%, 95% and 99% confidence intervals. Table below presents the means of those measures for pairs of consecutive years. As it was explained before the values below unity indicate improvement in productivity, efficiency or technical change, and vice versa. In addition, Figure 20 presents the trends in these three measures.

Table 22 Productivity, efficiency and technical change, consecutive years

Period \ Index	Malmquist index	Efficiency change	Technical change	No of firms
1995/1996	0.999*	1.021*	0.978*	322
1996/1997	0.987*	0.990*	0.996*	352
1997/1998	1.008*	0.983*	1.026*	396[1]
1998/1999	1.001*	0.995*	1.008*	424
1999/2000	0.995*	1.007*	0.988*	518
2000/2001	0.999*	1.049*	0.953**	617[1]
2001/2002	0.998*	1.057*	0.960*	665
2002/2003	1.006*	0.970*	1.037*	812[1]
2003/2004	0.999*	1.024*	0.977*	873

*** significant differences from unity at 0.05, *significant differences from unity at 0.1*
[1] *the means are for a smaller number of firms than initial sample due to infeasible solutions*

Figure 20 Principal findings: Productivity, efficiency and technical change

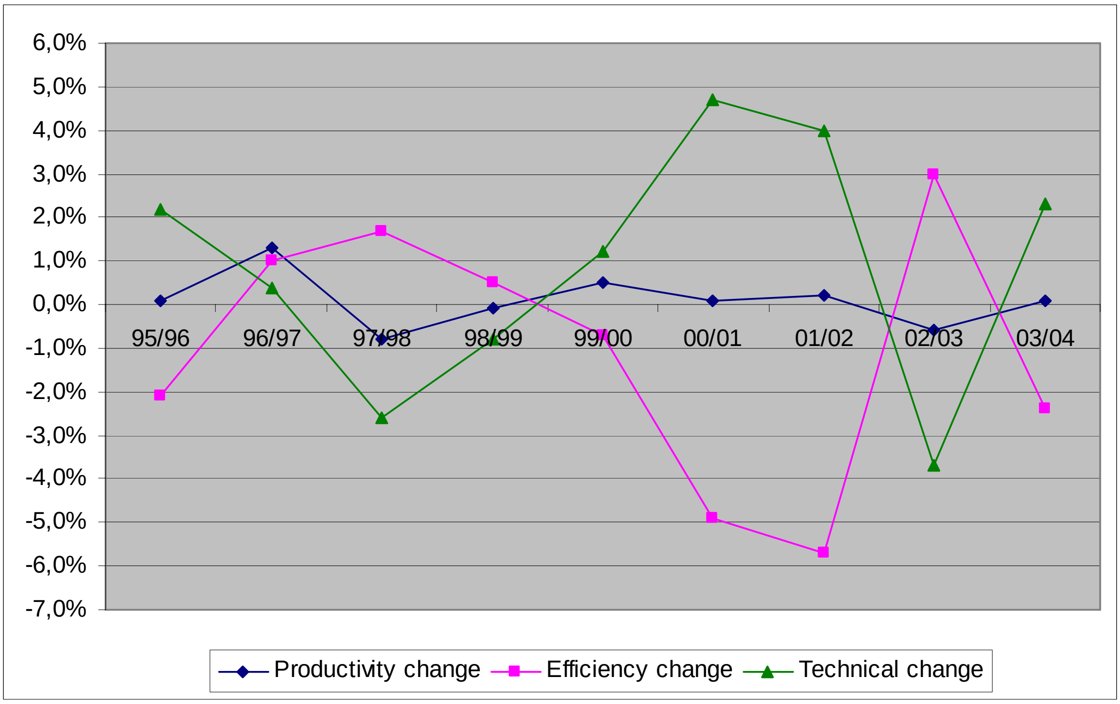


Table 22 and Figure 20 suggest that average Malmquist productivity index varies only slightly between different pairs of years. Productivity growth is the highest between 1996 and 1997 with the rate of 1.3%. There are deteriorations in 1997/1998, 1998/1999 and 2002/2003. Explanations for this trend come from the decomposition of this index. Concerning the efficiency change, its decline dominates the period analyzed with the highest decrease of 5.7% between 2001 and 2002. Technical change varies between periods and mostly increases in 2000/2001, and decreases to largest extent between 2002 and 2003. Only in 1996/1997 all components improve that is 1.3% productivity growth is caused by 1% "catching up" with the best practice frontier and 0.4% by technical progress. On the other hand, in 1999/2000 0.5% productivity growth is due to 1.2% of technical progress, despite 0.7% efficiency decline.

To interpret the changes described here from the point of view of their statistical significance we need to analyze the confidence intervals for indexes. If confidence interval for Malmquist index contains unity then the productivity growth is not significantly different from unity, that is we can summarize that the change in productivity did not occur. On the contrary, when interval excludes unity, we can conclude that this change is different from unity. The same applies for efficiency change and technical change. Our results confirm the significance of changes in all cases with only 90% of confidence. With 95% of confidence we can conclude that technical change increase is visible between 2000 and 2001.

Table 23 provides the summary of the findings with respect to a number of firms experiencing growth, decline and stagnation in productivity, efficiency and technical change.

Table 23 Growth, decline and stagnation in indexes - number of firms

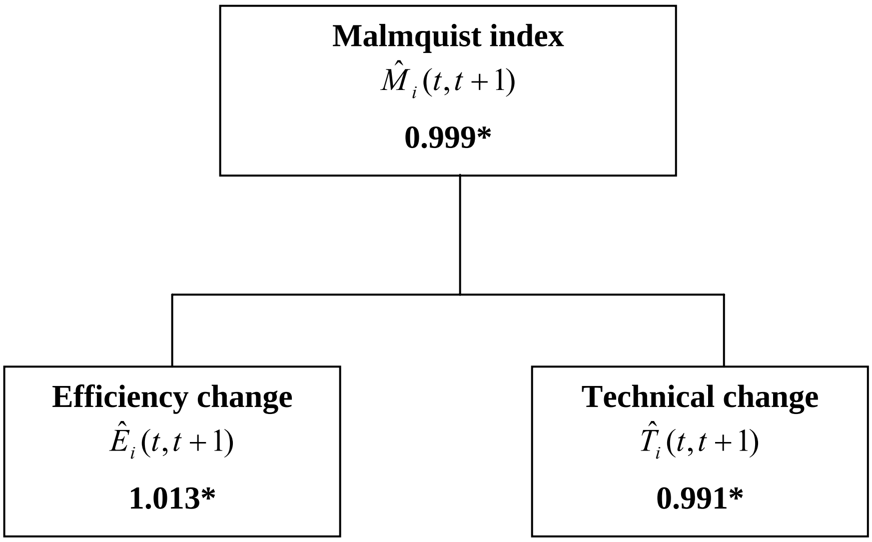
	1995 / 1996	1996 / 1997	1997 / 1998	1998 / 1999	1999 / 2000	2000 / 2001	2001 / 2002	2002 / 2003	2003 / 2004	**1995 - 2004**
Malmquist index										
Growth	183	226	180	223	295	294	362	380	447	2590
Decline	138	123	211	188	204	296	272	401	393	2226
Stagnation	1	3	5	13	19	27	31	31	33	163
Efficiency change										
Growth	125	213	222	223	269	156	247	576	314	2345
Decline	191	133	172	196	242	456	415	232	553	2590
Stagnation	6	6	2	5	7	5	3	4	6	44
Technical change										
Growth	295	172	149	258	375	563	428	43	772	3055
Decline	27	179	247	166	143	54	237	769	101	1923
Stagnation	0	1	0	0	0	0	0	0	0	1

Table 23 reveals that productivity growth in almost all periods is positive for more than 50% of firms (except for 1997/1998, 2000/2001 and 2002/2003). Treating efficiency change, the number of firms with positive and negative efficiency change varies, however firms with negative trends predominate those experiencing efficiency increase. With regard to technical change, the overwhelming majority of firms on the frontier noticed a positive shift. Particularly, three periods of time deserve further consideration due to extreme findings: between 1995 and 1996, and 2000 and 2001, when around 90% of firms undergo a positive change, and between 2002 and 2003 when the same amount experience a negative shift.

It is interesting to observe that almost all firms in all periods experience technical change (for only one firm in 1996/1997 the stagnation is reported). On the other hand, for considerable amount of companies no change occurred in productivity.

The interesting issue to interpret in above explained results is a technical regress observed between 1997 and 1998, 1998 and 1999, and 2002 and 2003 for some firms. One possible reason for such tendency is that in those periods demand was low and as a consequence firms produced less. Because of the fixity of some factors of production (capital and to a lesser extent also labour), firms do not adjust those factors, the utilization of capacities decreases, which as a result can explain the technical regress.

Globally for 1995-2004 the results of Malmquist index with its decomposition are presented below:



The average value of Malmquist index for 1995-2004 period indicates a gain in productivity as it is smaller than 1. Furthermore, this increase is significant with 90% of confidence. Analyzing the components of this magnitude we see that on average technical change is positive since the index is lower than 1. Therefore, the best practice frontier has improved over 1995-2004 time-period. Once again this change is significant with 90% of confidence. On the other hand, the average value of efficiency change is higher than 1 indicating a negative evolution that is inefficient firms are more far away from the frontier in 2004 compared to 1995. It is worth pointing out that such negative trend in efficiency was already revealed in regression and *DEA* analysis presented before, although computed with a larger sample size. Hence, the fundamental cause explaining the increase in Malmquist productivity index is technical change over analyzed period. The general picture is then that the Malmquist index grew due to the positive technical change, in spite of the negative efficiency change.

Our decomposition finding can be interpreted as follows. A positive shift in the frontier (upward movement of the frontier) caused a loss in efficiency for most of firms that could not utilize the frontier technology in actual production and follow the path. Maybe innovations and intangible assets helped the firms to shift the frontier and allowed the firms the production catch up to the frontier, but not large enough to improve technical efficiency in the period analyzed.

It is worth observing also that changes detected in productivity, efficiency and technology are relatively small and significant with only 90%. Therefore, to observe more significant changes one would need to analyze data on a longer period of time.

Trying to compare our results with those reported in other studies, first of all we should notice that there are only few papers dealing with productivity, efficiency and technical change in the textile and clothing sector. However, none of those studies are suitable for a direct comparison as they use different databases compromising of firms exclusively from one country. Nevertheless, confronting our results with those of other studies we note that our estimates are somehow similar. The technical progress reported here goes in line and is in the same class of magnitude as this obtained by Margono and Sharma (2006), Datta and Christoffersen (2005), Ayed-Mouelhi and Goaïed (2003), Chen (2003) and Taymaz and Saatçi (1997). In more details, the average technical progress in the textile and clothing sector found is identical as obtained by Ayed-Mouelhi and Goaïed (2003) for Tunisian industry. Slightly lower values are obtained by Margono and Sharma (2006) in Indonesian industry, while higher are reported by Datta and Christoffersen (2005) in the USA, Chen (2003) in China, and Taymaz and Saatçi (1997) in Turkey. However, those studies either consider a longer horizon of time or older data. With regard to productivity change, the average values are close to figures of Datta and Christoffersen (2005) and Chen (2003). Negative values of efficiency change are found in Chen (2003) and Kong, Marks and Wan (1999).

4.2.2 Productivity, efficiency and technical change in regions

We asses the differences in Malmquist indexes and its decomposition into efficiency and technical change between geographical regions. The results are represented by table below.

Table 24 Productivity, efficiency and technical change in regions, 1995-2004

Index / Period	Malmquist index	Efficiency change	Technical change	No of firms
Asia	0.996*	1.013*	0.988*	2365
Europe (Eur)	1.004*	1.015*	0.992*	1392
North America (Nam)	1.001*	1.012*	0.992*	1033
Middle and South America (Msam)	1.013	1.013*	1.008*	138
Rest of world:	0.994*	0.999*	0.997*	51
Australia and Oceania (Aus)	0.996*	1.003*	0.997*	34
Africa (Afr)	0.990*	0.993*	0.997*	17

**significant differences from unity at 0.1*

The analysis of results bring about the conclusion that the most worrying situation is observed in the textile and clothing firms in South and Middle America as all indices experience a negative change. However, confidence intervals show that this trend is not significant for productivity change as expressed by Malmquist index. The reverse position is presented by firms in the Rest of world and all indices show a positive change and a progress. It is interesting to note that all regions except South and Middle America undergo a positive technical change with biggest progress in Asia. On the contrary, almost all geographical locations experience regress in efficiency, with exception of the Rest of world.

4.2.3 Sectoral analysis

Furthermore, we are interested to assess the differences in Malmquist and indexes consisting of its decomposition between textile and clothing firms. The findings of this analysis are presented in table below.

Table 25 Productivity, efficiency and technical change per sector, consecutive years

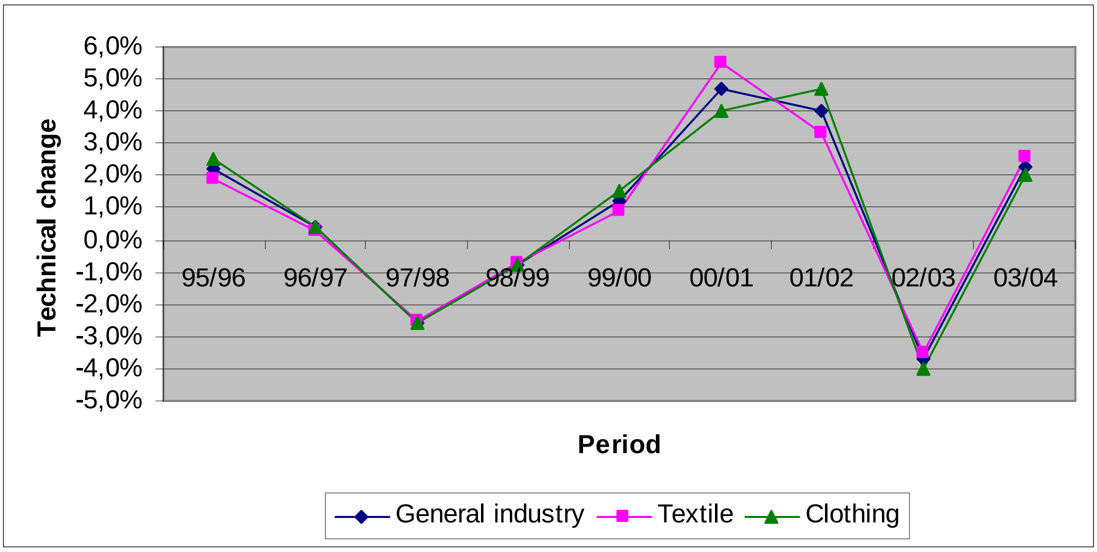
Index / Period	Malmquist index		Efficiency change		Technical change	
	Textile	Clothing	Textile	Clothing	Textile	Clothing
1995/1996	0.999*	0.998*	1.019*	1.024*	0.981*	0.975*
1996/1997	0.987*	0.987*	0.990*	0.991*	0.997*	0.996*
1997/1998	1.002*	1.014*	0.974*	0.990*	1.025*	1.026*
1998/1999	1.005*	0.998*	0.999*	0.991*	1.007*	1.008*
1999/2000	1.010*	0.981*	1.019*	0.996*	0.991*	0.985*
2000/2001	0.992*	1.006*	1.051**	1.046*	0.945	0.960*
2001/2002	1.011	0.986*	1.063*	1.052*	0.967*	0.953*
2002/2003	1.010*	1.001*	0.976*	0.964*	1.035*	1.040*
2003/2004	1.011*	0.988*	1.039*	1.009*	0.974*	0.980*
1995/2004	1.005*	0.995*	1.018*	1.008*	0.991*	0.991*

*** significant differences from unity at 0.05, *significant differences from unity at 0.1*

During the period of investigation textile industry undergo productivity decline due to a negative change in efficiency in spite of positive technical change. In case of clothing industry, productivity growth change and its decomposition into efficiency and technical change follow the trend of the entire textile and clothing industry for 1995-2004 as productivity growth and technical change experienced by this branch is positive, while efficiency change is negative. Comparing the indices of textile and clothing firms between them we see that for 1995-2004 time-period there are no differences in technological progress between those branches, while dissimilarities are observed for productivity and efficiency change. Therefore, textile firms experience greater decrease in efficiency than clothing, while productivity growth is negative for textile as opposite to clothing firms. Both branches made the same technological improvement during 1995-2004 time-period. To sum up, the decomposition of productivity change indicates that the efficiency decline contributed to productivity decrease in textiles, while the technical growth added to productivity growth in clothing.

What is common for both textile and clothing branches is a positive trend of technical change. Also with respect to consecutive years as both textile and clothing firms follow the same path of technical progress, except for 1997/1998, 1998/1999 and 2002/2003 time-period. The trend in technical change is the same as for the entire textile and clothing complex, what can be observed on the Figure 21. Therefore, we do not observe considerable differences between the textile and clothing branches and the entire textile and clothing complex with respect to technical change. It might be due to the fact that to detect more significant changes in magnitudes we would perhaps need to analyze the data on a longer period of time.

Figure 21 Comparison of technical change between textile, clothing and general textile and clothing industry



4.3 Hypotheses testing - results of panel data truncated regression[50]

Before proceeding with regression, we check for correlations between all independent variables, except for dummies, for the pooled sample, 1995-2004 (Table 26).

Table 26 Correlation between independent (non-dummy) variables for 1995-2004

	1	2	3	4	5
1. Intangibles	1.000				
2. Leverage	0.347***	1.000			
3. Learning	-0.001	0.148***	1.000		
4. Development	0.045***	0.039***	0.234***	1.000	
5. Size	-0.133***	-0.019	0.102***	-0.089***	1.000

**** significant at 0.01*

[50] Initial results of this analysis were presented during V Workshop on Efficiency and Productivity in Gijón in Spain, and were awarded a research grant of Associació Catalana de Comptabilitat i Direcció.

This table reveals no large significant correlation between variables. Although some coefficients appear as significant one, the absolute values are smaller than 0.25 except for leverage and intangibles that correlate at 0.347. As it was outlined in the section explaining the measurement of variables, intangibles' indicator that is *Tobin's Q* incorporates similar variables as leverage, therefore the significant correlation between both variables should be presented. However, because both variables have different interpretations and because the removal of one of those variables did not change the significance and signs of the model, we decided to leave both of them. To sum up, the multicollinearlity does not appear to be a serious problem in our analysis.

Within truncated regression we consider two model specifications that include different dependent variables: bias-corrected input distance function and original estimation of it to assess what is gained by using bootstrap. Of course the more importance is given to results with bias-corrected estimations. The results of both estimations are presented in Table 27. As it was already mentioned, the dependent variable represents inefficiency. Hence, the positive coefficients, which imply an increase in inefficiency, will be referred to as decrease in efficiency in the discussion that follows. Similarly, the coefficients with negative signs indicate sources of efficiency and will be regarded as increase in efficiency. Note that of course we do not report here the coefficients of dummies indicating each firm. On the other hand, we show year dummies as we are interested in assessing the time effect.

Table 27 Factors affecting efficiency

Independent variables	Estimated Coefficients *Dependent variable:* **Model 1:** Bias-corrected input distance function	 **Model 2:** Input distance function
Intangibles	-0.030***	-0.020***
Other Internal variables		
Leverage	0.103***	0.070***
Learning	-0.001	-0.001
External variables		
Development	-0.009***	-0.011***
EU	0.633***	0.672***
NAFTA	0.989	2.088**
Size	-0.077***	-0.115***
Industry	0.342***	0.881***
Regional dummies		
Aus	1.047***	0.341
Nam	-0.500	-1.113
Msam	0.396	0.250
Asia	0.737***	0.554**
Afr	0.455*	0.364
Time dummies		
Year2	0.105***	0.106***
Year3	0.133***	0.152***
Year4	0.135***	0.155***
Year5	0.236***	0.234***
Year6	0.200***	0.220***
Year7	0.265***	0.288***
Year8	0.256***	0.281***
Year9	0.231***	0.263***
Year10	0.293***	0.321***
constant	1.510***	1.603***

****significant at 0.01, **significant at 0.05, *significant at 0.1*

First to note from Table 27 is that the results of truncated regression with bias-corrected input distance function show the significance of majority of variables in explaining the inefficiency of individual firms in the textile and clothing industry for the 1995-2004 time-period[51].

The negative sign of intangibles coefficient with bias-corrected input distance function provides the support for the main hypothesis of this study indicating the

[51] Note, that we also included in the regression the squares of age, size, leverage, intangibles, and *GDP* per capita to capture any quadratic relationships between efficiency and those variables. We do not report those results here, because the variables proved not to be significant.

intangibles as rent generating resources. This result highlights the presence of a positive correlation between technical efficiency and intangible assets. However, this conclusion can be due to different causes like, for example, true causality or omitted factors. Regarding the omitted factors, some variables might be unobserved and their omission might drive the positive relationship between intangibles and efficiency. However, using fixed effects model we control for any unobserved effect which is time invariant so we rule out this possibility[52]. The true causality verifies the explanatory power of the Resource-Based View that corroborates the relationship that exists between intangible assets possession and achieving competitive advantage by firms, which in turn produces higher levels of performance (Barney, 1991). In particular, this finding confirms the contention of *RBV* with regard to intangible assets as predictors of dispersion of firm efficiencies (Peteraf, 1993). Therefore, the hypothesis positing that the companies with more intangible assets achieve higher efficiency outcomes is verified. That is the possession of resources that are valuable, rare, inimitable and non-substitutable makes the firms more efficient (Barney, 1991). Importantly, the competitive advantage of textile and clothing companies can be gained by means of intangible assets. This finding supports the results of studies conducted to analyze the relationship between intangible assets and performance in different geographical settings (for example, Chen, Cheng and Hwang (2005) analysis of Taiwanese stock exchange firms, Li and Wu (2004) study of public firms in China or Riahi-Belkaoui (2003) investigations of American international firms).

The second set of hypotheses concerns the relationship between other internal factors and firm efficiency. Table 27 shows that, in support for Hypothesis 2, leverage has a negative impact on efficiency. Hence, the increase in external financing seems to bring about the technical inefficiency. Such finding is consistent with the Agency Theory predictions on the basis of conflicts between owners and debtholders as textile and clothing firms with high debt might experience higher agency costs associated with costs of receiving credit, under- or overinvestment, or increased probability of bankruptcy (Jensen and Meckling, 1976). Monitoring activities of banks undertaken to obtain information about loan repayment involve costs that are passed to firms, as a result efficiency of firms is negatively influenced. Moreover, the banks prefer to finance

[52] Still there is a room for another cause called reverse causality, that is high technical efficiency induces high intangible assets. The analysis of those relationships are left for future research.

less risky investments which assure loan repayment, while firms choose riskier projects with higher returns, which give rise to conflict of interest between banks and firms. The following interpretation for such finding can be provided. Our sample consists of mostly large firms that in general have an easy access to bank credit and other external funds as banks see them as relatively low risk. Thus in this industry external financing might be more easily available to less efficient firms and credits are obtained not only by firms characterized by financial stability, good history of credits and permanent incomes. Such result indicates that resource allocation in the textile and clothing industry could be improved by implementing the screening mechanisms for the financial sector. It is worth pointing out that this finding goes in line with Kim (2003) who reported a negative association between efficiency and external funding in Korean textile industry, and Aras (2006) who found the same relationship for firms in Turkey.

With regard to the relationship between learning by experience and efficiency, this impact is ambiguous. The results do not provide a support for Hypothesis 3, because the coefficient with bias-corrected input distance function is not significant, although the sign of the relationship is as it was expected. It seems that that experience and learning through time does not play an important role in efficiency of textile and apparel firms. In this way, the Dynamic Capabilities predictions are not supported. Realizing of superior efficiency in the textile and clothing industry does not depend on the firm's already accumulated knowledge and experience. This finding in general goes in line with a number of studies in the textile and clothing sector that with respect to the relationship between age, experience and efficiency either show both positive and negative impact or not importance of this variable at all (Margono and Sharma, 2006; Wadud, 2004; Hill and Kalirajan, 1993).

The last set of hypotheses refers to the relationship between efficiency and external, country-specific factors, and with regard to variables considered we obtain mixed results. The coefficient of country development with bias-corrected input distance function is significant and negative implying that the more developed the country is and the more *GDP* per capita it has, the more efficient are firms in the textile and clothing industry, which supports Hypothesis 4. Therefore, the improvement in economical standard of living of countries seems to have a positive effect on firms. In other words, efficiency improves with economic growth and development. In this way, the predictions of Institutional Theory that the pressures from governments and expectations regarding product quality or environmental management have an impact upon firm performance are supported (Oliver, 1997). This result confirms the finding of prior studies concerning the influence of economic development on firm efficiency (Guran and Tosun, 2008; Afonso and Aubyn, 2006; Stavárek, 2006).

In contrast, the results do not support Hypothesis 5, which specified a positive effect of economic integration on efficiency. It is shown that economic integration is related with efficiency, however this relationship is varying and difficult to interpret. In particular, the coefficient with bias-corrected input distance function is positive and significant only for the European Union, that is it seems that *EU* integration is associated negatively with efficiency of firms in the textile and clothing industry. Economic integration as an example of institution that shape human interaction (North, 1994) functions as a constraint and a determinant of negative performance. It might confirm a negative side of integration as it might occur that after the elimination of trade barriers between member states follows the appearance of obstacles against other countries, and domestic production is replaced by imports from less efficient country (Maudos, Pastor and Seranno, 1999). Moreover, the economic integration induces a set of restrictions and regulations on firms concerning, for example, the environmental protection, security or work conditions, which might diminish efficiency of firms. This finding replicates and extends results of prior studies indicating a negative impact of *EU* or *NAFTA* integration on efficiency of firms (Feils and Rahman, 2008; Kasman and Yildrim, 2006). However, a longer horizon of time might be considered to analyze more properly the effects of integration initiatives and derive further conclusions.

Finally, concerning control variables, we found that industrial branch has a significant impact with positive sign. That is on average textile firms seem to be more efficient than clothing. Textile firms are in general more technologically-intensive than clothing due to the large scale and uniformity of much of production process. As a result of technology adaptation their productivity increases faster than of their apparel counterparts (Mittelhauser, 1997). This relationship can be analyzed together with the positive impact of economic development found as more developed countries are in general relatively more competitive in textiles than in clothing due to the fact that advanced technologies can be used more extensively in the textile sector (Stengg, 2001).

This finding is in accordance with results reported by Wadud (2004) for textile and clothing firms in Australia and Goaïed and Ayed-Mouelhi (2000) in Tunisian companies. It is worth observing that this result is to some extent contradictory to this reported before in this dissertation which was based on the statistical estimation of averages. In the first stage of analysis on average clothing firms were shown to be efficiently better than textile, however this contention was statistically significant only for some years of the entire period of investigation. Those differences in results can be explained by the fact that econometric analysis takes into account other factors (analysis conditional on other covariates), whereas the simple averages in an unconditional approach.

On the other hand, the gradual opening-up of markets in the textile and clothing industry has a negative impact as we find that coefficients of time dummies have positive signs for both model specifications. Therefore, during the period analyzed 1995-2004 efficiencies of firms decrease, which was confirmed before in this dissertation when *DEA* results were discussed.

Furthermore, coefficient for size with bias-corrected input distance function is found to be negative, which implies that larger firms exhibit lower level of inefficiencies that is higher levels of efficiencies. In other words, small firms seem to be less efficient and located more far away from their frontier as opposed to large firms. This finding in the context of *VRS* specification, which allows for the comparison of firms similar in size, can be interpreted as follows. Larger firms may benefit from pecuniary economies of scale that is can negotiate lower prices for inputs bought in bulk quantities. Moroever, large firms have more qualified and educated personnel which makes them more efficient. This result is compatible with empirical conclusions in the Australian textile and clothing industry of Wadud (2004) and Ayed-Mouelhi and Goaïed (2003) for Tunisia.

Finally, concerning geographical variables, we find that Australian, Asian and African textile and apparel firms are less efficient compared to European. In this way we confirm that although Asian firms might be better off with respect to cost, their efficiency is worse (Stengg, 2001). Analyzing this result more deeply and comparing with negative association reported between *EU* integration and efficiency, we can conclude that European companies in our database that do not belong to *EU* (for example Turkey and Switzerland) perform relatively well. The general results of other studies for Turkish textile and clothing industry show relatively high levels of efficiency of firms in this sector (Aras, 2006; Taymaz and Saatçi, 1997). In addition, the development trend of Turkish industry was already outlined in the introduction, where we show the constant increase in a number of employees.

From the methodological point of view, the comparison of regressions applying bias-corrected and original distance function (model 1 and 2) shows that results are slightly different. In particular, the impact of *NAFTA* and some geographical variables differs between specifications. We can conclude therefore that without applying bias-corrected input distance function we would not realize those dissimilarities in the significance of variables. The bootstrap allows us to correct the efficiency scores by bias and conduct more robust hypothesis tests.

CHAPTER 5

Conclusions, Implications and Future Research

5 Conclusions, Implications and Future Research

This chapter summarizes the dissertation. Here we provide the main conclusions of this study with regard to three issues investigated: static efficiency, evolution of efficiency, productivity and technology over time, and the relationship between internal, external and control factors and efficiency in the sample of firms from the textile and apparel industry. Then we summarize the implications: academic and practical for both managers of textile and clothing firms and policy makers. Finally, by outlining of limitations of this dissertation, we provide the future research directions.

5.1 Summary and conclusions of dissertation

The aim of this dissertation was to assess the efficiency performance of firms and its explanatory factors in the textile and clothing industry. In particular, the objective was to provide further insights on the impact of intangible assets on companies' performance. In this way this thesis was subscribed to two investigations lines: efficiency evaluations of firms and their intangible assets. To extend the research on the relationship between intangibles and performance, the performance in this dissertation was approached by a multidimensional indicator by means of efficiency. Unlike previous studies, which analyze very frequently high-tech industries, we focus on a more traditional and still less knowledge-based sector, the textile and apparel industry.

The empirical analyses were conducted with two unbalanced panels of textile and clothing firms within the period 1995 and 2004: consisting of total of 5477 and 4982 observations in different regions in the world. The dataset was developed through the linkage of the information from three databases: *COMPUSTAT*, *DATASTREAM* and *OSIRIS*. The regions of Asia, Europe and North America are mostly represented in this database, and the majority of firms come from the USA, Japan, China, Korea, Taiwan, Germany and the UK. From the methodological point of view, for a larger sample of firms we computed input distance functions using Data Envelopment Analysis (*DEA*) method, and assessed their statistical significance by the application of bootstrap. In addition, for a smaller sample we also estimated the productivity, efficiency and technological evolution over time (between two consecutive years) through the application of Malmquist index and its decomposition. Then the *DEA* efficiency indicators were explained in the panel data truncated regression with intangible assets and other internal, external, and control factors. In particular, we considered two regression specifications to assess the differences in results: one with dependent variable in the form of input distance function corrected by bias, and the second one as an original distance function. Other internal factors analyzed consisted of firm leverage and learning by experience, external included economic development and integration, while to control we applied firm size, industrial sub-sector and geographical location, which are used very frequently both in efficiency and intangibles research as controls. In this way we tested a theoretical model of this dissertation that hypothetically links those factors with firm efficiency. All independent variables and their hypothetical relationships with efficiency came from theoretical considerations and were grounded on Resource-Based View of the Firm, Dynamic Capabilities Approach, Agency and Institutional Theory. In such way, we also contributed to the efficiency literature, which basically is more interested in measuring than explaining efficiency and although many interesting papers exist that try to explain efficiency, most of them introduce those explanatory variables without clear connections with theoretical frameworks.

The major contributions of this dissertation lie in three main areas. First, in suggesting the alternative way of measuring performance for intangible assets research. Second, in basing our model that links firm efficiency with a set of internal and external factors on the solid theoretical frameworks. In addition, the empirical setting of this dissertation consisting of textile and clothing industry further adds to intangible assets research. Overall, the use of bootstrapping methods enriches these three contributions of this dissertation.

Hereafter, we present the detailed conclusions arising from three issues investigated in this dissertation: 1) static analysis of efficiency; 2) productivity, efficiency and technology evolution over time; and 3) factors affecting efficiency (regression results).

5.1.1 Principal conclusions with relation to efficiency in the textile and clothing industry

First of all, this dissertation revealed that there is a substantial room for improvements in technical efficiency in the sample of textile and clothing firms analyzed. Results indicate that input inefficiencies in the textile and clothing firms are quite high, on average reaching 68% level between 1995 and 2004, which implies the large possibilities of input reduction. The average inefficiency increased further to 78%, while analyzing bootstrap-adjusted input distance functions. Hence, we observed a significant scope for efficiency improvement implying that firms, near the average, can decrease the mean input by 78% with the same output level. The usage of bootstrap further revealed the statistical location of true input distance functions which are contained between the values of 1.697 and 1.891 for 1995-2004 time-period.

The most efficiently performing region was found to be North America with inefficiency reaching 67% (or 52% when original input distance function was considered), while Middle and South American firms obtained the lowest level of efficiency and inefficiency accounting to over 92% (or 85% for original input distance function). There was also observed a downward trend in technical efficiency recorded from 1995 to 2004, both with regard to bias-corrected and original efficiency. When considering the differences in this trend between considered regions, we reported that firms in almost all geographical locations saw their efficiency decreased between 1995 and 2004. Only the textile and clothing firms in the Rest of world (Australia and Oceania, and Africa) experienced efficiency increment between those two periods.

5.1.2 Principal conclusions with relation to productivity, efficiency and technology evolution over time in the textile and clothing industry

During the period of investigation, the productivity change of textile and clothing firms found was positive, although not very substantial of only 0.1%. However, this slight growth was found to be significant with 90% of confidence as revealed by bootstrap procedure. The analysis yield further that two elements contributed to such trend: technical progress (0.9%), despite of efficiency decrease (-1.3%). In general both trends were significantly different from unity with 90% of confidence. The decomposition of the growth in productivity implies that the technical change contributed to all productivity growth. Particularly worth noticing is an upward shift in the frontier that is positive technical change observed. The technical progress took place at a particularly high rate in 2000/2001, 2001/2002 and 2003/2004. Over the entire period about 61% of firms grew in terms of technology. Similar pattern was observed for productivity, although to lesser extent, as about 52% experienced productivity growth. On the contrary, about 52% of firms had found their efficiency decline.

Regional analyses bring about two extreme conclusions: South and Middle American firms saw their productivity, efficiency and technology decline over the period analyzed, while companies located in the Rest of world (Australia and Oceania, and Africa) managed to increase all indices. There were a very small disparities observed for technical change as all regions except of South and Middle America noticed a positive shift in the frontier, with Asia hitting the highest growth. The bootstrap allows for the more careful analysis as we can conclude that all changes observed were significant with 90% or 95%, except for productivity decline in South and Middle America. During the period of investigation both textile and clothing sub-sectors saw a shift in the frontier of 0.9%, significantly different from 1, but not different one from the other. Therefore, we do not observe considerable differences between textile and clothing branches with respect to technical change. On the other hand, the dissimilarities were reported with regard to productivity change as textile firms noticed a negative productivity change as opposite to a positive trend for clothing firms. Both branches saw their efficiency decline over the period analyzed. Bootstrap analysis brought about the conclusion that changes observed were significantly different from 1.

5.1.3 Principal conclusions with relation to factors affecting efficiency in the textile and clothing sector (hypotheses)

This dissertation focused on the factors affecting efficiency in the international textile and clothing industry and proposed a model linking some internal and external factors with firm efficiency outcomes. Drawing on solid theoretical frameworks, it provided the empirical evidence supporting following broad observations.

First of all, this dissertation empirically supported the main hypothesis of this study and the main contention of the Resource-Based View of the Firm: intangible assets seem to be associated with improving performance and efficiency of firms. In this way, this thesis provided a direct test of this theory suggesting that firms use intangible assets to achieve competitive advantage and in turn increase their efficiency. This contention in previous literature was usually supported for knowledge-intensive firms possessing a large bundle of intangible resources which value added is directly related to knowledge and intangibles. In differentiation, in this dissertation it proved to be true in more traditional and labour-intensive textile and clothing sector with mature business models that are well known on the market. Our research clearly shows that the increase in efficiency and competitiveness of textile and clothing firms can be obtained by managing the resources that are invisible in character. This result suggests that those companies need to invest in intangibles. Therefore, the managers need to perform a number of important tasks related to identification, development, protection and deployment of those resources.

The second conclusion sheds some additional light on the relationship between level of debt and firm efficiency and supports the view that the firm level of leverage is a negative factor for efficiency. It confirms the Agency Theory predictions on the basis of conflicts between managers-owners and debtholders. Such negative relationship between external financing and efficiency might provide an argument in a favour of policies promoting equity in the textile and clothing industry. At the same time, it implies the need to implement some screening mechanisms for financial sector in order not to allow the inefficient firms to easily access the bank credit.

Firm learning by experience, although positively related, did not prove to be a significant factor in explaining efficiency of textile and clothing firms. Our results suggest that prior experience and learning from it neither helps nor hurts firm efficiency. It implies that older companies with more experience might act routine, they might get "stuck" in their past and do not look into future and develop their activities. This finding might imply also that experience and learning from experience alone is not enough. Firms' learning depends not only on the previously accumulated knowledge and experience, but also on the current investment efforts. Hence, companies might need to change the plant and equipment, and develop human capital.

Based on the results of internal factors impact on firm efficiency, it follows the conclusion that intangible assets and leverage are both important determinants of efficiency of firms in the textile and clothing industry, and the optimal procedure for those companies is to focus on the investment in intangible assets and the minimisation of external financing in order to increase efficiency outcomes.

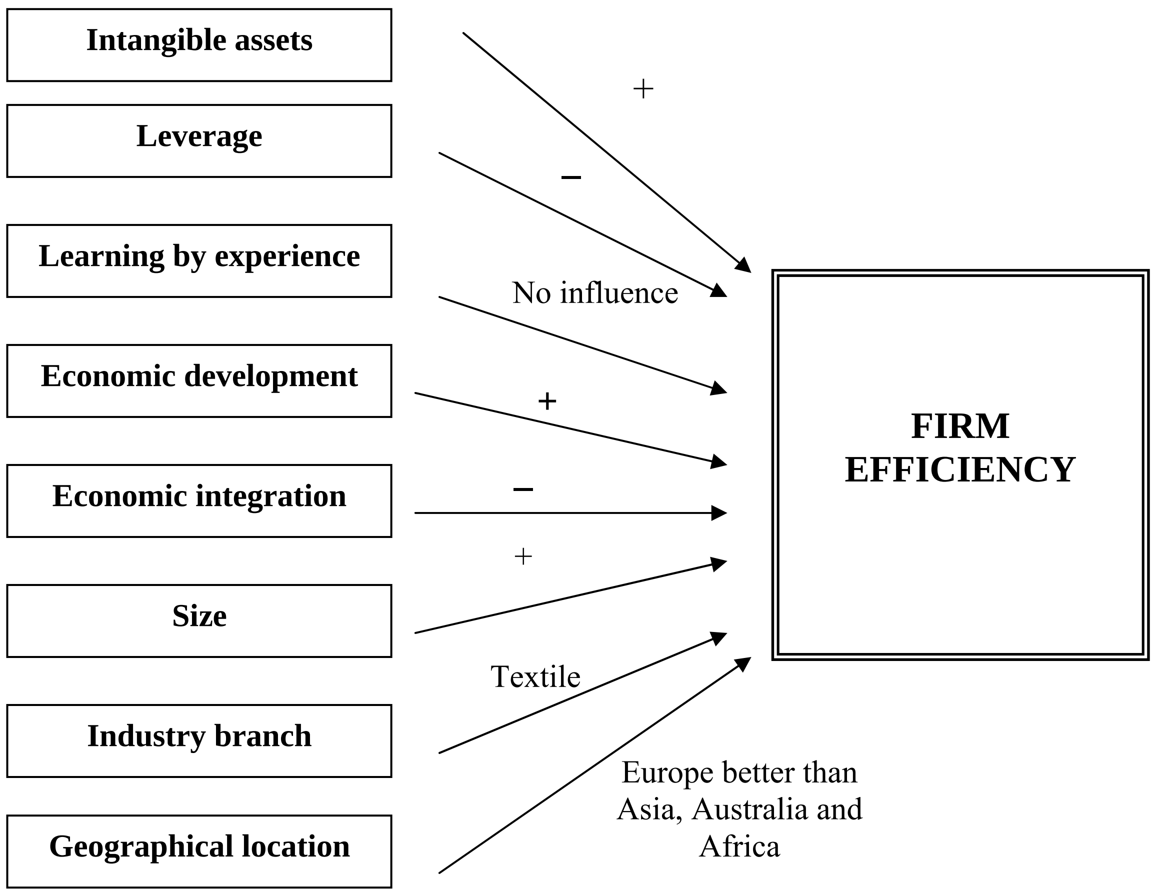
Another set of conclusions concerns the impact of external factors on firm efficiency. According to the predictions of Institutional Theory, the impact of external factors resulted to be important for explaining firm efficiency. In particular, firms from more developed countries found to be more efficient. Therefore, macro performance of economies proved to influence the micro performance of firms consisting of these economies. Surprisingly, economic integration with *EU* seems to be a negative factor for efficiency of firms in the textile and apparel sector. It seems then that the integration initiatives, although facilitating the flow of capital and investment, also constrain economic behaviour of companies by imposing many restrictions, resulting in the negative efficiency outcomes.

This dissertation also revealed that industrial branch, size and geographical location are important factors in impacting firm efficiency. With regard to some characteristics of industry under analysis, textile firms were found to be more efficient than clothing. It implies that being more technologically intensive allows for a better efficiency results. This relationship can be viewed together with the positive impact of economic development as more developed countries are in general relatively more competitive in textiles than in clothing. Moreover, larger firms are proved to be more efficient, and this relationship suggests that pecuniary economies or hiring of highly-qualified workforce might be factors for textile and clothing firms to attain higher levels of efficiency. On the other hand, although economic integration with *EU* has a negative impact on efficiency, European firms proved to be better than Asian, Australian and African, which implies that European companies in our database that do not belong to *EU* (for example Turkey and Switzerland) perform relatively well. In addition, efficiency of the textile and clothing firms in our sample was further confirmed to decrease significantly between 1995 and 2004, indicating that increased competition due to the liberalization of markets impacts their efficiency in a negative way.

Finally, our analysis applied both bias-corrected and original input distance function in the truncated regression providing different findings. Therefore, without applying bias-corrected input distance function we would not realize those dissimilarities in the significance of variables.

To sum up, the results obtained in this dissertation allow us to conclude that: 1) the greater the bundle of intangible resources contributes to increased efficiency of textile and clothing firms; 2) the possible effects of pecuniary economies of scale are also relevant for improved efficiency; 3) textile and clothing firms are influenced negatively by agency costs caused by the issuance of debt; 4) institutions matter for textile and clothing firms and both function as a constrain and advantage for efficiency. The figure below presents the relationships found in this dissertation between internal, external and control factors, and firm efficiency, providing in this way the verified model of this study.

Figure 22 Verified model of the investigation: Relationships among intangible assets, other internal factors, external variables and efficiency



5.2 Implications

This dissertation has several academic and practical implications. With relation to academic implications, this study contributed to intangible assets research by introducing the alternative method for performance measurement. Furthermore, we also benefited the efficiency literature by trying to integrate different theoretical perspectives considering the factors affecting efficiency. In this way we brought the empirical evidence on the relationship between different factors affecting firm efficiency, both from internal and external to the firm point of view, which allowed verifying a model hypothetically linking those variables with firm efficiency outcomes. Furthermore, the research conducted in this dissertation concerns the textile and clothing sector which is an example of traditional and labour-intensive industry as opposite to knowledge-intensive firms usually investigated in the intangible assets literature. It is also a novel empirical setting for application on bootstrapping methods.

Regarding practical implications, this dissertation brings several guides and advices for the textile and clothing managers of how to improve efficiency of firms. In particular, the evidence on factors affecting efficiency provides a meaningful reference. The conclusions of this dissertation about the importance of intangible assets can constitute a help for firms to realize that those resources are responsible for firm success. The results are interesting because they provide information that supports the fact that intangible assets appear to be what really determines the success of textile and clothing industry. The study serves to inform business managers that their firms need to invest in new bundles of intangible resources or deploy existing ones to maximize efficiency. Firms might develop and strengthen their intangible basis by advertisement and promotion, for example during sectoral exhibitions or through fashion designers. A guidance for developing intangible assets and practical implications of *RBV* in general can be found for example in Grant (1991), who proposed a five stage procedure involving: analyzing the firm's resource base, appraising the firm's capabilities, analyzing the profit-generating potential of firm's resources and capabilities, selecting the strategy, and extending and upgrading the firm's resources and capabilities. In particular, the development of firm resources can be connected with pursuing diversification strategy. In addition, a relevant way of upgrading intangibles are benchmarking activities: firms might identify intangibles that need improving and follow the examples of world leaders in those activities. Furthermore, firms might reconsider their external financing and plan it better as high levels of debt mitigate their efficiency outcomes. Finally, the relevance of firm size for efficiency implies that larger companies might benefit from pecuniary economies of scale.

At the same time, the conclusions of this dissertation are also important from the point of view of policy-making, which pays a great concern about the competitiveness of the textile and clothing firms, and tries to support and develop this industry. A possible implication of this study may be that policy-makers have to intensify initiatives to encourage the understanding and development of intangible assets. Also local government has their role to play. Textile and clothing firms might be included in the local strategies through the development of clusters, which favor the appearance of networks between firms and other intangibles. Another general message for governments from this study is that if the economy develops faster, the textile and clothing firms will perform better. Finally, the authorities of economic integration initiatives might reconsider their directives. Economic integration may be difficult for firms, especially just after joining the initiative as firms need to adapt to different requirements. On the other hand, for example *EU* includes both more and less developed countries, but the directives are for all of them the same. Hence, authorities might influence to soften some directives, especially for the less developed regions. In addition, as an implication of negative impact of firm leverage on efficiency, our dissertation provides the arguments in favour of the development of policies promoting equity as well as a need to undertake some screening activities for financial sector. Government might develop some policies to ensure that banks can exercise a disciplining influence on the textile and clothing managers. Finally, also textile and clothing industry specialists and analysts might benefit from our results and introduce several measures aimed at improving efficiency of firms. In particular, they must include intangible assets in the design of the strategies for the survival and development.

5.3 Limitations and future research

All findings of this dissertation should be considered with care due to their limitations. In particular, several limitations should be noted. One of the shortcomings of this research is a measurement of variables. For example, we assess economic development by the country's *GDP* per capita, which, although is a very common measure, it only captures one dimension of economic development. There are other factors that comprise of economic development like population health, knowledge and education, and future research should focus on developing better metrics. Moreover, the measurement of intangibles is another issue to discuss. Due to the invisible character of these resources, intangibles are difficult to assess and no ideal tool exists to capture them. *Tobin's Q* used in this dissertation is a relatively aggregated model, and more comprehensive method could be build to assess particular types of intangibles. Hence, the future research might develop a new model of measurement, for example based on a more qualitative research. Another measurement problem comes from the indicator of learning by experience. One might assess this variable by other dimension than the firm age applied here, for example developing a new scale for this construct. To sum up then, the future studies could apply different indicators of some of the variables. In parallel, other variables could be included in the model, like for example ownership, which for listed firms could investigate if some of the companies are family owned, others are part of multinationals and some are partially under state control.

Furthermore, our sample although representative at the world level, is predominated by large firms which are listed on the stock exchange, as this is the characteristic of databases which were the source of our data. The extrapolation of results for smallest firms has to be done with certain caution.

Worth mentioning is also another limitation regarding a small number of firms in our database for some geographical zones and countries (like Australia and Oceania and Africa). A future study considering more firms from these world regions would be essential. Furthermore, due to the limitations of our database outlined here, our analyses of *DEA* efficiency and Malmquist index were conducted integrating textile and clothing branches, while the empirical analyses including industrial activity as a control variable shown that textile firms are more efficient than clothing. Knowing this result, if it is possible to obtain more data, for the future research we will consider separating textile and clothing branches for computing *DEA* efficiency and Malmquist index.

In addition, the changes in productivity, efficiency and technology reported in this study, although are significant, they are not very substantial. We believe that more considerable changes can be observed by analyzing a longer horizon of time, for example 20 years. With regard to the methodology used to compute productivity, efficiency and technology evolution over time, another decompositions and formulations of Malmquist could be considered as for example: changes in efficiency, scale and technology (Färe et al., 1994), change in pure efficiency, pure technical change, change in scale efficiency, and change in scale of technology (Wheelock and Wilson, 1999), or total factor productivity Malmquist (Bjurek, 1996).

Moreover, although by using fixed effects model in the truncated regression we eliminate the possibility of omitted factors influence that might drive the relationships found, still the subject of reverse causality exists. Therefore, in line with some recent studies, and as an additional area of research, we propose the comprehensive analysis of the reverse causal links between the variables included in our model using more sophisticated techniques as dynamic panel data for non-linear models.

Finally, our study gave a general picture of efficiency and intangible assets in the international textile and clothing industry. Given this limitation, future research could focus on some cases of specific countries to see more deeply if institutional framework plays a role in firm efficiency. A comparative study of firms from developed versus developing countries may be challenging. At the same time, the analysis of some regional concentrations of firms in the form of textile and clothing clusters is another interesting avenue for future research. In addition, because the textile and clothing industry is a very heterogeneous one, the future research could consider in depth-analysis of some sub-sector branch, of course if availability of data allows for such investigations.

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Appendices

Appendix 1 Purchasing Power Parity (*PPP*) (current)

Country	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Australia	1.388	1.380	1.375	1.361	1.370	1.405	1.411	1.429	1.442	1.461
Austria	0.961	0.952	0.936	0.929	0.921	0.918	0.912	0.907	0.902	0.896
Belgium	0.924	0.912	0.908	0.915	0.908	0.904	0.898	0.899	0.896	0.893
Bermuda*	7.736	7.734	7.742	7.745	7.758	7.791	7.799	7.799	7.787	7.788
Brazil	0.627	0.722	0.768	0.797	0.830	0.881	0.924	1.000	1.127	1.189
Canada	1.255	1.251	1.245	1.226	1.229	1.254	1.238	1.229	1.244	1.250
Cayman Islands*	7.736	7.734	7.742	7.745	7.758	7.791	7.799	7.799	7.787	7.788
Chile	267.840	270.005	276.909	279.141	281.856	288.422	292.322	299.268	310.336	323.704
China	2.007	2.096	2.093	2.052	1.997	1.995	1.988	1.965	1.976	2.059
Colombia	383.247	439.527	505.106	573.355	636.532	698.419	724.605	753.811	798.971	827.234
Czech Republic	10.962	11.869	12.653	13.900	14.092	13.999	14.336	14.486	14.330	14.460
Denmark	8.327	8.335	8.361	8.368	8.387	8.454	8.461	8.507	8.500	8.466
Estonia	4.766	5.815	6.316	6.806	7.009	7.228	7.452	7.643	7.647	7.680
Finland	0.977	0.955	0.960	0.984	0.967	0.976	0.983	0.976	0.953	0.934
France	0.975	0.973	0.967	0.965	0.951	0.943	0.939	0.945	0.944	0.935
Germany	1.064	1.049	1.035	1.030	1.018	0.990	0.978	0.975	0.966	0.948
Greece	0.564	0.595	0.625	0.650	0.660	0.668	0.664	0.678	0.687	0.693
Hong Kong	8.232	8.535	8.868	8.743	8.167	7.529	7.216	6.846	6.283	5.901
Hungary	57.141	67.961	79.194	88.222	94.309	101.427	107.217	114.537	119.718	121.446
India	7.118	7.491	7.847	8.373	8.639	8.752	8.814	8.999	9.154	9.310
Indonesia	853.079	911.259	1008.963	1748.990	1968.228	2320.106	2644.375	2754.559	2817.472	2917.335
Israel	2.525	2.757	2.960	3.119	3.275	3.255	3.238	3.323	3.257	3.169
Italy	0.785	0.810	0.817	0.829	0.828	0.827	0.831	0.845	0.853	0.855
Japan	169.819	165.545	163.675	161.787	157.373	151.383	145.994	141.227	136.251	131.237
Jordan	0.300	0.301	0.300	0.314	0.308	0.301	0.296	0.293	0.294	0.295
Korea	706.785	729.087	750.216	785.168	773.215	762.292	770.696	778.811	784.071	784.592
Lithuania	1.118	1.323	1.483	1.541	1.510	1.503	1.461	1.439	1.394	1.397

Malaysia	1.549	1.576	1.604	1.721	1.698	1.742	1.652	1.685	1.708	1.768
Mexico	2.893	3.711	4.296	4.902	5.562	6.102	6.309	6.631	7.051	7.382
Netherlands	0.903	0.897	0.900	0.905	0.906	0.922	0.947	0.967	0.971	0.954
New Zealand	1.503	1.494	1.502	1.505	1.495	1.514	1.532	1.507	1.518	1.522
Pakistan	9.161	9.743	10.865	11.554	12.057	14.612	15.371	15.476	15.834	16.638
Peru	1.212	1.315	1.391	1.461	1.497	1.519	1.505	1.491	1.500	1.544
Poland	1.174	1.359	1.522	1.672	1.749	1.836	1.855	1.864	1.834	1.860
Portugal	0.609	0.613	0.626	0.642	0.653	0.659	0.667	0.681	0.686	0.687
Singapore	1.860	1.850	1.832	1.781	1.663	1.688	1.619	1.580	1.534	1.546
South Africa	1.771	1.878	1.997	2.128	2.246	2.391	2.514	2.730	2.795	2.876
Spain	0.661	0.671	0.676	0.685	0.693	0.702	0.714	0.732	0.746	0.757
Sri Lanka	13.913	15.130	16.210	17.509	17.978	18.875	20.949	22.259	22.909	24.414
Sweden	9.736	9.647	9.653	9.609	9.560	9.484	9.457	9.444	9.439	9.275
Switzerland	1.992	1.954	1.919	1.893	1.878	1.853	1.820	1.818	1.803	1.766
Taiwan*	26.476	27.457	28.662	33.445	32.266	31.225	33.800	34.575	34.418	33.422
Thailand	11.975	12.222	12.510	13.515	12.785	12.681	12.639	12.523	12.473	12.557
Turkey	0.023	0.041	0.073	0.127	0.195	0.286	0.432	0.611	0.734	0.786
UK	0.577	0.585	0.593	0.603	0.607	0.601	0.600	0.608	0.613	0.610
USA	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Venezuela	106.677	225.621	307.173	361.186	449.299	569.222	600.282	784.779	1037.296	1326.556

** for those countries PPP was not available and we report exchange rates instead*

Appendix 2 Purchasing Power Parity (*PPP*) (constant)

Country	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Australia	1.388	1.353	1.366	1.330	1.316	1.367	1.400	1.454	1.399	1.388
Austria	0.961	0.930	0.918	0.929	0.907	0.888	0.886	0.899	0.862	0.846
Belgium	0.924	0.911	0.941	0.953	0.938	0.977	0.981	0.998	0.942	0.915
Bermuda*	-	-	-	-	-	-	-	-	-	-
Brazil	0.627	0.749	0.878	0.967	1.166	1.380	1.612	2.084	2.843	3.121
Canada	1.255	1.228	1.233	1.244	1.259	1.274	1.258	1.279	1.212	1.183
Cayman Islands*	-	-	-	-	-	-	-	-	-	-
Chile	267.840	280.511	292.527	307.891	324.862	349.828	378.055	423.236	444.024	446.985
China	2.007	1.964	1.875	1.805	1.744	1.788	1.777	1.743	1.783	1.924
Colombia	383.247	494.397	656.843	895.273	1083.496	1272.315	1428.386	1601.166	1757.493	1802.917
Czech Republic	10.962	12.164	13.602	16.075	16.331	16.087	16.751	17.237	16.135	16.195
Denmark	8.327	8.233	8.428	8.587	8.588	8.666	8.751	9.012	8.563	8.207
Estonia	4.766	6.521	7.679	8.843	8.928	9.120	9.709	10.230	9.741	9.480
Finland	0.977	0.924	0.945	0.979	0.954	0.984	0.978	0.981	0.909	0.851
France	0.975	0.925	0.911	0.911	0.868	0.853	0.851	0.874	0.831	0.785
Germany	1.064	1.013	1.012	1.026	0.998	0.937	0.946	0.946	0.930	0.890
Greece	0.564	0.614	0.668	0.733	0.756	0.761	0.775	0.828	0.816	0.802
Hong Kong	8.232	8.332	8.641	8.568	7.819	6.824	6.366	6.011	5.220	4.725
Hungary	57.141	80.910	113.525	144.302	160.843	182.646	200.138	215.649	219.105	216.915
India	7.118	7.646	8.380	9.695	10.279	10.480	10.940	11.725	11.931	12.177
Indonesia	853.079	961.338	1161.590	4162.062	5134.209	6433.331	8195.556	9122.318	9155.812	9590.109
Israel	2.525	2.928	3.344	3.760	4.198	4.084	4.016	4.382	4.249	4.107
Italy	0.785	0.807	0.825	0.859	0.849	0.849	0.861	0.894	0.870	0.845
Japan	169.819	158.962	158.407	157.927	150.224	136.696	127.396	123.524	112.159	103.061
Jordan	0.300	0.302	0.299	0.330	0.303	0.293	0.292	0.291	0.294	0.297
Korea	706.785	735.533	786.742	946.669	905.939	861.244	856.958	883.469	862.874	863.174
Lithuania	1.118	1.516	1.774	1.748	1.725	1.907	1.765	1.714	1.572	1.597

Malaysia	1.549	1.576	1.647	2.007	1.900	1.899	1.790	1.857	1.868	1.947
Mexico	2.893	4.854	6.612	8.965	11.533	12.895	13.849	15.657	16.981	18.304
Netherlands	0.903	0.894	0.914	0.940	0.944	0.951	0.996	1.048	1.014	0.975
New Zealand	1.503	1.470	1.483	1.534	1.528	1.573	1.668	1.683	1.595	1.532
Pakistan	9.161	10.567	13.131	14.633	16.273	19.372	21.084	22.366	23.111	24.814
Peru	1.212	1.405	1.599	1.846	1.968	1.970	1.957	1.963	1.905	1.945
Poland	1.174	1.502	1.890	2.283	2.499	2.671	2.715	2.822	2.707	2.768
Portugal	0.609	0.634	0.665	0.656	0.681	0.759	0.783	0.808	0.796	0.787
Singapore	1.860	1.810	1.775	1.713	1.620	1.712	1.598	1.572	1.477	1.476
South Africa	1.771	1.961	2.237	2.526	2.799	3.075	3.469	4.403	4.347	4.243
Spain	0.661	0.667	0.679	0.701	0.708	0.714	0.731	0.773	0.759	0.749
Sri Lanka	13.913	17.812	20.427	24.011	24.374	24.591	30.153	36.300	36.521	41.275
Sweden	9.736	9.257	9.382	9.518	9.499	9.424	9.592	9.859	9.271	8.783
Switzerland	1.992	1.874	1.830	1.828	1.782	1.676	1.637	1.664	1.567	1.464
Taiwan*	-	-	-	-	-	-	-	-	-	-
Thailand	11.975	12.170	13.095	16.266	14.547	14.173	14.322	14.762	14.517	14.695
Turkey	0.023	0.072	0.235	0.704	1.647	3.633	8.856	18.952	28.492	33.688
UK	0.577	0.586	0.600	0.625	0.627	0.596	0.587	0.609	0.592	0.568
USA	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Venezuela	106.677	447.574	792.595	1165.438	1672.103	2306.330	2778.601	5104.267	9693.578	15244.110

** for those countries PPP was not available (we used first exchange rates and then price indexes)*

Appendix 3 Price Indexes

Country	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Australia	100	100.311	101.553	97.516	96.584	103.520	106.729	106.936	107.453	111.698
Austria	100	100.000	100.309	99.794	98.970	102.987	104.531	104.119	105.870	111.020
Belgium	100	102.184	105.977	103.908	103.908	114.943	117.471	116.667	116.437	120.460
Bermuda	100	98.555	98.037	97.909	106.164	109.044	112.211	114.803	118.451	122.674
Brazil	100	106.167	116.833	121.000	141.167	166.667	187.667	219.000	279.333	308.667
Canada	100	100.432	101.297	101.297	102.919	108.108	109.297	109.405	107.892	111.243
Cayman Islands	100	100.098	100.195	100.488	104.195	100.195	98.634	99.902	98.146	101.854
Chile	100	106.167	116.833	121.000	141.167	166.667	187.667	219.000	279.333	308.667
China	100	100.432	101.297	101.297	102.919	108.108	109.297	109.405	107.892	111.243
Colombia	100	115.116	132.946	155.814	171.124	193.798	212.016	223.256	243.605	256.202
Czech Republic	100	104.890	109.902	115.403	116.504	122.249	125.672	125.061	124.694	131.663
Denmark	100	101.091	103.053	102.399	102.944	109.051	111.232	111.341	111.559	113.959
Estonia	100	114.765	124.295	129.664	128.054	134.228	140.134	140.671	141.074	145.101
Finland	100	99.034	100.644	99.249	99.142	107.296	106.974	105.687	105.579	107.189
France	100	97.305	96.728	95.861	94.321	96.246	97.401	97.209	97.498	98.653
Germany	100	98.779	99.898	99.491	98.474	101.729	104.781	104.374	106.205	107.935
Greece	100	105.697	109.333	112.485	115.152	121.212	125.576	128.485	131.515	136.121
Hong Kong	100	99.904	99.614	97.782	96.239	96.432	94.889	92.285	91.996	94.118
Hungary	100	121.839	146.552	163.218	171.456	191.571	200.766	197.893	202.682	209.962
India	100	104.459	109.172	115.541	119.618	127.389	133.503	136.943	144.331	153.758
Indonesia	100	107.965	117.699	237.463	262.242	294.985	333.333	348.083	359.882	386.431
Israel	100	108.678	115.487	120.294	128.838	133.511	133.378	138.585	144.459	152.336
Italy	100	101.967	103.279	103.388	103.060	109.290	111.366	111.257	113.005	116.066
Japan	100	98.271	98.943	97.406	95.965	96.061	93.852	91.931	91.162	92.315
Jordan	100	100.185	99.378	104.052	97.783	97.762	98.927	99.066	100.255	101.205
Korea	100	103.245	107.212	120.313	117.788	120.192	119.591	119.231	121.875	129.327
Lithuania	100	117.274	122.267	113.225	114.845	134.953	129.960	125.236	124.831	134.413

Malaysia	100	102.320	104.988	116.357	112.529	116.009	116.589	115.777	121.114	129.466
Mexico	100	133.858	157.352	182.487	208.476	224.820	236.106	248.156	266.704	291.479
Netherlands	100	101.976	103.842	103.622	104.720	109.769	113.063	113.941	115.587	120.088
New Zealand	100	100.663	100.994	101.657	102.762	110.497	117.127	117.348	116.354	118.343
Pakistan	100	111.001	123.554	126.375	135.684	141.044	147.532	151.904	161.636	175.317
Peru	100	109.379	117.517	126.069	132.138	137.931	139.862	138.345	140.690	148.138
Poland	100	113.158	126.935	136.223	143.653	154.799	157.430	159.133	163.467	174.923
Portugal	100	105.817	109.035	103.837	107.550	123.762	127.104	127.599	128.094	131.807
Singapore	100	100.108	99.029	96.009	97.950	107.875	106.149	104.639	106.688	112.190
South Africa	100	106.840	114.501	118.468	125.308	136.799	148.427	169.494	172.230	173.461
Spain	100	101.733	102.709	102.059	102.709	108.342	110.184	110.943	112.568	116.360
Sri Lanka	100	120.485	128.829	136.840	136.299	138.600	154.802	171.407	176.549	198.739
Sweden	100	98.203	99.366	98.837	99.894	105.708	109.091	109.725	108.774	111.311
Switzerland	100	98.171	97.498	96.343	95.380	96.246	96.728	96.246	96.246	97.401
Taiwan	100	88.627	83.816	89.722	51.573	64.011	54.392	54.733	73.408	165.676
Thailand	100	101.902	107.015	120.095	114.388	118.906	121.879	123.900	128.894	137.574
Turkey	100	175.924	319.873	549.554	841.274	1273.885	2058.981	3090.573	3880.637	4311.083
UK	100	102.532	103.481	103.481	103.903	105.485	105.169	105.274	106.857	109.494
USA	100	102.340	102.234	99.787	100.532	106.383	107.553	105.106	110.745	117.553
Venezuela	100	203.017	263.793	321.983	374.138	431.034	497.845	683.621	1034.914	1350.862

Appendix 4 Sample for *DEA* and regression analysis – distribution between countries

Country	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	TOTAL 1995-2004
Australia	0	1	1	1	1	2	5	5	5	8	29
Austria	2	2	2	2	2	3	2	2	2	2	21
Belgium	0	0	0	0	3	3	4	4	5	5	24
Bermuda	0	0	1	0	2	5	9	11	25	26	79
Brazil	2	2	3	1	4	9	9	12	14	17	73
Canada	0	0	0	0	0	2	2	2	2	2	10
Cayman Islands	0	0	0	0	0	0	1	5	11	17	34
Chile	0	0	0	1	1	1	0	0	0	0	3
China	9	5	5	3	28	40	53	72	76	85	376
Colombia	2	2	3	3	4	2	2	3	4	3	28
Czech Republic	0	0	0	0	0	0	1	0	0	0	1
Denmark	0	1	1	1	1	4	1	4	3	3	19
Estonia	0	1	1	1	1	1	1	0	1	2	9
Finland	2	2	2	2	2	4	5	5	5	5	34
France	8	8	9	9	9	31	32	36	33	31	206
Germany	24	25	24	26	24	28	28	27	30	29	265
Greece	11	11	9	11	8	11	11	9	10	14	105
Hong Kong	2	6	9	8	7	10	25	36	46	46	195
Hungary	0	0	0	1	1	1	1	1	1	1	7
India	2	3	3	3	2	1	3	5	6	10	38
Indonesia	3	6	5	9	13	18	24	26	26	25	155
Israel	0	0	0	0	0	0	0	0	1	0	1
Italy	8	12	15	15	16	20	19	21	22	20	168
Japan	71	63	70	74	86	106	113	117	115	124	939
Jordan	0	0	0	0	0	0	0	1	1	1	3
Korea	10	12	15	12	24	27	28	52	51	51	282

Lithuania	0	0	0	0	0	0	0	1	1	1	3
Malaysia	0	0	0	0	4	18	21	30	36	41	150
Mexico	0	0	0	1	2	3	2	3	3	3	17
Netherlands	2	3	2	3	3	7	7	6	4	3	40
New Zealand	1	1	1	1	1	1	1	1	1	1	10
Pakistan	0	0	0	0	2	3	4	5	8	8	30
Peru	3	1	3	3	4	2	4	7	8	8	43
Poland	3	2	4	0	2	2	4	4	4	6	31
Portugal	1	1	1	0	1	1	2	2	2	2	13
Singapore	0	0	0	0	0	3	7	11	13	16	50
South Africa	1	1	1	1	1	3	2	2	3	3	18
Spain	2	2	2	3	3	5	6	7	7	6	43
Sri Lanka	0	0	0	0	0	0	1	1	1	1	4
Sweden	1	1	1	1	1	3	3	5	5	5	26
Switzerland	5	5	5	5	5	6	6	6	5	5	53
Taiwan	8	10	12	21	21	15	21	39	69	69	285
Thailand	8	7	8	11	14	24	25	26	25	26	174
Turkey	1	1	4	4	7	13	12	23	23	23	111
UK	14	15	18	19	19	37	38	36	32	34	262
USA	66	72	80	96	97	114	123	125	118	117	1008
Venezuela	0	0	2	0	0	0	0	0	0	0	2
TOTAL	**272**	**284**	**322**	**352**	**426**	**589**	**669**	**797**	**864**	**905**	**5477**

Appendix 5 Sample for Malmquist analysis – distribution between countries

Country	1995/1996	1996/1997	1997/1998	1998/1999	1999/2000	2000/2001	2001/2002	2002/2003	2003/2004	TOTAL 1995-2004
Australia	0	1	1	1	1	2	5	4	5	20
Austria	2	2	2	2	3	2	2	2	2	19
Belgium	0	1	1	1	4	3	3	4	5	22
Bermuda	0	0	0	0	2	7	8	9	24	50
Brazil	3	2	1	1	4	8	6	10	13	48
Canada	0	0	0	0	0	2	2	2	2	8
Cayman Islands	0	0	0	0	0	2	1	8	11	22
Chile	1	1	1	1	1	0	0	0	0	5
China	5	5	3	2	39	56	59	86	91	346
Colombia	2	2	3	3	2	1	2	3	3	21
Czech Republic	0	0	0	0	0	0	0	0	0	0
Denmark	2	3	3	3	3	3	3	3	3	26
Estonia	0	1	1	1	1	1	0	0	1	6
Finland	2	2	2	2	2	5	5	5	5	30
France	18	17	19	22	26	31	29	32	31	225
Germany	26	26	26	25	27	27	27	27	29	240
Greece	12	10	9	8	7	7	5	8	8	74
Hong Kong	3	7	8	7	6	11	25	38	46	151
Hungary	0	0	0	1	1	1	1	1	1	6
India	2	3	3	2	1	1	3	5	6	26
Indonesia	3	3	5	9	13	19	25	26	25	128
Israel	0	0	0	0	0	0	0	0	0	0
Italy	9	14	15	15	19	18	18	21	19	148
Japan	65	66	71	72	87	101	110	115	114	801
Jordan	0	0	0	0	0	0	0	1	1	2
Korea	29	32	34	35	46	46	49	59	52	382

Lithuania	0	0	0	0	0	0	0	1	1	2
Malaysia	0	0	0	0	4	17	23	32	38	114
Mexico	0	1	1	2	3	2	2	3	3	17
Netherlands	2	4	6	7	7	7	6	4	3	46
New Zealand	1	1	1	1	1	1	1	6	1	14
Pakistan	0	0	0	0	1	3	4	0	8	16
Peru	1	1	3	3	2	1	2	6	8	27
Philippines	0	0	0	0	0	0	0	0	0	0
Poland	2	2	0	0	2	3	3	4	4	20
Portugal	1	1	0	0	1	0	2	2	1	8
Singapore	0	0	0	0	0	5	9	18	21	53
South Africa	1	1	3	3	2	1	1	2	3	17
Spain	2	2	2	4	4	6	6	7	6	39
Sri Lanka	0	0	0	0	0	0	1	1	1	3
Sweden	1	2	2	2	2	3	3	6	6	27
Switzerland	5	5	5	6	6	6	6	5	5	49
Taiwan	6	11	12	18	14	12	17	41	68	199
Thailand	7	5	8	9	13	24	25	26	27	144
Turkey	1	1	3	2	7	12	12	25	26	89
UK	35	38	41	37	33	37	34	33	29	317
USA	73	79	102	117	121	124	120	122	117	975
Venezuela	0	0	0	0	0	0	0	0	0	0
TOTAL	**322**	**352**	**397**	**424**	**518**	**618**	**665**	**813**	**873**	**4982**

Appendix 6 Descriptive statistics for *DEA* input-output set per sector

TEXTILE INDUSTRY

1995	Mean	Std. dev.	Min	Max	25th per.	75th per.
Costs	216269.2	320774.5	2704.7	2350872	53194.5	240272.9
Tangibles	126002.9	207220.4	295.1	1281327	20802	126087.6
Employees	1766	2085	48	13498	488	2442
Revenues	284464	414230.4	3294.9	2976661	74619.1	305638.8
Number of observations: 128						

1996	Mean	Std. dev.	Min	Max	25th per.	75th per.
Costs	227536.3	314983.4	1303.6	2181471	54757.7	257368.7
Tangibles	151795.1	259667.1	153.4	1718735	22377.1	143424.6
Employees	2437	5327	4	57000	494	2506
Revenues	304392.1	418849.1	1700.9	2785641	79052.2	373386.5
Number of observations: 135						

1997	Mean	Std. dev.	Min	Max	25th per.	75th per.
Costs	228307.2	313606.9	3301.9	2260391	59947	292284.3
Tangibles	152588.9	254707.4	232.2	1931677	25529.3	169933.5
Employees	2008	2381	47	13487	524	2494
Revenues	309715.2	425231.8	4198.3	2902975	81527.3	381894.1
Number of observations: 147						

1998	Mean	Std. dev.	Min	Max	25th per.	75th per.
Costs	217036.5	306012.4	916	2290737	48692.2	276024.9
Tangibles	155230.7	264935.1	24.3	1992130	22356	164040
Employees	1905	2397	2	13897	462	2342
Revenues	294169.9	420537.8	1498.8	2968172	69817	352056.2
Number of observations: 163						

1999	Mean	Std. dev.	Min	Max	25th per.	75th per.
Costs	223967.1	392170.6	2964.2	4373075	51900.8	270463.2
Tangibles	176598.3	360862.3	55	4044479	27031.7	176906.7
Employees	2115	3296	17	35516	483	2363
Revenues	300611.5	544000.2	2683.5	6293890	68087.9	361198.4
Number of observations: 206						

2000	Mean	Std. dev.	Min	Max	25th per.	75th per.
Costs	282005.8	865747.6	533	1.26e+07	50112.8	275948.4
Tangibles	171189.6	368388.7	80.8	4155070	25516.4	172432
Employees	2863	8398	15	121636	477	2498
Revenues	377209.3	1034730	606	1.41e+07	70164.3	355113.4
Number of observations: 272						

2001	Mean	Std. dev.	Min	Max	25th per.	75th per.
Costs	272119.8	805834.7	521.5	1.26e+07	48059	278131.5
Tangibles	184510.7	369005.1	81.8	4338144	25522	211198.4
Employees	2926	7737	3	115929	495	2754
Revenues	357517.6	935423	367	1.36e+07	67506.8	368775.5
Number of observations: 317						

2002	Mean	Std. dev.	Min	Max	25th per.	75th per.
Costs	248943.5	763659	329.206	1.32e+07	36701.9	243377.7
Tangibles	168048.1	345926.4	82	4130087	21644.8	162689.6
Employees	2598	7046	10	114694	342	2335
Revenues	323103.9	896140.1	182.2	1.44e+07	48389	320671.3
Number of observations: 402						

2003	Mean	Std. dev.	Min	Max	25th per.	75th per.
Costs	258726.7	803726.1	625.6	1.44e+07	36567.2	246152
Tangibles	171227.5	360545.2	5.2	3987601	21672.1	171530.5
Employees	2701	7456	2	111022	360	2327
Revenues	331686.2	943995.9	1100.5	1.57e+07	46062	310050.8
Number of observations: 442						

2004	Mean	Std. dev.	Min	Max	25th per.	75th per.
Costs	322214.2	960686.7	679.5	1.52e+07	39458	268700.3
Tangibles	200320.2	479893	3.9	4673960	21756.7	184847.4
Employees	3090	9266	2	110083	380	2507
Revenues	408158.7	1148640	1535.6	1.70e+07	55731.8	348649.4
Number of observations: 464						

CLOTHING INDUSTRY

1995	Mean	Std. dev.	Min	Max	25th per.	75th per.
Costs	250735.2	333843.7	7273	2500089	51081.8	300287
Tangibles	79228.3	128060.3	355.1	832178.1	12855.5	72106.9
Employees	3654	6646	41	64000	411	4275
Revenues	370811.9	510275.1	12567	3835171	70736.7	430073.8
Number of observations: 144						

1996	Mean	Std. dev.	Min	Max	25th per.	75th per.
Costs	245594.8	331994.5	2550.2	2556920	50367	286566.5
Tangibles	87972.2	153662.5	332.2	1292767	11774	86892.7
Employees	3767	6616	65	62800	472	3983
Revenues	365893.1	512585.7	4844.5	3983320	65535	396213.6
Number of observations: 149						

1997	Mean	Std. dev.	Min	Max	25th per.	75th per.
Costs	250353.4	356228.4	5.7	2903524	45791	273800.8
Tangibles	96420.8	177627.3	35.5	1459583	9919	89413.2
Employees	3607	6439	3	63400	450	3900
Revenues	378818.6	560290.1	11.7	4616705	63184	426307.7
Number of observations: 175						

1998	Mean	Std. dev.	Min	Max	25th per.	75th per.
Costs	252367.8	370579.8	2342.9	3078181	42097	288263.5
Tangibles	90208.2	163297.5	92.2	1100805	6573	83227.4
Employees	3355	6575	25	70000	341	3547
Revenues	384133.4	591685.1	4026	4923582	60087	414953.7
Number of observations: 189						

1999	Mean	Std. dev.	Min	Max	25th per.	75th per.
Costs	229812.1	370828.7	103.2	3307236	39375.9	239073.8
Tangibles	88729.3	152683.9	15.5	953140.1	8622.7	82660.8
Employees	3260	6538	2	73000	355	3406
Revenues	356199.3	604244.5	130.7	5211927	53685	368213.8
Number of observations: 220						

2000	Mean	Std. dev.	Min	Max	25th per.	75th per.
Costs	234453.5	409490.4	91.9	3960305	38698.5	232884.5
Tangibles	82118.9	143352.9	15.8	842782.8	7858.6	70533
Employees	3040	5940	3	75000	412	3300
Revenues	370234.6	671423.3	164.03	6237353	57224.7	333823.8
Number of observations: 317						

2001	Mean	Std. dev.	Min	Max	25th per.	75th per.
Costs	229451	422118.7	11.4	3952837	32748.3	224648.2
Tangibles	81728.3	166909	13	1873214	6880.2	69308.6
Employees	2835	5538	3	71000	374	2605
Revenues	363473.8	700822.3	8.1	6168376	48648.3	329027.8
Number of observations: 351						

2002	Mean	Std. dev.	Min	Max	25th per.	75th per.
Costs	210610.7	393633.4	10.51428	3319899	29603.3	205001
Tangibles	75818.8	156384	5.9	1943090	5754	70189.4
Employees	2842	5155	3	56000	325	2700
Revenues	338527	666667.9	8.1	5425365	42712.4	307689.9
Number of observations: 394						

2003	Mean	Std. dev.	Min	Max	25th per.	75th per.
Costs	187576.7	358282.4	11.4	3515028	24074.5	180814
Tangibles	71772.3	162018.8	0.5	2251317	4734.9	66904.3
Employees	2972	5463	4	52300	301	2786
Revenues	300618.7	605997.6	8.1	6162798	36428.6	275298.7
Number of observations: 421						

2004	Mean	Std. dev.	Min	Max	25th per.	75th per.
Costs	190629.9	368945.8	11.4	3731360	23766	185860.2
Tangibles	74524.3	177810.2	14.4	2608799	4825.2	66288.4
Employees	3056	5732	3	53200	293	2914
Revenues	315553.6	668505.4	8.1	7494352	34704	281144.5
Number of observations: 441						

<u>TEXTILE AND CLOTHING INDUSTRY: GLOBAL</u>

1995	Mean	Std. dev.	Min	Max	25th per.	75th per.
Costs	234515.9	327609.7	2704.7	2500089	51920.2	285886.4
Tangibles	101239.9	171242.5	295.1	1281327	14545.5	96464.3
Employees	2766	5122	41	64000	426	3012
Revenues	330177.6	468692.2	3294.9	3835171	70736.7	399599.2
Number of observations: 272						

1996	Mean	Std. dev.	Min	Max	25th per.	75th per.
Costs	237010.7	323575.8	1303.6	2556920	53048.9	284882.1
Tangibles	118310.5	212824.9	153.4	1718735	14090.2	112746.1
Employees	3135	6064	4	62800	489	3265
Revenues	336658.4	470554.4	1700.9	3983320	73522	392896.8
Number of observations: 284						

1997	Mean	Std. dev.	Min	Max	25th per.	75th per.
Costs	240288.8	337104.2	5.7	2903524	51962.7	290057.5
Tangibles	122062.7	217704.5	35.5	1931677	14858.7	119582
Employees	2877	5069	3	63400	482	3600
Revenues	347271.4	503583.6	11.7	4616705	77163	411888
Number of observations: 322						

1998	Mean	Std. dev.	Min	Max	25th per.	75th per.
Costs	236007	342179.4	916	3078181	46244.2	277976.3
Tangibles	120318.1	218477.8	24.28325	1992130	13387.9	114493.6
Employees	2684	5132	2	70000	388	2860
Revenues	342474.2	520725.8	1498.762	4923582	62577	385982.3
Number of observations: 352						

1999	Mean	Std. dev.	Min	Max	25th per.	75th per.
Costs	226985.6	380858.9	103.3	4373075	44642.8	255108.4
Tangibles	131220	277052.7	15.5	4044479	18129.3	134972.5
Employees	2706	5253	2	73000	419	2857
Revenues	329318.8	575898.4	130.7	6293890	61895.2	361808.3
Number of observations: 426						

2000	Mean	Std. dev.	Min	Max	25th per.	75th per.
Costs	256413.1	660393.4	91.9	1.26e+07	44126.5	243908.5
Tangibles	123251.7	274892.4	15.8	4155070	15126.1	112938.6
Employees	2958	7174	3	121636	450	2836
Revenues	373455.5	857751	164	1.41e+07	62316.9	343310.3
Number of observations: 589						

2001	Mean	Std. dev.	Min	Max	25th per.	75th per.
Costs	249635.6	633163	11.4	1.26e+07	40157.2	248840.2
Tangibles	130349.9	285662.8	13	4338144	14191.4	130555.7
Employees	2878	6664	3	115929	414	2612
Revenues	360656.2	819578.9	8.1	1.36e+07	57145	343025.7
Number of observations: 668						

2002	Mean	Std. dev.	Min	Max	25th per.	75th per.
Costs	229969.7	609195.6	10.5	1.32e+07	32634.3	227989
Tangibles	122396.9	273089.7	5.9	4130087	12403.6	118895.5
Employees	2719	6180	3	114694	341	2501
Revenues	330737.9	790465.6	8.1	1.44e+07	45668.1	315189.8
Number of observations: 796						

2003	Mean	Std. dev.	Min	Max	25th per.	75th per.
Costs	224017.4	627927.6	11.4	1.44e+07	29314	213502.2
Tangibles	122709.9	285952.4	0.5	3987601	11162.1	110243
Employees	2833	6557	2	111022	324	2465
Revenues	316530.4	796915.2	8.1	1.57e+07	41161.7	288023
Number of observations: 863						

2004	Mean	Std. dev.	Min	Max	25th per.	75th per.
Costs	258094.1	737071.1	11.4	1.52e+07	31704	232624.8
Tangibles	139020.8	370536.7	3.89761	4673960	11285.8	118641
Employees	3074	7744	2	110083	334	2719
Revenues	363032.9	946257.8	8.1	1.70e+07	43124	309824.8
Number of observations: 905						

Appendix 7 Descriptive statistics for Malmquist input-output set per sector

TEXTILE INDUSTRY

1995/1996	Mean	Std. dev.	Min	Max	25th per.	75th per.
Costs	242198.4	496043.5	2704.7	4311300	40951.7	236166.3
Tangibles	124473.3	214929	295.1	1281327	13950.4	126087.6
Employees	2357	6584	48	71009	423	2212
Revenues	319016.5	622929.4	3294.9	4714400	53012.3	300352.9
Number of observations: 152						

1996/1997	Mean	Std. dev.	Min	Max	25th per.	75th per.
Costs	264007.1	570410	3327.1	5629400	41890.6	241266.8
Tangibles	141221.8	254614.8	182.4	1683883	15678.7	137708.6
Employees	2557	6528	45	68000	414	2440
Revenues	350023.6	711744	4244.2	6249100	61329.2	338760.7
Number of observations: 167						

1997/1998	Mean	Std. dev.	Min	Max	25th per.	75th per.
Costs	258608.5	594411.4	1144	6533500	43448.1	250304.9
Tangibles	132692.2	246796.1	239.9	1808918	15532.4	124867.6
Employees	2494	6437	23	66656	422	2477
Revenues	345129.3	730921.5	1155	7342900	59808	318692.5
Number of observations: 185						

1998/1999	Mean	Std. dev.	Min	Max	25th per.	75th per.
Costs	256763.8	675808.4	1285	8198000	37874.7	232259
Tangibles	135460.8	240078.4	24.4	1720501	16957.7	139620.2
Employees	2530	6700	18	65316	414	2342
Revenues	343408.9	803262.2	1657	9059400	54477.4	297183.9
Number of observations: 192						

1999/2000	Mean	Std. dev.	Min	Max	25th per.	75th per.
Costs	272764.9	815613	728.5	1.12e+07	36978.2	258319.6
Tangibles	169907	406490	52	4236935	21904.4	173740.1
Employees	2847	8937	15	121102	413	2430
Revenues	360946.8	980315.1	1100	1.24e+07	53850.1	345225
Number of observations: 249						

2000/2001	Mean	Std. dev.	Min	Max	25th per.	75th per.
Costs	276198.2	861992.5	574.5	1.26e+07	41056	265805.2
Tangibles	158020.6	379621.9	150	4601519	22649.8	163186.5
Employees	2977	8335	17	121636	486	2808
Revenues	366866.8	1039610	760	1.41e+07	49570.5	335078.5
Number of observations: 287						

2001/2002	Mean	Std. dev.	Min	Max	25th per.	75th per.
Costs	271872.9	835045.4	414.5	1.26e+07	37023.7	280762.6
Tangibles	175194.8	410322.3	67.1	4971454	21714.6	202439.1
Employees	2883	7799	12	115929	465	2600
Revenues	353021.6	986482.1	690.4	1.36e+07	50723.6	366153.1
Number of observations: 310						

2002/2003	Mean	Std. dev.	Min	Max	25th per.	75th per.
Costs	247456.3	776084.8	457.7	1.32e+07	32224.8	231558.3
Tangibles	165190.2	387517.9	56.5	4722013	18776	170556
Employees	2614	6970.8	10	114694	352	2481
Revenues	323259.1	928172.7	703.5	1.44e+07	39760.4	294655.8
Number of observations: 411						

2003/2004	Mean	Std. dev.	Min	Max	25th per.	75th per.
Costs	259546.8	828652.6	250.7	1.44e+07	28661.2	232194.8
Tangibles	169226.3	396431.9	53.3	4844167	17880.5	172565.8
Employees	2680	7284	2	111022	386	2402
Revenues	334590.5	987306.4	358.5	1.57e+07	38212.8	294914.1
Number of observations: 448						

CLOTHING INDUSTRY

1995/1996	Mean	Std. dev.	Min	Max	25th per.	75th per.
Costs	243342.2	389017.5	5407.6	3045193	41447.6	282451.8
Tangibles	77580.2	166112.1	355.2	1739766	9201.2	69398.3
Employees	3511	6411	41	64000	400	4035
Revenues	361985.4	568134	7926.8	3928091	58878.8	410770.5
Number of observations: 170						

1996/1997	Mean	Std. dev.	Min	Max	25th per.	75th per.
Costs	229353.8	323083.4	2274.1	2556920	42355.7	266347
Tangibles	77795.5	138550.3	346	1225423	9886.5	71114
Employees	3385	6146	65	62800	421	3631
Revenues	346474.1	502577.7	4320.1	3983320	61167.1	386047
Number of observations: 185						

1997/1998	Mean	Std. dev.	Min	Max	25th per.	75th per.
Costs	240877.6	358116	2281.7	2903524	38120.7	263788.2
Tangibles	85490.7	158976.2	287	1267801	6858.9	79481.3
Employees	3331	6120	24	63400	335.5	3722.5
Revenues	367939.7	558043	4662.4	4616705	58480	403542
Number of observations: 212						

1998/1999	Mean	Std. dev.	Min	Max	25th per.	75th per.
Costs	239952.5	368751.9	1803.1	3078181	36751.2	249492
Tangibles	82513.6	157107.8	275	1256690	6368.1	73170
Employees	3368	6608	30	70000	334	3535
Revenues	368560	586753.1	2869	4923582	55964.7	396753.5
Number of observations: 232						

1999/2000	Mean	Std. dev.	Min	Max	25th per.	75th per.
Costs	225656.8	367434.4	103.3	3307236	37521.2	241460
Tangibles	85374.4	166429.8	15.45	1592582	8559.4	70856.3
Employees	3140	6125	2	73000	365	3300
Revenues	354345.8	603728	130.73	5211927	53785.97	350069.8
Number of observations: 269						

2000/2001	Mean	Std. dev.	Min	Max	25th per.	75th per.
Costs	236027.2	420941.2	11.4	3960305	34161.5	228879.5
Tangibles	82847	169526	14.4	1874814	6756.1	68933.5
Employees	2960	5897	3	75000	380	2900
Revenues	373380.9	694416.5	8.1	6237353	51932	333396.7
Number of observations: 331						

2001/2002	Mean	Std. dev.	Min	Max	25th per.	75th per.
Costs	232001.9	428951.8	11.4	3952837	28510.6	223798.1
Tangibles	82817.9	167215.7	12.9	1828485	6302.7	69162.1
Employees	2852	5552	3	71000	351	2613
Revenues	368020.7	711474.1	8.1	6168376	44809.8	325847.8
Number of observations: 355						

2002/2003	Mean	Std. dev.	Min	Max	25th per.	75th per.
Costs	202142.7	388439	10.5	3319899	25342.3	199277.5
Tangibles	72461.4	152661	5.9	1840872	4716.3	66309.2
Employees	2743	5102	3	56000	298	2476
Revenues	325128.1	660569.5	8.1	5394074	36073.2	285257.2
Number of observations: 402						

2003/2004	Mean	Std. dev.	Min	Max	25th per.	75th per.
Costs	192070.3	372074.8	11.4	3458102	21501.7	183845
Tangibles	70558.9	161551.3	14.4	2214856	4329.6	63075.6
Employees	2925.2	5399.2	4	52300	302	2768
Revenues	309425.1	640441.5	8.1	6062991	31928	284487
Number of observations: 425						

TEXTILE AND CLOTHING INDUSTRY: GLOBAL

1995/1996	Mean	Std. dev.	Min	Max	25th per.	75th per.
Costs	242802.3	442066	2704.7	4311300	41388.2	252504.1
Tangibles	99716.1	191851.8	295.1	1739766	12139.5	95040.5
Employees	2967	6509	41	71009	409	2965
Revenues	341702	594081.8	3294.9	4714400	57134	372528.5
Number of observations: 322						

1996/1997	Mean	Std. dev.	Min	Max	25th per.	75th per.
Costs	245794.4	457052.6	2274.1	5629400	42123.1	254142.5
Tangibles	107886.9	204275.9	182.4338	1683883	12814.6	106283.4
Employees	2992	6336	45	68000	417	3000
Revenues	348158.1	609910.6	4244.2	6249100	61248.2	355428.3
Number of observations: 352						

1997/1998	Mean	Std. dev.	Min	Max	25th per.	75th per.
Costs	249140.1	482269.8	1144	6533500	40180	261933.2
Tangibles	107486.4	205725.7	239.9	1808918	10902.5	100044
Employees	2941	6276	23	66656	386	3134
Revenues	357310.2	643657.2	1155	7342900	59492.4	359567.8
Number of observations: 397						

1998/1999	Mean	Std. dev.	Min	Max	25th per.	75th per.
Costs	247565.1	529671.7	1285	8198000	37510.7	246855.9
Tangibles	106489.7	200502	24.4	1720501	11105.4	103067.3
Employees	2988	6655	18	70000	367	3130
Revenues	357170.8	692468.6	1657	9059400	54477.4	361599.9
Number of observations: 424						

1999/2000	Mean	Std. dev.	Min	Max	25th per.	75th per.
Costs	248301.4	624212.9	103.3	1.12e+07	37498.1	245822.7
Tangibles	126008.8	308880	15.5	4236935	13248.7	120688
Employees	2999	7601	2	121102	385	3039
Revenues	357518.9	806190.6	130.7	1.24e+07	53785.9	348567.5
Number of observations: 518						

2000/2001	Mean	Std. dev.	Min	Max	25th per.	75th per.
Costs	254682.7	663017.2	11.4	1.26e+07	36916.6	246860.8
Tangibles	117757.7	289101.9	14.4	4601519	12667.7	110946.5
Employees	2968	7127	3	121636	429	2850
Revenues	370355.8	871149.9	8.1	1.41e+07	51216	333396.7
Number of observations: 618						

2001/2002	Mean	Std. dev.	Min	Max	25th per.	75th per.
Costs	250588.4	650376.3	11.4	1.26e+07	32742	248945
Tangibles	125880.8	308843.1	12.9	4971454	11740.6	126535
Employees	2867	6689	3	115929	394	2605
Revenues	361028.6	850170.8	8.1	1.36e+07	46612.6	354341.8
Number of observations: 665						

2002/2003	Mean	Std. dev.	Min	Max	25th per.	75th per.
Costs	225050.3	615750	10.5	1.32e+07	27291.7	214695.8
Tangibles	119339.1	299142.2	5.91	4722013	9918.1	116210.3
Employees	2679	6115	3	114694	332	2476
Revenues	324183.2	806527.2	8.1	1.44e+07	38614.9	293851.6
Number of observations: 813						

2003/2004	Mean	Std. dev.	Min	Max	25th per.	75th per.
Costs	226697.4	648419.7	11.4	1.44e+07	24796.9	214749.7
Tangibles	121192.4	309332.8	14.4	4844167	9260.3	111604
Employees	2799	6433	2	111022	337	2486
Revenues	322339.3	836229.6	8.1	1.57e+07	35293.9	286675.2
Number of observations: 873						

Appendix 8 Descriptive statistics for regression variables per sector

TEXTILE INDUSTRY

1995	Mean	Std. dev.	Min	Max	25th per.	75th per.
Intangibles	1.380	1.466	0.131	8.664	0.640	1.309
Leverage	0.403	0.292	0	2.153	0.190	0.559
Learning	16.781	30.872	0	229	5	22
Development	18.137	8.004	1.790	27.574	13.110	22.763
EU	0.297	0.459	0	1	0	1
NAFTA	0.148	0.357	0	1	0	0
Size	339992.1	566136.1	1452.916	3173477	65495.75	343220.9
Asia	0.492	0.502	0	1	0	1
Eur	0.305	0.462	0	1	0	1
Nam	0.148	0.357	0	1	0	0
Msam	0.047	0.212	0	1	0	0
Aus	0.008	0.088	0	1	0	0
Afr	0	0	0	0	0	0
Number of observations: 128						

1996	Mean	Std. dev.	Min	Max	25th per.	75th per.
Intangibles	1.352	1.398	0.108	7.836	0.641	1.298
Leverage	0.410	0.326	0	2.947	0.213	0.566
Learning	19.259	31.743	1	230	7	23
Development	19.527	7.846	1.925	28.814	14.098	23.732
EU	0.319	0.468	0	1	0	1
NAFTA	0.156	0.363	0	1	0	0
Size	390799.2	631033.3	1829.393	3592436	74897	438763.4
Asia	0.481	0.502	0	1	0	1
Eur	0.326	0.470	0	1	0	1
Nam	0.156	0.364	0	1	0	0
Msam	0.030	0.170	0	1	0	0
Aus	0.007	0.086	0	1	0	0
Afr	0	0	0	0	0	0
Number of observations: 135						

1997	Mean	Std. dev.	Min	Max	25th per.	75th per.
Intangibles	1.174	0.880	0.112	6.297	0.640	1.387
Leverage	0.430	0.310	0	2.124	0.225	0.583
Learning	19.497	28.295	1	231	7	24
Development	19.527	8.500	2.010	30.261	14.067	24.399
EU	0.279	0.450	0	1	0	1
NAFTA	0.143	0.351	0	1	0	0
Size	382857.5	614732.3	2086.946	3537902	74693	416107.7
Asia	0.483	0.501	0	1	0	1
Eur	0.306	0.462	0	1	0	1
Nam	0.143	0.351	0	1	0	0
Msam	0.061	0.241	0	1	0	0
Aus	.007	0.082	0	1	0	0
Afr	0	0	0	0	0	0
Number of observations: 147						

1998	Mean	Std. dev.	Min	Max	25th per.	75th per.
Intangibles	1.226	1.106	0.124	8.883	0.629	1.396
Leverage	0.467	0.401	0	3.528	0.234	0.621
Learning	20.828	30.491	0	232	8	25
Development	19.514	8.782	2.117	31.519	12.779	24.176
EU	0.276	0.448	0	1	0	1
NAFTA	0.147	0.355	0	1	0	0
Size	348397.3	549485.1	1997	3559236	63231.22	411347.8
Asia	0.509	0.501	0	1	0	1
Eur	0.301	0.460	0	1	0	1
Nam	0.141	0.349	0	1	0	0
Msam	0.043	0.203	0	1	0	0
Aus	0.006	0.078	0	1	0	0
Afr	0	0	0	0	0	0
Number of observations: 163						

1999	Mean	Std. dev.	Min	Max	25th per.	75th per.
Intangibles	1.401	1.514	0.107	8.768	0.589	1.425
Leverage	0.451	0.403	0	4.257	0.240	0.592
Learning	20.073	29.640	0	233	7	26
Development	17.560	10.306	1.809	52.429	5.963	24.487
EU	0.209	0.407	0	1	0	0
NAFTA	0.107	0.310	0	1	0	0
Size	460382.2	1026020	1944.554	9791020	70820.72	462467.2
Asia	0.597	0.492	0	1	0	1
Eur	0.238	0.427	0	1	0	0
Nam	0.107	0.310	0	1	0	0
Msam	0.053	0.225	0	1	0	0
Aus	0.005	0.070	0	1	0	0
Afr	0	0	0	0	0	0
Number of observations: 206						

2000	Mean	Std. dev.	Min	Max	25^{th} per.	75^{th} per.
Intangibles	1.280	1.191	0.089	7.892	0.603	1.462
Leverage	0.477	0.440	0	5.405	0.267	0.619
Learning	25.629	35.615	1	254	7	27
Development	18.711	11.221	1.881	55.953	6.396	26.214
EU	0.257	0.438	0	1	0	1
NAFTA	0.107	0.309	0	1	0	0
Size	459639.9	1142797	739.128	1.07e+07	60814.79	424495.5
Asia	0.544	.499	0	1	0	1
Eur	0.298	0.458	0	1	0	1
Nam	0.107	0.309	0	1	0	0
Msam	0.044	0.206	0	1	0	0
Aus	0.004	0.061	0	1	0	0
Afr	0.004	0.061	0	1	0	0
Number of observations: 272						

2001	Mean	Std. dev.	Min	Max	25^{th} per.	75^{th} per.
Intangibles	1.261	1.195	0.121	7.440	0.569	1.375
Leverage	0.469	0.437	0	6.182	0.254	0.600
Learning	25.423	34.510	0	255	8	28
Development	18.450	11.672	1.918	58.001	6.031	26.990
EU	0.2371	0.426	0	1	0	0
NAFTA	0.101	0.302	0	1	0	0
Size	457906.6	1003135	407.863	1.09e+07	60943.66	515784
Asia	0.577	0.495	0	1	0	1
Eur	0.268	0.444	0	1	0	1
Nam	0.104	0.306	0	1	0	0
Msam	0.041	0.199	0	1	0	0
Aus	0.006	0.079	0	1	0	0
Afr	0.003	0.056	0	1	0	0
Number of observations: 317						

2002	Mean	Std. dev.	Min	Max	25^{th} per.	75^{th} per.
Intangibles	1.141	1.003	0.045	7.919	0.569	1.342
Leverage	0.450	0.403	0	5.015	0.238	0.582
Learning	23.408	30.884	0	256	8	29
Development	17.898	11.702	1.966	62.531	6.238	27.123
EU	0.179	0.384	0	1	0	0
NAFTA	0.085	0.279	0	1	0	0
Size	413948.3	930182.5	244.865	1.05e+07	45875.23	464766.7
Asia	0.634	0.482	0	1	0	1
Eur	0.221	0.416	0	1	0	0
Nam	0.087	0.282	0	1	0	0
Msam	0.055	0.228	0	1	0	0
Aus	0.002	0.050	0	1	0	0
Afr	0	0	0	0	0	0
Number of observations: 402						

2003	Mean	Std. dev.	Min	Max	25th per.	75th per.
Intangibles	1.118	1.041	0.017	7.168	0.560	1.226
Leverage	0.426	0.329	0	3.411	0.219	0.580
Learning	21.853	28.708	0	257	7	22
Development	18.394	12.459	2.053	66.234	6.930	27.710
EU	0.161	0.368	0	1	0	0
NAFTA	0.075	0.263	0	1	0	0
Size	429689.9	983217.6	236.169	1.15e+07	48559.57	459707.1
Asia	0.645	0.479	0	1	0	1
Eur	0.199	0.400	0	1	0	0
Nam	0.084	0.277	0	1	0	0
Msam	0.068	0.252	0	1	0	0
Aus	0.005	0.067	0	1	0	0
Afr	0	0	0	0	0	0
Number of observations: 442						

2004	Mean	Std. dev.	Min	Max	25th per.	75th per.
Intangibles	1.156	1.097	0.016	7.973	0.570	1.300
Leverage	0.442	0.460	0	6.924	0.212	0.564
Learning	21.009	27.008	0	258	7	20
Development	19.285	13.423	2.209	70.283	5.993	29.082
EU	0.153	0.360	0	1	0	0
NAFTA	0.060	0.238	0	1	0	0
Size	456900.2	1135722	311.318	1.36e+07	48066.95	449827.1
Asia	0.655	0.476	0	1	0	1
Eur	0.190	0.392	0	1	0	0
Nam	0.073	0.261	0	1	0	0
Msam	0.075	0.264	0	1	0	0
Aus	0.006	0.080	0	1	0	0
Afr	0	0	0	0	0	0
Number of observations: 464						

CLOTHING INDUSTRY

1995	Mean	Std. dev.	Min	Max	25th per.	75th per.
Intangibles	1.137	0.782	0.059	5.317	0.720	1.296
Leverage	0.378	0.282	0	2.130	0.194	0.479
Learning	15.271	22.090	0	137	5	22
Development	22.335	5.952	1.790	27.574	21.652	27.574
EU	0.278	0.449	0	1	0	1
NAFTA	0.326	0.471	0	1	0	1
Size	328658.5	479393.1	8796	2582306	57325.95	332781.8
Asia	0.347	0.478	0	1	0	1
Eur	0.313	0.465	0	1	0	1
Nam	0.326	0.471	0	1	0	1
Msam	0.007	0.083	0	1	0	0
Aus	0	0	0	0	0	0
Afr	0.007	0.083	0	1	0	0
Number of observations: 144						

1996	Mean	Std. dev.	Min	Max	25th per.	75th per.
Intangibles	1.193	0.946	0.057	6.458	0.672	1.349
Leverage	0.377	0.280	0	2.240	0.203	0.505
Learning	16.738	22.980	0	138	6	23
Development	23.142	6.417	1.925	28.814	22.210	28.814
EU	0.289	0.455	0	1	0	1
NAFTA	0.342	0.476	0	1	0	1
Size	338825.2	486636.6	3429.879	2714596	57733.08	384115
Asia	0.315	0.466	0	1	0	1
Eur	0.322	0.469	0	1	0	1
Nam	0.342	0.476	0	1	0	1
Msam	0.007	0.082	0	1	0	0
Aus	0.007	0.082	0	1	0	0
Afr	0.007	0.082	0	1	0	0
Number of observations: 149						

1997	Mean	Std. dev.	Min	Max	25th per.	75th per.
Intangibles	1.175	0.885	0.038	5.550	0.657	1.313
Leverage	0.395	0.302	0	2.671	0.218	0.539
Learning	16.783	22.771	0	139	6	22
Development	24.136	6.993	2.010	47.115	23.101	30.261
EU	0.286	0.453	0	1	0	1
NAFTA	0.337	0.474	0	1	0	1
Size	359473.7	541192.1	266.23	3420374	58428	389310.1
Asia	0.32	0.468	0	1	0	1
Eur	0.314	0.466	0	1	0	1
Nam	0.343	0.476	0	1	0	1
Msam	0.011	0.107	0	1	0	0
Aus	0.006	0.076	0	1	0	0
Afr	0.006	0.076	0	1	0	0
Number of observations: 175						

1998	Mean	Std. dev.	Min	Max	25th per.	75th per.
Intangibles	1.164	1.021	0.077	8.557	0.637	1.339
Leverage	0.389	0.261	0	1.701	0.238	0.509
Learning	16.640	22.240	0	140	6	21
Development	25.168	7.220	2.117	31.519	23.687	31.519
EU	0.259	0.439	0	1	0	1
NAFTA	0.386	0.488	0	1	0	1
Size	325407.4	509835.1	797.83	3293380	50382.28	359017.8
Asia	0.307	0.462	0	1	0	1
Eur	0.286	0.453	0	1	0	1
Nam	0.386	0.488	0	1	0	1
Msam	0.011	0.103	0	1	0	0
Aus	0.005	0.073	0	1	0	0
Afr	0.005	0.073	0	1	0	0
Number of observations: 189						

1999	Mean	Std. dev.	Min	Max	25th per.	75th per.
Intangibles	1.160	1.148	0.039	7.389	0.625	1.213
Leverage	0.419	0.284	0	1.875	0.227	0.545
Learning	17.191	21.516	1	141	6	22.5
Development	24.809	8.915	2.262	52.429	24.425	33.028
EU	0.241	0.4295	0	1	0	0
NAFTA	0.35	0.478	0	1	0	1
Size	341577.8	580573.2	354.78	4017270	46054	363097.3
Asia	0.355	0.479	0	1	0	1
Eur	0.268	0.444	0	1	0	1
Nam	0.35	0.478	0	1	0	1
Msam	0.018	0.134	0	1	0	0
Aus	0.005	0.067	0	1	0	0
Afr	0.005	0.067	0	1	0	0
Number of observations: 220						

2000	Mean	Std. dev.	Min	Max	25th per.	75th per.
Intangibles	1.149	1.082	0.004	7.540835	0.619	1.220
Leverage	0.436	0.318	0	3.489805	0.243	.561
Learning	20.823	24.648	0	142	7	27
Development	25.307	9.601	2.364	55.953	25.64639	34.600
EU	.287	.453	0	1	0	1
NAFTA	.284	.452	0	1	0	1
Size	350089.6	631734.5	646.01	4642021	45101.65	310566
Asia	0.366	0.482	0	1	0	1
Eur	0.312	0.464	0	1	0	1
Nam	0.290	0.455	0	1	0	1
Msam	0.019	0.136	0	1	0	0
Aus	0.006	0.079	0	1	0	0
Afr	0.006	0.079	0	1	0	0
Number of observations: 317						

2001	Mean	Std. dev.	Min	Max	25th per.	75th per.
Intangibles	1.06	0.945	0	7.326	0.584	1.206
Leverage	0.417	0.283	0	2.435	0.233	0.558
Learning	20.917	24.003	0	143	7	28
Development	26.283	10.281	2.507	58.001	26.307	35.315
EU	0.256	0.437	0	1	0	1
NAFTA	0.271	0.445	0	1	0	1
Size	350061.7	670950.9	54.43	4608208	38977	289585.6
Asia	0.405	0.492	0	1	0	1
Eur	0.279	0.449	0	1	0	1
Nam	0.288	0.453	0	1	0	1
Msam	0.014	0.119	0	1	0	0
Aus	0.011	0.106	0	1	0	0
Afr	0.003	0.053	0	1	0	0
Number of observations: 351						

2002	Mean	Std. dev.	Min	Max	25th per.	75th per.
Intangibles	1.075	0.983	0	7.903	0.596	1.146
Leverage	0.419	0.305	0	2.958	0.219	0.576
Learning	20.246	23.497	0	144	7	25
Development	26.274	11.062	2.605	62.531	23.756	36.126
EU	0.249	0.433	0	1	0	0
NAFTA	0.244	0.430	0	1	0	0
Size	318883.4	618817.3	54.43	3898062	35691	278302.3
Asia	0.421	0.494	0	1	0	1
Eur	0.279	0.449	0	1	0	1
Nam	0.261	0.440	0	1	0	1
Msam	0.020	0.141	0	1	0	0
Aus	0.013	0.112	0	1	0	0
Afr	0.005	0.071	0	1	0	0
Number of observations: 394						

2003	Mean	Std. dev.	Min	Max	25th per.	75th per.
Intangibles	1.076	0.962	0	8.195	0.577	1.213
Leverage	0.396	0.268	0	1.741	0.196	0.546
Learning	19.242	22.519	0	145	7	20
Development	27.683	13.028	2.838	66.234	19.317	37.545
EU	0.228	0.420	0	1	0	0
NAFTA	0.214	0.410	0	1	0	0
Size	308641.5	637376.6	54.43	4627891	27742.89	253207.5
Asia	0.449	0.498	0	1	0	1
Eur	0.254	0.436	0	1	0	1
Nam	0.257	0.437	0	1	0	1
Msam	0.024	0.152	0	1	0	0
Aus	0.010	0.097	0	1	0	0
Afr	0.007	0.084	0	1	0	0
Number of observations: 421						

2004	Mean	Std. dev.	Min	Max	25th per.	75th per.
Intangibles	1.244	1.188	0	7.961	0.632	1.312
Leverage	0.415	0.399	0	4.787	0.216	0.545
Learning	19.583	21.868	0	146	8	21
Development	29.144	13.447	3.110	70.283	20.661	38.1
EU	0.222	0.416	0	1	0	0
NAFTA	0.213	0.410	0	1	0	0
Size	326159.9	703952.7	54.43	5620148	26413.24	248120.9
Asia	0.451	0.498	0	1	0	1
Eur	0.247	0.432	0	1	0	0
Nam	0.252	0.434	0	1	0	1
Msam	0.029	0.169	0	1	0	0
Aus	0.014	0.116	0	1	0	0
Afr	0.007	0.082	0	1	0	0
Number of observations: 441						

TEXTILE AND CLOTHING INDUSTRY: GLOBAL

1995	Mean	Std. dev.	Min	Max	25th per.	75th per.
Intangibles	1.252	1.160	0.059	8.664	0.703	1.296
Leverage	0.390	0.286	0	2.153	0.194	0.518
Learning	15.982	26.547	0	229	5	22
Development	20.360	7.288	1.790	27.574	19.449	26.732
EU	0.287	0.453	0	1	0	1
NAFTA	0.243	0.429	0	1	0	0
Industry	0.529	0.500	0	1	0	1
Size	333991.9	521059.9	1452.916	3173477	62857	341155.9
Asia	0.415	0.494	0	1	0	1
Eur	0.309	0.463	0	1	0	1
Nam	0.243	0.429	0	1	0	0
Msam	0.026	0.159	0	1	0	0
Aus	0.004	0.061	0	1	0	0
Afr	0.004	0.061	0	1	0	0
Number of observations: 272						

1996	Mean	Std. dev.	Min	Max	25th per.	75th per.
Intangibles	1.269	1.183	0.057	7.836	0.653	1.316
Leverage	0.393	0.303	0	2.947	0.208	0.534
Learning	17.937	27.475	0	230	6	23
Development	21.425	7.345	1.925	28.814	21.919	28.814
EU	0.303	0.460	0	1	0	1
NAFTA	0.254	0.436	0	1	0	1
Industry	0.525	0.500	0	1	0	1
Size	363531.1	559527.7	1829.393	3592436	62719.08	405184.3
Asia	0.394	0.490	0	1	0	1
Eur	0.324	0.469	0	1	0	1
Nam	0.254	0.436	0	1	0	1
Msam	0.018	0.132	0	1	0	0
Aus	0.007	0.084	0	1	0	0
Afr	0.004	0.059	0	1	0	0
Number of observations: 284						

1997	Mean	Std. dev.	Min	Max	25th per.	75th per.
Intangibles	1.174	0.881	0.038	6.297	0.652	1.332
Leverage	0.411	0.306	0	2.671	0.224	0.560
Learning	18.022	25.437	0	231	7	24
Development	22.032	8.041	2.010	47.115	18.575	30.261
EU	0.283	0.451	0	1	0	1
NAFTA	0.248	0.433	0	1	0	0
Industry	0.543	0.499	0	1	0	1
Size	370148.9	575131.4	266.23	3537902	64175.71	398610.9
Asia	0.394	0.489	0	1	0	1
Eur	0.311	0.463	0	1	0	1
Nam	0.252	0.435	0	1	0	1
Msam	0.034	0.182	0	1	0	0
Aus	0.006	0.079	0	1	0	0
Afr	0.003	0.056	0	1	0	0
Number of observations: 322						

1998	Mean	Std. dev.	Min	Max	25th per.	75th per.
Intangibles	1.192	1.060	.077	8.883	0.633	1.380
Leverage	0.425	0.335	0	3.528	0.238	0.571
Learning	18.580	26.427	0	232	7	25
Development	22.550	8.455	2.117	31.519	19.555	31.519
EU	0.267	0.443	0	1	0	1
NAFTA	0.276	0.447	0	1	0	1
Industry	0.537	0.499	0	1	0	1
Size	336053.3	527928.6	797.83	3559236	58995.1	372494.4
Asia	0.401	0.491	0	1	0	1
Eur	0.293	0.456	0	1	0	1
Nam	0.273	0.446	0	1	0	1
Msam	0.026	0.158	0	1	0	0
Aus	0.006	0.075	0	1	0	0
Afr	0.003	0.053	0	1	0	0
Number of observations: 352						

1999	Mean	Std. dev.	Min	Max	25th per.	75th per.
Intangibles	1.277	1.341	0.039	8.768	0.608	1.330
Leverage	0.435	0.346	0	4.257	0.229	0.569
Learning	18.585	25.776	0	233	6	24
Development	21.303	10.264	1.809	52.429	13.739	28.586
EU	0.225	0.418	0	1	0	0
NAFTA	0.232	0.423	0	1	0	0
Industry	0.516	0.500	0	1	0	1
Size	399027.8	827648.4	354.78	9791020	57652.57	410873.2
Asia	0.472	0.500	0	1	0	1
Eur	0.254	0.436	0	1	0	1
Nam	0.232	0.423	0	1	0	0
Msam	0.035	0.185	0	1	0	0
Aus	0.005	0.068	0	1	0	0
Afr	0.002	0.048	0	1	0	0
Number of observations: 426						

2000	Mean	Std. dev.	Min	Max	25th per.	75th per.
Intangibles	1.210	1.135	0.004	7.893	0.615	1.309
Leverage	0.455	0.380	0	5.405	0.255	0.587
Learning	23.042	30.280	0	254	7	27
Development	22.261	10.881	1.881	55.953	14.723	27.244
EU	0.273	0.446	0	1	0	1
NAFTA	0.202	0.402	0	1	0	0
Industry	0.538	0.499	0	1	0	1
Size	400679.9	905191.6	646.01	1.07e+07	50207.21	368483.2
Asia	0.448	0.498	0	1	0	1
Eur	0.306	0.461	0	1	0	1
Nam	0.205	0.404	0	1	0	0
Msam	0.031	0.172	0	1	0	0
Aus	0.005	0.071	0	1	0	0
Afr	0.005	0.071	0	1	0	0
Number of observations: 589						

2001	Mean	Std. dev.	Min	Max	25th per.	75th per.
Intangibles	1.156	1.075	0	7.440	0.578	1.256
Leverage	0.442	0.365	0	6.182	0.240	0.584
Learning	23.055	29.523	0	255	7	28
Development	22.566	11.633	1.918	58.001	12.283	28.275
EU	0.247	0.432	0	1	0	0
NAFTA	0.191	0.393	0	1	0	0
Industry	0.525	0.500	0	1	0	1
Size	401239.6	846088.8	54.43	1.09e+07	48803.57	386745.5
Asia	0.487	0.500	0	1	0	1
Eur	0.274	0.446	0	1	0	1
Nam	0.201	0.401	0	1	0	0
Msam	0.027	0.162	0	1	0	0
Aus	0.009	0.094	0	1	0	0
Afr	0.003	0.055	0	1	0	0
Number of observations: 668						

2002	Mean	Std. dev.	Min	Max	25th per.	75th per.
Intangibles	1.109	0.993	0	7.919	0.595	1.224
Leverage	0.435	0.358	0	5.015	0.231	0.579
Learning	21.843	27.505	0	256	7	27
Development	22.044	12.130	1.966	62.531	8.955	28.979
EU	0.214	0.410	0	1	0	0
NAFTA	0.163	0.370	0	1	0	0
Industry	0.495	0.500	0	1	0	1
Size	366893.6	792458.7	54.43	1.05e+07	40035.43	348780.5
Asia	0.529	0.499	0	1	0	1
Eur	0.25	0.433	0	1	0	.5
Nam	0.173	0.379	0	1	0	0
Msam	0.038	0.191	0	1	0	0
Aus	0.008	0.087	0	1	0	0
Afr	0.003	0.050	0	1	0	0
Number of observations: 796						

2003	Mean	Std. dev.	Min	Max	25th per.	75th per.
Intangibles	1.098	1.003	0	8.195	0.570	1.224
Leverage	0.412	0.301	0	3.411	0.204	0.562
Learning	20.579	25.893	0	257	7	21
Development	22.925	13.553	2.053	66.234	9.472	29.500
EU	0.194	0.395	0	1	0	0
NAFTA	0.143	0.350	0	1	0	0
Industry	0.488	0.500	0	1	0	1
Size	370638.4	834373.3	54.43	1.15e+07	39628.92	331237
Asia	0.549	0.498	0	1	0	1
Eur	0.226	0.418	0	1	0	0
Nam	0.168	0.374	0	1	0	0
Msam	0.046	0.210	0	1	0	0
Aus	0.007	0.083	0	1	0	0
Afr	0.003	0.059	0	1	0	0
Number of observations: 863						

2004	Mean	Std. dev.	Min	Max	25th per.	75th per.
Intangibles	1.199	1.143	0	7.973	0.604	1.305
Leverage	0.429	0.431	0	6.924	0.215	0.553
Learning	20.314	24.635	0	258	7	20
Development	24.089	14.304	2.209	70.283	10.232	31.808
EU	0.187	0.390	0	1	0	0
NAFTA	0.135	0.342	0	1	0	0
Industry	0.487	0.500	0	1	0	1
Size	393191.4	951892.7	54.43	1.36e+07	36289.85	332069.7
Asia	0.556	0.497	0	1	0	1
Eur	0.218	0.413	0	1	0	0
Nam	0.160	0.367	0	1	0	0
Msam	0.053	0.224	0	1	0	0
Aus	0.010	0.099	0	1	0	0
Afr	0.003	0.058	0	1	0	0
Number of observations: 905						