Technological competence in Brazilian multinational firms: the case of WEG*

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Abstract: The article aims to understand the productive and technological competence buildup of WEG as compared to its main competitors in the world industry of electrical equipment. In theoretical terms, this paper is based on concepts related to the competence theory of the firm. As for its methodological terms, the study attempts to measure technological competence based on patent data coming from Derwent Innovations Index base. It is revealed that the companies possess technological competencies that go beyond their core areas' productive competencies. The methodology employed here also allows us to rank WEG' technological competencies and those of its competitors in four different categories all through the 1963-2010 periods, namely: 1) core competencies; 2) niche advantages; 3) background competencies; and 4) marginal competencies.

Keywords: Technological competence; electrical equipments; WEG; Brazil.

Resumo: O artigo se propõe a recuperar os principais aspectos do processo de construção de competências produtivas e tecnológicas da multinacional brasileira, WEG, em comparação com seus principais competidores na indústria mundial de equipamentos elétricos. Em termos teóricos, o artigo se baseia em conceitos relacionados à teoria da competência da firma. Em termos metodológicos, mede-se competência tecnológica com base em dados de patentes, para o período 1963-2010, extraídos da base Derwent Innovations Index. Revela-se que as empresas do setor possuem competências tecnológicas que vão além de suas competências produtivas centrais. A metodologia empregada permite classificar as competências tecnológicas da WEG e de seus competidores em quatro diferentes categorias: (1) competências centrais; (2) competências de nicho; (3) competências de base; e (4) competências marginais.

Palavras-chave: Competência tecnológica; patentes; indústria de equipamentos elétricos; WEG; Brasil.

JEL: F23; O30; L20.

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1. Introduction

The electrical equipment industry manufactures generators, turbines, power transformers, electric motors, in addition to equipment for distribution and control of electric power. As it belongs to the capital goods industry, this sector could be understood as a disseminator of technical progress, innovation catalyzer and productivity determinant for other sectors in the economy (Rosenberg, 1982; Pavitt, 1984).

The electric motor industry has been an offshoot of the electrical equipment industry. For this reason, major electric motor manufacturers have also previously produced equipment for generation, transport and distribution of electric power. However, the market of capital goods in the electrical sector is highly heterogeneous, the number of competitors of which depends on the company's market niche. Big companies in this sector are present in a wide variety of markets, i.e., from those in which competitiveness depends on scope and scale economies to those more specialized market segments.

Besides placing the Grupo WEG (hereafter referred to as WEG) in such a heterogeneous market, this paper addresses to the degree and nature of technological competences of the main companies within the world electrical equipment industry. This study measures technological competence based on patent data from the Derwent Innovations Index for 1963-2010, in accordance with the methodology developed by Patel and Pavitt (1997). Such methodology allows us to rank WEG among the main players in the electrical equipment sector as well as reveals which companies possess technological competences that go beyond their core competences, such as background competences, marginal competences and niche advantages.

This paper is divided into six sections in addition to the present introduction. The theoretical aspects in the literature on the firm's competences are recovered in the following section. Major manufacturers in the electrical equipment industry as well as WEG's recent economic indicators are shown in section 3. Section 4 presents this company's main strategies as for its productive expansion, diversification, internationalization, acquisition of other companies and own technological efforts. Section 5 exposes technological competences of the major companies in this industry as measured by number of patent applications. The study conclusions are presented in section 6.

2. Productive and technological competences, diversification and growth of the firm

The firm-specific competences are focused in the theoretical and empirical discussion of authors in the neo-Schumpeterian tradition and that of strategic management, which are sometimes grouped and known as "the resource-based perspective" (RBP). According to Foss (1998) RBP aims to understand how companies generate, hold and renew their competitive advantages in terms of their own resource dynamic characteristics.

Teece (2010) defines tangible or intangible resources as specific assets of the firm, which are hardly or even impossible to be copied and for this reason understood as the firm's stock instead of flow. Penrose (1959) uses the same distinction between stock and flow, which takes resources as a potential service package. The firm's resources constitute its prime source of competitive advantage and have to be constantly renewed. In this sense, the firm is impelled to combine, construct and refashion its internal and external resources and competences in order to deal with ever-changing competitive environments. Such abilities are understood as the dynamic capabilities of the firm.

The firm's competences, in turn, involve a particular kind of organizational resources that have been brought about by activities repeatedly performed (Teece, 2010). In other words, competences constitute packages of organizational routines and abilities in solving

problems. As for this matter, the works of Simon (1947), Nelson and Winter (1982) and Dosi, Nelson and Winter (2000) should be highlighted. However, it should be recognized that the idea of core competence was popularized by Prahalad and Hamel (1990), who have compounded it with the competitive power and all hard technology areas of the firm.

The concept of technological competence involves the ability to effectively design and develop processes and products, as well as to efficiently operate productive facilities. In this sense, the firm becomes predominant in certain technological fields, when using its organizational competences. This occurs especially when the firm: i) allocates its resources preferentially in some projects in detriment of others; ii) accumulates experience from previous projects; iii) employs and trains human resources and; iv) adds and absorbs new discoveries and external information, as well as manages a set of activities connected with technological problem solving.

According to Dosi and Teece (1993), technological competences are derived from economic and organizational competences that affect the firm's compromising level with technological activities and its entry rate in rapidly growing market segments. However, a reciprocal influence between organizational competence and technological competence of the firm can be suggested based on Patel e Pavitt (1997), because the latter may strongly restrict the possibilities for new opportunities. In this sense, different technological competences constitute one of the most important factors explaining the boundaries and coherence of the firm.

There are several theoretical elements and empirical evidence showing the effect of technological competences on what the firm is able to produce, its growth prospects, as well as its competitive advantage in certain fields of action. Firstly, it should be highlighted that capabilities and fields of action – that constitute a firm's competitive advantage – are themselves influenced by "path dependencies", which are inherent to technological progress. In other words, the organization's drive to seek innovations and the direction it follows viewing this, as well as new product developments and technological improvements are in connection with its natural trajectory. This path once followed is a result of the success previously achieved in its chosen field of action at the starting point. Therefore, path dependencies define the environments or surroundings where the company's abilities can be more productively explored.

The firm's starting point and the running technological regime, as well as its trajectories initially chosen shall mostly define the kind of competences it gives birth to and the products it is to produce and sell. Upon the first sale, a set of routines – here defined as a repetitive use of abilities – is developed and this leads to improving competences in certain fields of action. Competences – together with strategic vision – help to define the firm's core business. The firm's core business is a set of competences, which in turn defines the firm's distinctive advantage. The core business is stable and consistent, since the promising areas under exploration are near to each other, and the set of activities is derived from a particular research focus.

Investment in R&D is liable to accelerate the acquisition of new knowledge and also the generation of productive services. As a matter of fact, Penrose (1959) states that the latter may prove to be useless for the existing productive activity, although it creates a base on which the firm should eventually hold advantage in totally new productive and technological areas. Resource allocation in R&D amplifies the firm's technological opportunities to the extent that it improves specialized knowledge that is not specific to a particular type of product. At the end of the 1950's, Penrose (1959) already recognized that a high degree of competence and technical knowledge in specialized industrial areas was one of the constituting features of big companies in the economy.

Patel and Pavitt (1997), by presenting empirical evidence on more than 400 big companies, examined the relation between what these companies produce and their

underlying technological competences. Results showed that the most striking aspect of technological competence of such firms was their diversified technological fields of action, which were beyond their core areas of activity. In other words, according to Pavitt (1998), big companies are active in a wider technology range than that of the goods they produce. This brings about a contemporaneous characteristic of capitalism, i.e., products have been increasingly multi-technology made, in the sense that each specific body of technical knowledge can not only be associated to a single class of product (Pavitt, 1998). This is especially true for big companies where the range of technology competences held by them increases with time when such new opportunities emerge. From the firm's viewpoint, a diversified technology constitutes the base on which it produces and improves its products. As for the electronic industry, the most successful companies are those that have amplified their technological focus and narrowed their product focus. In some cases, firms have used their range of technological abilities to create and entry new markets.

Additionally, Patel and Pavitt (1997) showed that there had been a relative stability of the technology profiles of these companies through the studied period (1969-1990). Such evidence may be associated to the above mentioned proposition by Teece (1988), i.e., the core business is stable through time. Such stability may be partially associated with Pavitt's (1998) arguments that the costs needed to control all technology fields are high and liable to exceed benefits. Therefore, companies develop their technological competences in an incremental fashion and constrain their search activities close to what they already know.

3. The world industry of electrical equipment and the performance of WEG

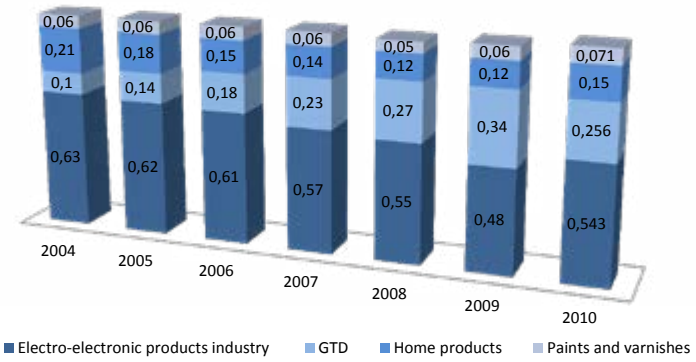
The world industry of electric motors is extensive and well-distributed with scattered manufacturers who compete for small percentages of global demand varying from 5% to 6% of sales share (Strachman, 2006; Silva, 2006). The companies showing higher gross revenue within WEG's competitive environment in 2009 were as follows: Siemens (US$ 106.87 billion), ABB (US$ 31.80 billion), Schneider Electric (US$ 22.02 billion) and Emerson Electric (US$ 20.92 billion). Other companies with lower gross revenue were: Regal Beloit and Baldor (US$ 1.83 billion and US$ 1.52 billion, respectively). WEG is closer to these latter companies as it reached a gross revenue of US$ 2.58 billion in 2009 (WEG, 2010b).

As for the specific case of WEG, its productive activities are associated with production and trade of industrial electronic equipment, electric power generation, transmission and distribution, motors for domestic use and paints and varnishes (WEG, 2010a). The above mentioned productive activity of the group is organized in five different production units: motors, automation, energy, transmission and distribution of energy and paints (WEG, 2010c).

As far as revenue is concerned, the electro-electronic equipment industry accounted for 54.3% of total gross operating revenue of the group in 2010, while this production item amounted to 63% in 2004. As for domestic-use motors, WEG's industrial revenue amounted to 15% in 2010, although showing a remarkable decreasing trend in its total revenue share since 2004, which was 21% in that year (Chart 1; WEG, 2011). When motors for home appliances and automation products are considered, total revenue of the group reached 69.3% in 2010 (WEG, 2011). However, these products together accounted for 84% of WEG's total revenue in 2004 (Chart 1).

On the other hand, a growth trend is perceived as for the share of energy products, transmission and distribution of the business unit in the total gross operating revenue of the group as can be seen in data for 2007 (22.9%), 2008 (27.1%) and 2009 (33.5%). Despite a recent decline in 2010 (25.6%), data show a remarkable improvement in this area, as compared to data for 2004, when only a 10% of total revenue was generated in this unit – WEG (2010c; 2011).

Chart 1. Participation of activity fields in WEG's total revenue (2004-2010)



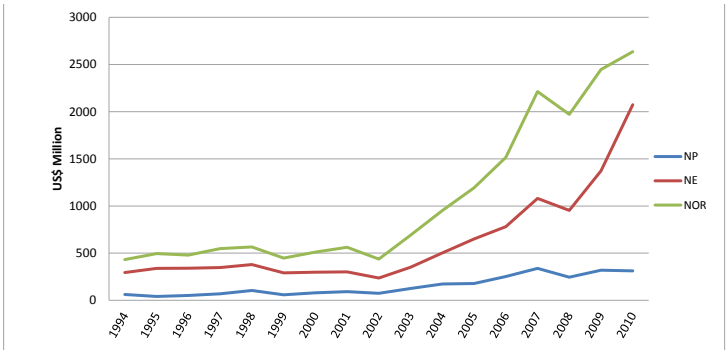
Note: GTD= Generation, Transmission and Distribution of Energy.
Source: WEG (2011).

As for paints and varnishes, this business unit focus exclusively on the Brazilian market, whose share in total revenue is small – around 7,1% (WEG, 2011) – and hence stable through time.

WEG is present in Brazil, Argentina, Mexico, Portugal, South Africa, China and India. Considering its plants, commercial branches and distribution outlets altogether, WEG is present in more than 100 countries in five continents, looking to diversify its geographic presence so as to avoid variations in the economic cycle in each of such countries (WEG, 2010a).

WEG's consolidated indicators of net operating revenue, net profit and net equity – as of 2010 – totalized US$ 2.6 billion, US$ 311.9 million and US$ 2.0 billion, respectively. As can be seen, Chart 2 shows the net operating income (NOI) for 1994-2010, whose growth path is remarkable until 2008, then interrupted due to the international financial crisis. A similar result can be seen for WEG's net profit (NP), except for the inflection point of the series – which corresponds to 2007 – as the annual growth rate was slightly lower (10.69%). On the other hand, net equity (NE) increased even under the 2008 world crisis. Net equity jumped from US$ 211 million in 1994 to US$ 2.0 billion in 2010, which accounted for an annual average growth rate of 12.95%.

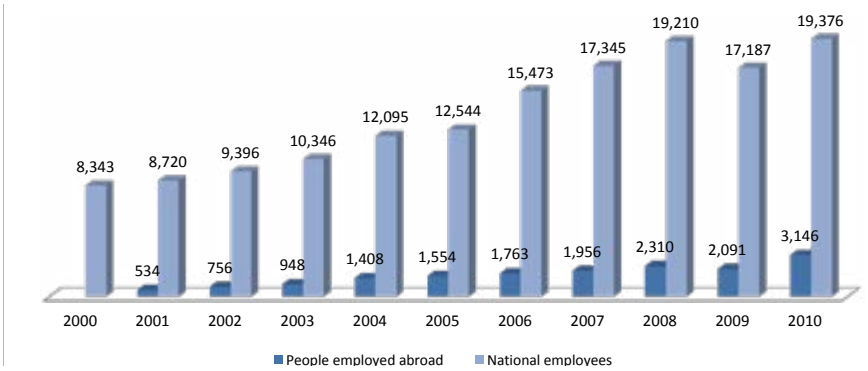
Chart 2. Evolution of Net Operating Revenue, Net Profit and Net Equity of WEG (1994-2010)



Note: NP= Net Profit; NE= Net Equity; NOR= Net Operating Revenue
Source: prepared by the author, using data from Economatica. All series are in constant prices, deflated by means of Implicit Price Deflator for U.S. GDP.

Job numbers of WEG were consistent with the indicators shown above, whose growth amounted to 32.6% for 2000-2010 (Chart 3), totalizing 19,406 employees in Brazil in the last year of the series. The number of employees abroad showed a continued growth – except for 2009 – ranging from 534 in 2001 to 3,146 in 2010, a result of the company's internationalization in the 2000s. The total number of employees has multiplied six fold, since WEG counted on 6,683 employees in 1994 (Moraes, 2004).

Chart 3. Number of Employees of WEG in Brazil and abroad (2000-2010)



Source: made up by the author based on WEG's annual reports.

4. The origin of WEG's productive and technological competences

The business scope of the company has evolved from a mere production of electric motors in 1961 to its present diversified production structure. This structure now includes components, industrial automation products, energy and distribution of electro-electronic transformers, liquid and powder paints and electro-isolating varnishes. There has been "a continuing and natural process of associated diversification" (Brasil, 1995). Diversification has been envisaged as a way to seek new enterprises and a long-lasting company, by better exploring its technology base, benefits of vertical integration, in addition to offering higher value-added products to its clients (Diegues and Bruno, 2009).

The productive structure of the company is highly integrated, since only few components of its products are not made by WEG itself. The vertical integration strategy has come up from an attempt to reduce its dependence on input suppliers, which blocked the company's growth path in the 1960s and 1970s (Moraes, 2004; Melo, 2010; Costa et al., 2010).

According to Beausang (2003), it can be asserted that diversification of WEG has preceded the company's internationalization, which is divided into four phases: i) exports to neighboring countries in the 1970s; ii) extending distribution networks from the 1980s; iii) setting up its own subsidiary companies abroad for distribution and technical assistance (commercial branches) and; installing plants abroad since the 2000s (Gehlen, 2008; Melo, 2010).

In the first and second phases, it is possible to verify that WEG has experienced a productive and technological learning process in order to support the third phase of internationalization, in which several subsidiaries of WEG were created. Such a strategy was put forth viewing to overpass the restraints to the growth of its foreign businesses, which were designed based on location criteria, such as: market potential (Mexico and USA), cultural affinity (Germany) and existing export facilities to developed countries (Beausang, 2003).

The fourth phase of WEG's internationalization has been designed to increase the number of commercial branches abroad as its first foreign plants were installed. From

2000 and on, companies were acquired by WEG in several countries (Argentina, Mexico, Portugal, China and South Africa). Such acquisitions were made in the segments of motors for washing machines and circuit breakers (Argentina), low voltage electric motors from ABB, a competitive company, or in the segment of transformers (Mexico), big motors for risk areas as gasoline stations, etc. (Portugal). In this latter country, the Efacec plant had already been certified for the production of such equipment (Melo, 2010). The purchase made in China has allowed WEG to explore the Asian market potential, as well as provided it with geographical proximity to global clients, in addition to strengthening its competitiveness in the face of local production. Therefore, WEG then counted on 24 subsidiaries abroad in 2010.

A progressive improvement of WEG can be perceived as far as business expansion abroad through its life history is concerned, especially in the 2000s. The beginning of WEG's internationalization is associated with market factors, as it has intended to grow at the time it had already been dominant in a large part of the Brazilian market. Therefore, WEG's growth had to occur via foreign market, which was achieved by means of subsidiaries or plants, in this way strategically amplifying its presence in all continents.

In Brazil, more recent acquisitions (after 2000) were made with a view to strengthen productive and technological competences in the same WEG's field of activity or in those complementary fields to its own activities (i.e., Trafo, Hisa, Equisul, Instrutech, Logotech). In brief, WEG has strengthened or acquired productive and technology know-how in electrical transformers, hydraulic turbines, electrical feeding systems, no-breaks, stabilizers and industrial and commercial automation.

Such internationalization and acquisition efforts have been supplemented by domestic R&D investment, as well as other domestic technology efforts. Technology purchasing and independent advisory are easily found all through WEG's initial phases right after the company's foundation, particularly from 1961 to 1978 (Brasil, 1995). However, still in 1968, several research laboratories were installed, which later, from 1979, have been united for the creation of the *Centro Tecnológico* (technology center) that was a qualitative benchmark in terms of domestic technological improvement. The 1980s were characterized by setting up own research teams and laboratories that led to the production of prototypes. Interchange with education and research institutions has been frequently accomplished, and the year of 1985 was the benchmark of WEG's own technology production (Costa, 2007; Melo, 2010).

WEG set out its strategy of productive and technological diversification in the beginning of the 1980's and two subsidiaries were created, namely: WEG Máquinas, a machine manufacturing subsidiary, and WEG Acionamentos, starting mechanisms manufacture subsidiary. The first had as its aim to produce big electric rotating machines, mainly designed for industries of energy, petrochemical, mining, paper and cellulose and also absorbing the production of direct current and medium and high voltage motors, in addition to energy generators. The second was designed to produce electronic components and develop engineering for industrial systems applications for motor protection, as well as develop programmable controllers for industrial processes (WEG, 2009). Later on, in 1985, WEG acquired technology for producing programmable controllers. Still in 1985, WEG Automação S.A. was created in order to develop industrial servomechanisms and robots for insalubrious environments and repetitive works, such as handling, loading and unloading of parts (WEG, 2009).

According to Schmelzer Júnior (2002), the structuring stage of the R&D department was completed in 2000. From then on, WEG Acionamentos became entitled to register patents derived from its own technological efforts. "When any multinational firm launches any product having a specific function ", WEG "is apt to manufacture a similar product without infringing on patents of competitors".

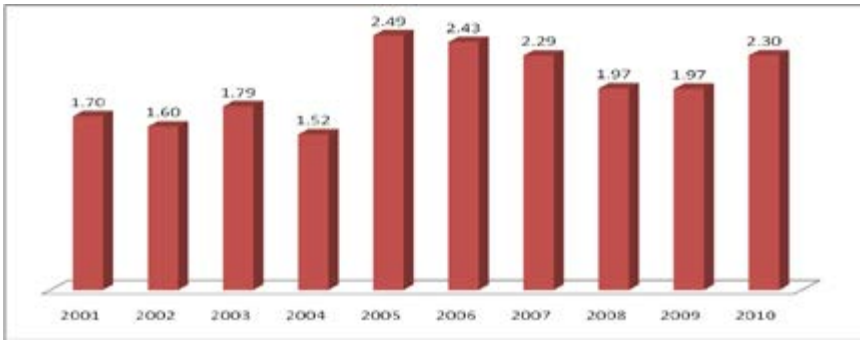
According to Beausang (2003), this was what distinguished WEG in relation to the

other Latin multinational companies, as it has sought active strategic investments.[1] Such a strategy was closer to those of Japanese, South Korean and Taiwanese companies, requiring a minimum previous technical training for effective foreign technology absorption. According to the author, this strategy was well-succeeded because there were strong ethnic and cultural ties of the company leaders with Germany that enabled WEG's managers to construct its technological competence portfolio, which is analyzed in section 5.

It is worth noting the recent and systematic R&D investment all through the 2000s. Resources applied to R&D have focused on new technologies and applications, new motor lines and their optimization, in addition to new materials and tests (Costa et al., 2010; Mata, 2008).

As for its costs, total R&D spending represented 2.3% of the net operating revenue in 2010 (Chart 4), which was significantly higher than that for 2001 (1.7%). These percentages are higher than the observed average figures for Brazilian manufacturing companies or for those companies belonging to the main segment in which WEG is inserted in Brazil – 0.64% and 1.01%, respectively (IBGE, 2010). Therefore, WEG appears to be the R&D spending leader in the industrial sector in Brazil.

Chart 4. R&D Intensity of WEG (2001-2010)



Notes: R&D intensity is estimated by dividing R&D spending by the net operating revenue.
Source: made up by the author based on WEG's annual reports.

As a result of R&D investment and other technological efforts, new process and product technologies were developed by WEG's technical staff. Generally, such innovations sought to reduce the levels of electric power consumption, global engine operating costs, noise and temperature levels, size of products (lower material consumption), and increased facility for equipment maintenance, in addition to increasing electronic content in products. Investment in R&D allowed WEG to manufacture more competitive electric motors in the world level in terms of quality and cost, in addition to adapting products to its clients' needs (Silva, 2006; Strachman, 2006).

The participation of new products in WEG's total revenue has evolved from 49% to 63% from 2004 to 2009. It is worth noting that a significant portion of WEG's revenue can be assigned to its innovative performance since the mid-2000s. This is a significant participation even if similar indicators of the manufacturing industry or WEG's activity sector are considered.

1 According to Beausang (2003) Weg has adopted the "asset-seeking investment" type of strategy.

5. Technological competences of electric equipment industries

5.1. Patent data and technological competences

Data on patent applications and grants were taken from the Derwent Innovations Index base and are used in this paper as indicators of technological competence of electric equipment industrial companies. Although data on patents show well-known restrictions[2], there are copious pieces of information of this kind that justify studies such as this. Firstly, data on patents allow firms to monitor their competitors as for their patents so as to assess their own technological improvement (Nagaoka, Motohashi and Goto, 2010). Secondly, the single fact of applying for a patent in a certain technological domain means that a firm is at the technology frontier or near to it, besides showing to possess technological competences in a specific field of activity (Breschi, Lissoni and Malerba, 2003). And this is precisely what this study is intended to capture, mainly because the potential use of patent codes are underestimated in order to identify the technological capabilities (Strumsky, Lobo and van der Leeuw, 2012).

In order to assess in which technological fields a firm has enough competence, researchers use detailed information available in patent codes, such as those describing technology classification. Patent examiners attribute at least one code to each patent, in accordance with the International Patent Classification (IPC). IPC codes are internationally agreed upon, non-overlapping and comprehensive and they encompass almost 60 thousand individual codes consisting of 12 digits. In this paper, technological competences are measured based on 4-digit IPC codes, grouped in 30 technology subdomains (fields), in accordance with clustering algorithms given by the *Observatoire des Sciences et des Techniques* (OST, 2004). Technological domains can be seen in Table 1.

Table 1. Technology classification (30 fields or subdomains) based on International Patent Classification

1 - Electrical devices, electrical engineering, electrical energy	16 - Pharmaceuticals, cosmetics
2 - Audiovisual technology	17 - Agriculture and food products
3 - Telecommunications	18 - Technical procedures
4 - Information technology	19 - Handling, printing
5 - Semiconductors	20 - Agricultural and food processing, machinery and apparatus
6 - Optics	21 - Materials processing, textiles, paper
7 - Analysis, measurement, control technology	22 - Environmental technology
8 - Medical technology	23 - Machine tools
9 - Nuclear engineering	24 - Engines, pumps, turbines
10 - Organic fine chemistry	25 - Thermal processes and apparatus
11 - Macromolecular chemistry	26 - Mechanical elements
12 - Basic materials chemistry	27 - Transport
13 - Surface technology	28 - Space technology, weapons
14 - Materials metallurgy	29 - Consumer goods and equipment
15 - Biotechnology	30 - Civil engineering, building, mining

Source: based on OST (2004) and Breschi, Lissoni and Malerba (2003).

After grouping electric equipment patents as to the subdomains listed in Table 1, this paper used criteria provided by Patel and Pavitt (1997) in order to measure a firm's technological competence in two different dimensions: patent share (PS) and the firm's Revealed Technology Advantage (RTA). A firm's patent share is measured in relation to

2 See Nagaoka, Motohashi and Goto (2010).

the 30 technological subdomains, which reflects the relative importance of each field of activity in its total technological portfolio. RTA is measured by dividing the patenting participation of each firm in each subdomain by the aggregate patenting participation of the firm in all subdomains taken into account.

These two technological competence dimensions may be represented in a graph in which the Y axis – representing the PS dimension – indicates the relative importance of each subdomain in the firm's total patent portfolio and the X axis – representing RTA dimension – indicates the relative importance of the firm's subdomain under consideration[3]. Each quadrant may be classified as follows: i) Quadrant I (right upper quadrant): defines and describes the firm's core competences; ii) Quadrant II (left upper): shows the firm's background competences, as they are subdomains in which a relatively large portion of its technological resources is allocated, though not reaching a high technological advantage as compared to those of its competitors; iii) Quadrant III (left lower quadrant): show marginal competences in which subdomains a large portion of own resources is not allocated and a clear advantage in relation to competitors is not reached either and; iv) Quadrant IV (right lower): reveals niche advantages in relatively small subdomains.

The next companies are considered in the empirical section: ABB (ABB), Alstom (ALM), A. O. Smith (AOS), Areva (ARV), Baldor (BLR), CMG (CMG), Dresser (DRSS), Eberle (EBE), Emerson Electric (EME), Fuji Electric (FUJI), General Electric (GE), Hitachi (HIT), Krebs & Aulich (KREB), Loher (LOH), Leroy-Somer (LRY), Mitsubish (MIT), Mitsubish Electric (MITE), Marathon (MRT), NIDEC (NID), Regal Beloit (REG), Reliance (REL), Schorch (SCH), Schneider Electric (SCHD), Siemens (SIEM), Sulzer (SULZ), Tatung (TATG), Teco (TCO), Toshiba (TSB), VA Tech (VAT), Voith (VTH) and WEG (WEG).

5.2. Technological competences of electric equipment industries: WEG's position

The innovative capacity of big corporations in the electric equipment industrial segment is remarkable. Companies like Hitachi, Toshiba, Siemens, General Electric and Fuji Electric possess considerable patent stock accumulated over the period 1963-2010[4]. If the Derwent Innovations Index is taken into account, there are more than 380 thousand patents by Hitachi and more than 267 thousand in the case of Toshiba. Siemens, GE and Fuji Electric then follow with 107 thousand, 46 thousand and 33 thousand patents, respectively. ABB, with several conspicuous trademarks in the industrial segment of motors (such as Alstom, Baldor Electric and Reliance Electric), has more than 12 thousand patent registers in the period.

WEG has a small number of patents – 28 in the period – even if compared to those companies ranked closer in its market performance, such as Alstom (3,498), Emerson Electric (2,259), Marathon (1,085), Tatung (835), Grupo Voges (16), Dresser-Rand Company (210), Schorch (83), Loher (89), VA Tech (148), Mitsubish (56), Regal Beloit (31), CMG (22).

At least three reasons explain a lower usage of the innovation protection strategy in WEG's life history. Firstly, as mentioned in section 4, the structuring of its R&D department was completed in 2000, when the company could register patents developed by its own technological efforts. Secondly, it can be perceived that WEG's stance related to patenting has started to change as the company's internationalization advanced especially from 2005. According to Nau (2011), internationalization requires a higher effort as for a firm's innovation protection. As a matter of fact, only 31 patent application registers were made in Brazil until 2010 (INPI), six in USA (USPTO), five in Europe (European Patent Office) and four under the Patent Cooperation Treaty (PCT). WEG's patenting

3 The points at the right of the origin at Y-axis are measured from a RTA > 2 and those at left between 2>RTA>0.5. In the case of X-axis, the points above the origin are measured from PS > 3% and those below, PS< 3%.

4 A table with these data could be shown under request.

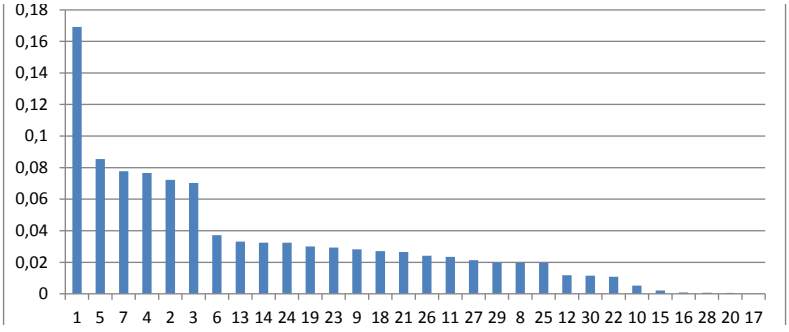
effort in Brazil and abroad was very small in the 1980s and 1990s. In the decade of 2000, 13 deposits were made at INPI until 2007 and 11 abroad. From 2008, WEG deposited 13 more patent requests in Brazil and four abroad. The third reason is related to the use of secrecy as a way of protecting an innovation return, by following a common trend found in the sector as a whole according to Nau (2011). Although the WEG's patents are fewer in comparison with its competitors, it is helpful to consider the patent codes as a piece of information to reveal the most important technological subdomains for WEG.

A varied diversity of technological domains presented by the companies listed is another aspect that can be observed in the data. The big corporations group, comprised by firms like Siemens, Hitachi, Toshiba, Fuji Electric and GE, is characterized by showing diversified technological subdomains. If the technological diversification index – which is obtained based on Herfindahl[5], index – is high, ranging from 0.81 to 0.94. A persistent and diversified innovative component is a common aspect in these companies. Persistence is due to that they hold patents all through the period observed; diversification, in turn, stems from the fact that they possess patent registers in more than one of the 30 technological subdomains. According to Breschi, Lissoni and Malerba (2003), both characteristics are associated because persistent innovators seek technology innovations near to those they are currently involved in, due to effects of knowledge proximity. However, persistent innovative firms follow this same technology path continuously in view of the high cumulativeness degree of technological knowledge.

WEG possesses a quite lower technological diversification degree with an indicator equal to 0.30, which is the smallest index as compared to those firms having more than one patent register in the group of companies selected. This means that WEG proves to be an electric equipment producer more concentrated in specific technological knowledge than its competitors, at least based on IPC patent codes available until now.

In order to show the relevance of each technological subdomain in the electric equipment industry, Chart 5 presents the relative frequency of all patent codes listed in the patent stock for the 1963-2010 periods. Firstly, except for the negligible subdomains in this industry (15, 16, 17, 20 e 28) it can be verified that the remaining subdomains show figures at least ranging from 0.5% to 3.7%. This fact reveals technological diversity, as technological competences go beyond those needed for the core productive activities of the firms, which indicates the multi-technology character of big corporations as pointed out by Pavitt (1998) and Patel and Pavitt (1997). In other words, these firms are active in a broader technology range.

Chart 5. Frequency of patent codes indicated in patent applications in 1963-2010 for selected firms in the electric equipment industry



Source: made up by the author based on base data from the Derwent Innovations Index.

5 The Herfindahl index is estimated by taking the relative share of each 4-digit technology class frequency in the total technological frequency registered in the firm's patents for 1963-2010. Once the Herfindahl indicator of the unit is subtracted, the technological diversification is obtained, which varies from 0 to 1 and is interpreted as follows: the closer to zero, the smaller the technological diversity and the higher the index, the more technologically diversified the company. These calculations could be shown under request.

Secondly, the following subdomains prove to be more important: (1) electrical devices, electrical engineering and electrical energy, (5) semiconductors, (7) analysis, measurement, control technology, (4) information technology, (2) audiovisual technology and (3) telecommunications. Except for subdomain (7), which is associated with the field of Instruments, the remaining groups belong to the large area of Electrical Engineering. In these cases, the figures vary from 7% to 17% of patent codes. However, subdomain (1) clearly prevails in this industry, as it shows more than twofold indications as compared to other more frequent subdomains.

The Charts 6a to 6f, in the annex I, reveal the relative importance of the technological domain by firm for each subdomain aforementioned. Beyond, the charts 6g and 6h, by dealing with mechanical engineering technologies, are included because are general technology for the market of motors, pumps and turbine. Some general remarks can be done.

Firstly, it can be seen that subdomain (1) – Charts 6a – constitutes core technology (Quadrant I) for WEG and several other companies, such as A.O. Smith, Baldor, Fuji Electric, Krebs & Aulich, Loher, Leroy-Somer, NIDEC, Regal Beloit, Schorch, Schneider Electric and TECO. As for other firms (Quadrant II), the subdomain constitutes background technology, as they do not show high competitive advantage in relation to their competitors, although many resources are allocated in this field. This is true for ABB, Alstom, CMG, EBERLE, General Electric, Hitachi, Reliance, Siemens, Tatung, Toshiba and VA Tech[6].

Secondly, in Chart 6e, Fuji Electric, Hitachi, Mitsubish, Siemens and Toshiba possess subdomain (5) as background technology. These companies – being big and diversified corporations – operate in several industrial segments, not only in that of electric motors and equipment. It is worth noting that those companies more concentrated in the latter segment do not show to have competencies in such specific domain in the area of Electric Engineering.

Thirdly, when the subdomains directly related to Mechanical Engineering – which encompasses subdomains from 23 to 27 – are considered, it can be noted that subdomains like engines, pumps and turbine (24) prevail as core technology in companies such as EBERLE, Mitsubish Electric, Dresser, Alstom, VA Tech, Baldor, NIDEC, General Electric and Mitsubish. In the case of mechanical components – subdomain (26) – this technology seems to be marginal for WEG (Quadrant III).

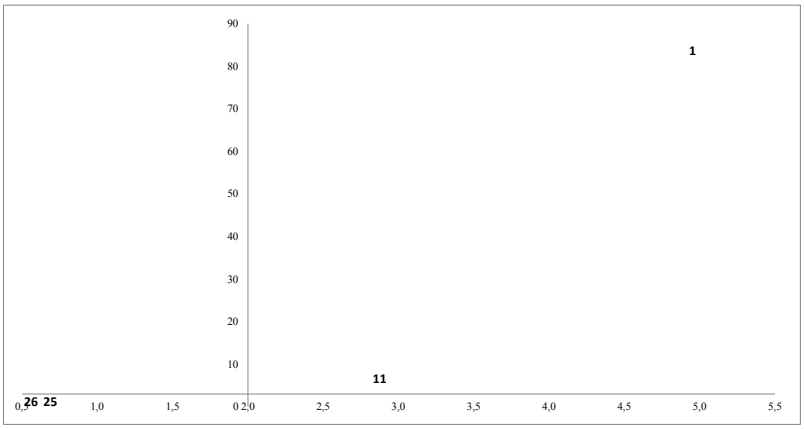
When analyzing data from the viewpoint of more relevant domains for a firm, it can be verified that WEG' patents indicate codes in only four fields: electrical devices, electrical engineering and electrical energy (1), macromolecular chemistry (11), optics (6), analysis, measurement, control technology (7), surface technology (13), thermal process and apparatus (25) and mechanical elements (26). Out of these, subdomain (1) is present in 83% of code frequencies, while subdomains (11) and (6) appear in 6.7% e 4% of times. The remaining fields are indicated only one time.

Based on the Chart 7 the most relevant subdomains for WEG are subdomains (1) and (11) in the right upper quadrant, that indicates the WEG's core competences. The subdomain (6), in the left upper quadrant, shows the WEG's background competence. The last two subdomains showed in chart (25) and (26), specifically in the left lower quadrant, indicate the WEG's margin competence.[7]

6 All statistics used to group the technologies according to their importance for the companies are showed in tables 2 and 3, annexed to this study (Annex III).

7 A complete list of charts referring to other companies is included in Annex II, following alphabetical order.

Chart 7. Technological profile of WEG based on patent statistics (1984-2010)



Source: made up by the author based on base data from the Derwent Innovations Index.

In general, WEG is a close competitor with companies like Baldor Electric, Leroy-Somer, Voges Metalúrgica, Schorch, Loher, A.O. Smith, CMG, Regal Beloit e Krebs & Aulich, as for the criterion of total patent stock in the period. However, if the weight of subdomain (1) is considered, WEG is closer to Schneider Electric, Regal Beloit, Leroy-Somer, Loher and Schorch.

Companies are usually active in several technological fields, but only few of these may be considered as core technology, which confirm the argument of Prahalad and Hamel (1990) that only a small number of companies have constructed world leadership in more than five or six core competences. However, conversely to these authors, the present work shows, as can be seen in Patel and Pavitt (1997), that companies may be active in other technologies through which they may guarantee an interface with foreign sources of technological competence in the condition of specialized equipment and material. Therefore, background technologies become essential for processes like "learning by doing" and "learning by using". According to the authors, the idea of "distributed competencies" would be more adequate than that of "distinctive core competencies" by describing how technology may contribute for building up competitive advantages specific to a firm.

There a relative heterogeneity among firms in a sector, as far as such subdomains appear as core technology. This fact reflects a degree of productive diversity of many companies operating in the sector. However, the electric equipment production usually requires that subdomains (1) and others constitute core technologies among firms.

Final considerations

This paper addressed the distribution of technology competences according to their significance for major electric equipment manufacturers in the world for the 1963-2010 time period, with a focus on the Brazilian multinational company in the sector. The main results have showed that this sector possesses a considerable heterogeneity, whose companies have different competences in relative terms. However, few technological fields arise as the core technology for such companies. At the same time, it is worth noting that these companies have other competences needed to deal with the multi-technology characteristic of their products in the present stage of capitalism. Therefore, companies accumulate technological knowledge that made them able to learn in a more efficient way in their surrounding economic environment.

WEG has set up its productive activities in the branch of electric motors and later

amplified its productive activity to include electric machines and equipment. Further on, it has also offered its clients packages of complete solutions in this way enhancing its value chain. Therefore, it can be verified that WEG's technical know-how, acquired in the decades of 1970, 1980 and 1990, is comparable to those of centennial companies like General Electric, Siemens, Alstom, Hitachi, Toshiba, Mitsubishi and ABB, which have already produced turbines, generators, power transformers, circuit breakers and motors when they were set up. The difference in such events is a temporal gap between WEG and the above mentioned companies, which reflects the technology gap that usually distinguishes developed countries from technologically dependent countries. While its competitors carried on along this path in the 1980s, WEG was only able to saw it through in the 2000s, by the time it completed the R&D department structuring, specifically as far as motor starting and automation industrial segments are concerned, which made it able to produce engines integrated to other components by using its own technology.

Systematic investment in R&D has been made to this end by WEG and actions have been taken – such as investment in expanding productive capacity, technology purchase, acquisition of other companies and upstream and downstream integration in the productive chain – to incorporate economies of scope and scale. The degree of integration and vertical integration of production is a feature that differentiates WEG from its competitors. The company's vertical integration ranges from inputs for motor and machine making to packaging, including paints used in products.

As for technological efforts, purchase of technology, reverse engineering and access to advisory were very important measures. At the same time, investments in the improvement of internal capacity to innovate have also been achieved. Research laboratories were built, whose research team has made it possible to construct its own prototypes, as well as the start-up of production using its own technology. As soon as the restructuring of the R&D department was finished, investment in this area could be achieved in several related specialties. Such an effort has made it possible to generate knowledge and capacity to assimilate relevant external technological knowledge, such as those coming from universities and other innovative sources of knowledge. The acquisition of other companies for technology absorption has occurred in areas related to the company's core business, namely transformers, engines and paints.

Such investments altogether have made it possible for the company to develop its own technology and innovations, enabling it to reach the national leadership in terms of technological innovation and an outstanding position in terms of capacity to follow the world technology frontier. To a certain extent, this can be perceived by data on patents, the most conspicuous subdomain of which for companies belonging to the sector – electrical devices, electrical engineering and electrical energy – appears as the core technology of WEG, and the same is true for the macromolecular chemistry subdomain.

The Grupo WEG has made use of strategies for productive and technological diversification all through its life history and – having in view the effect of path dependencies – it is possible that its technological competences improve and become consolidated within its core activity. Therefore, diversified technological opportunities seem to be associated with the production of motors, generators and transformers, in addition to integrated solutions in the energy area.

Future research in this area could focus on the WEG's knowledge flow, tracking the source of knowledge spillovers absorbed by WEG along its trajectory of technological efforts. What companies were important in the acquisition of the main WEG's technological competences? We could answer this research question by means of patent citation analysis.

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Annex I
Chart 6 – Relative importance of selected subdomains for the electric equipment industries (1963-2010)

Chart 6a: Subdomain (1)

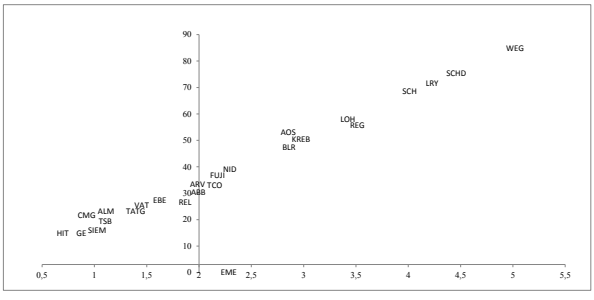


Chart 6b: Subdomain (2)

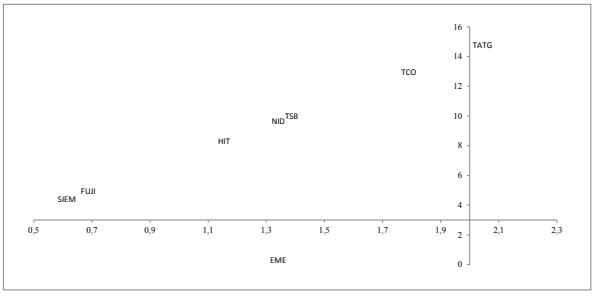


Chart 6c: Subdomain (3)

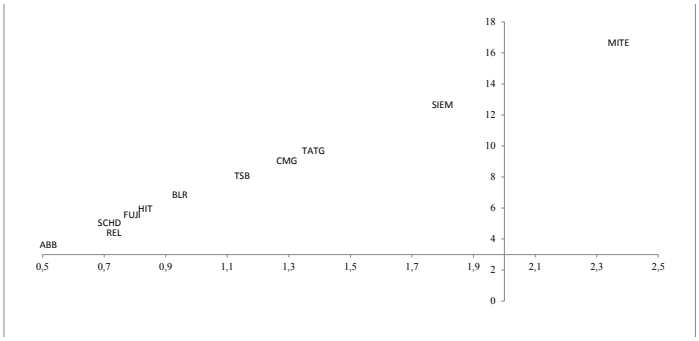


Chart 6d: Subdomain(4)

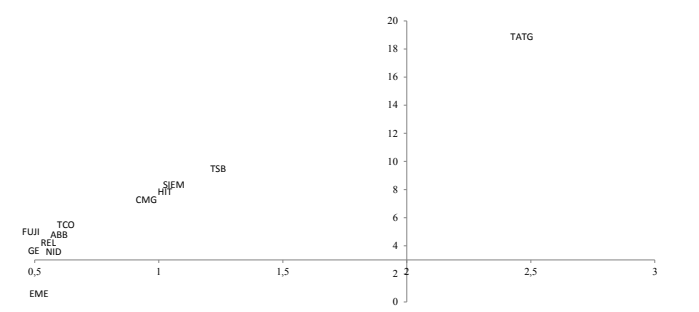


Chart 6e: Subdomain (5)

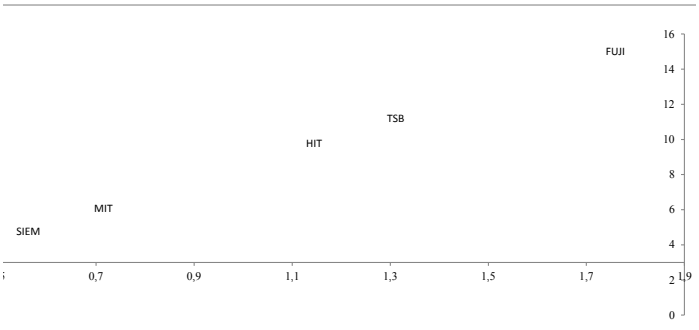


Chart 6f: Subdomain (7)

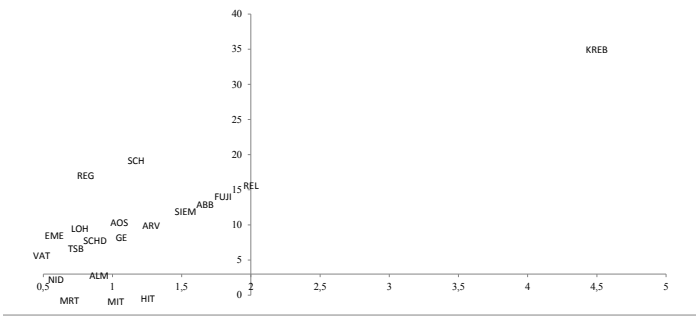


Chart 6g: Subdomain (24)

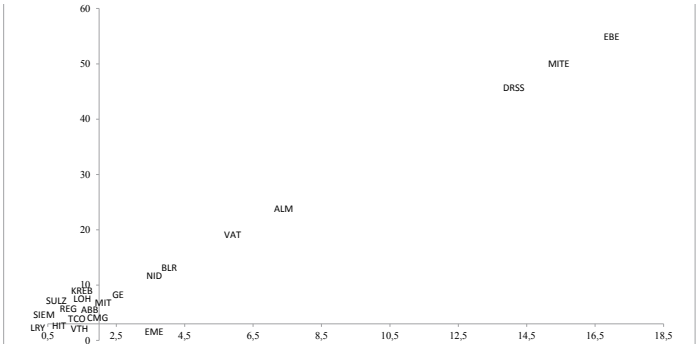
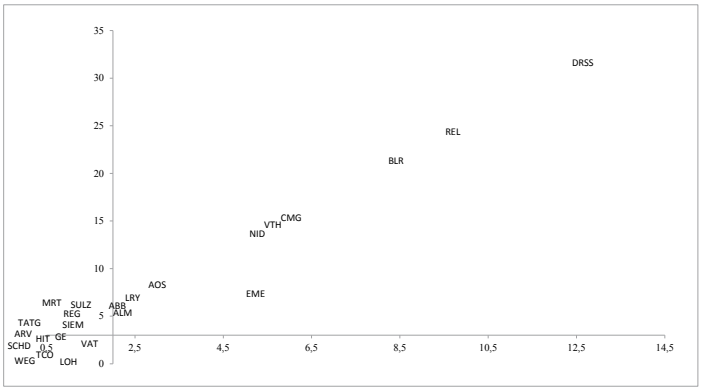
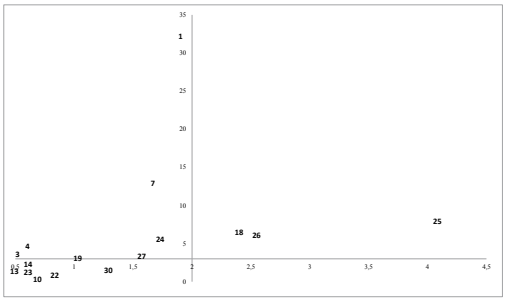


Chart 6h: Subdomain (26)

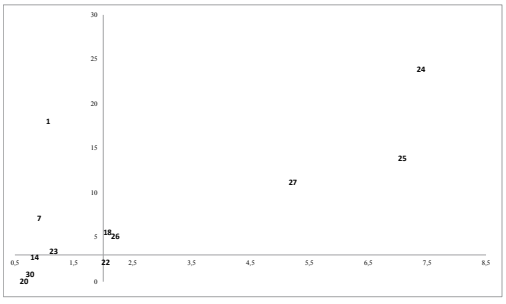


Annex II

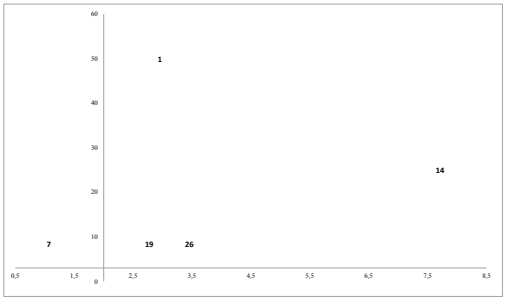
ABB



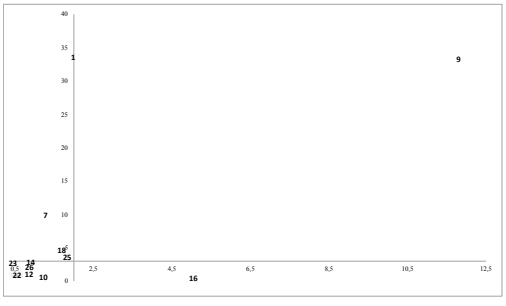
Alstom



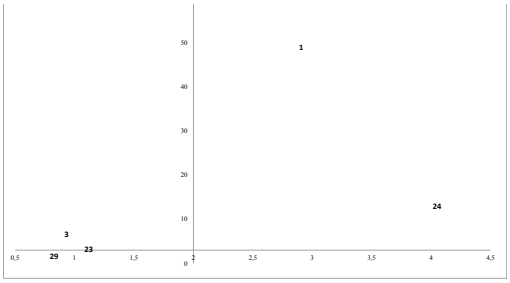
A. O. Smith



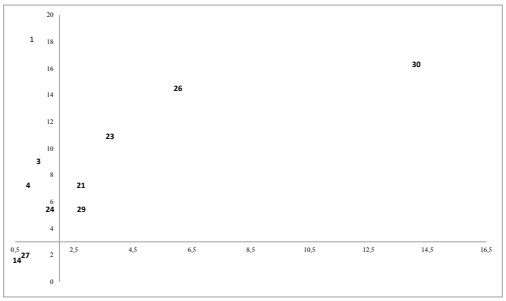
AREVA



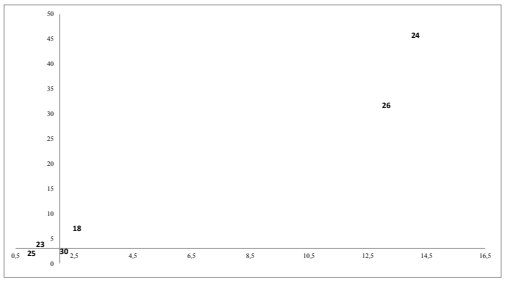
Baldor



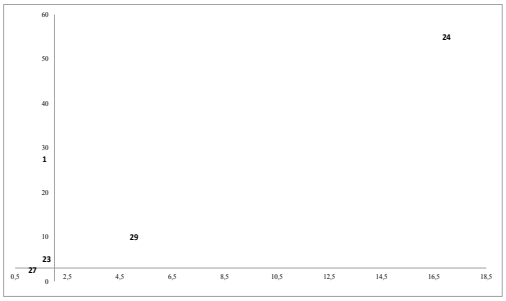
CMG



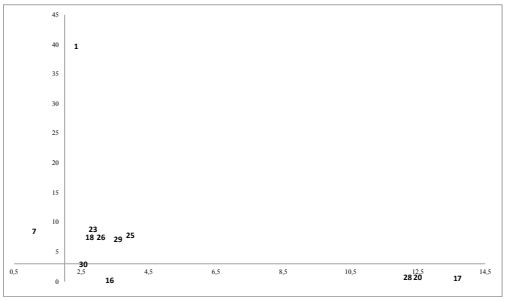
Dresser-Rand Company



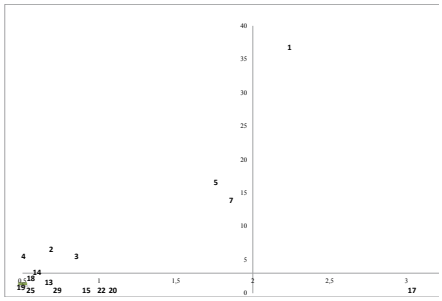
EBERLE S.A.



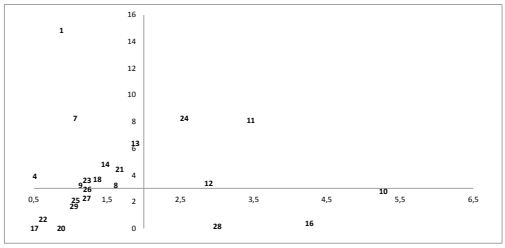
Emerson



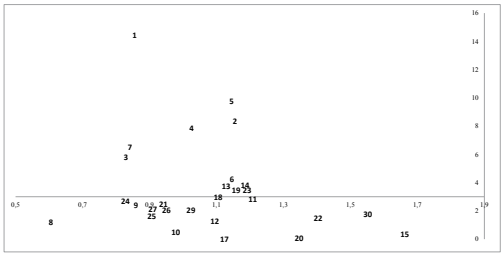
Fuji Electric



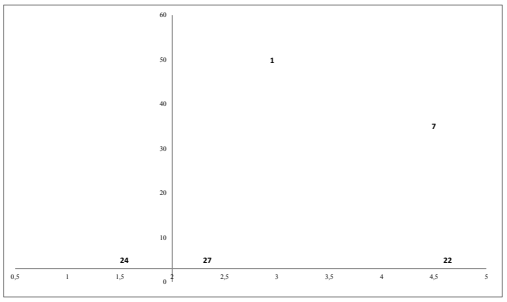
General Electric



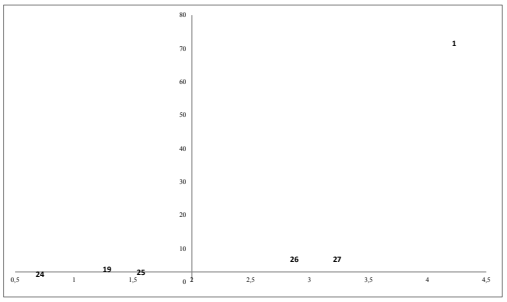
Hitachi



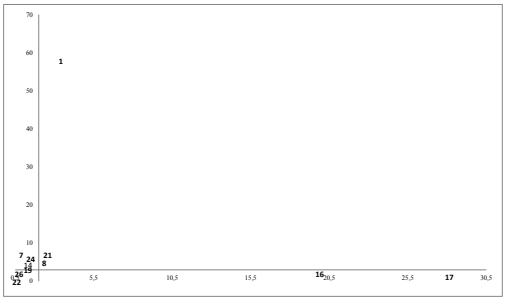
Krebs & Aulich



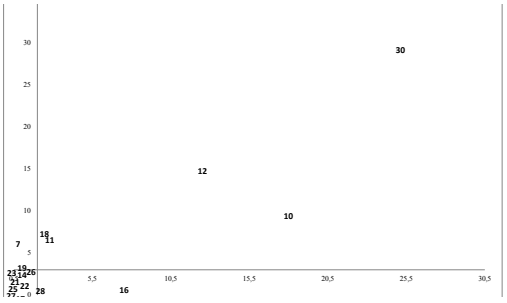
Leroy-Somer



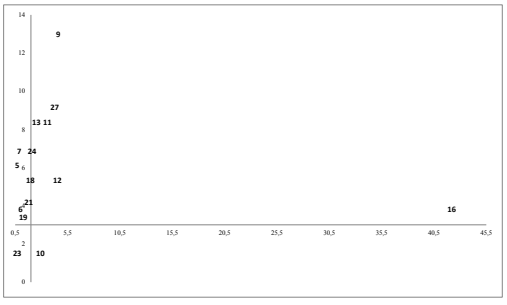
Loher



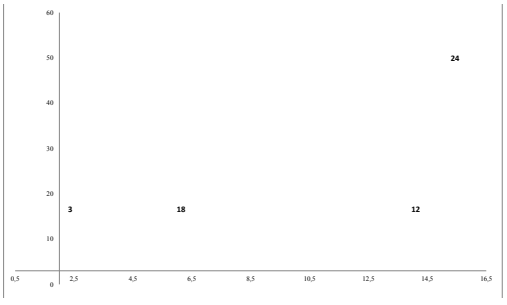
Marathon



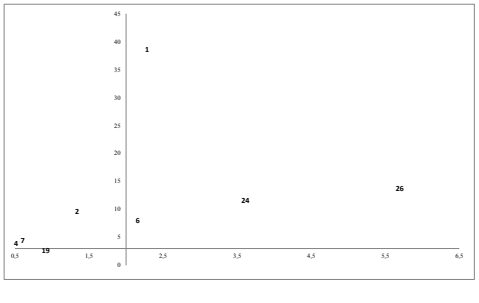
Mitsubish



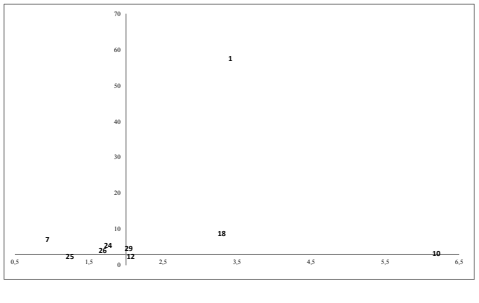
Mitsubish Electric



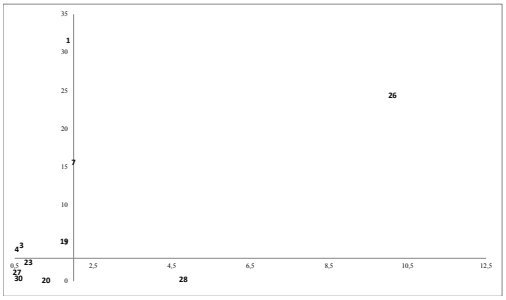
NIDEC



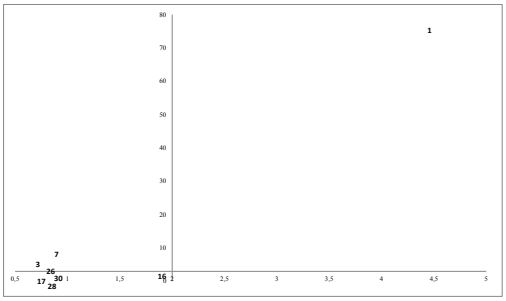
Regal Beloit



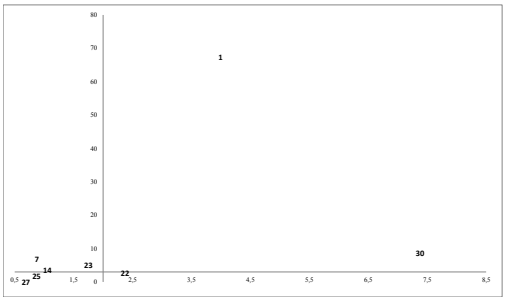
Reliance Electric



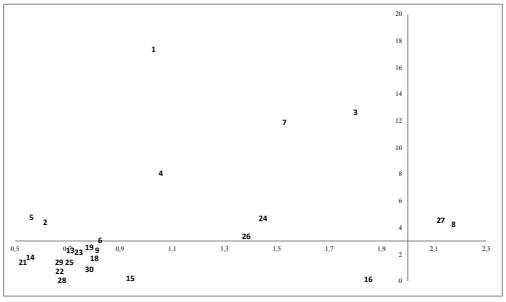
Schneider Electric



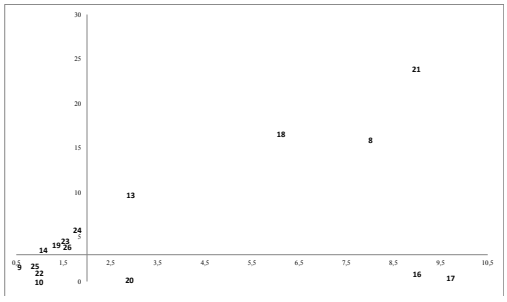
Schorch



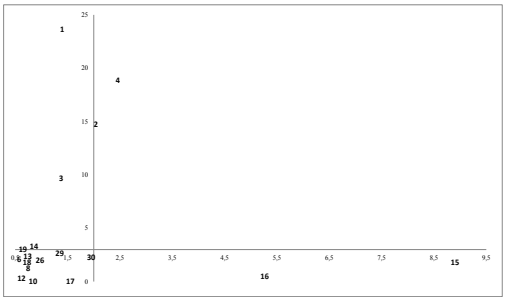
Siemens



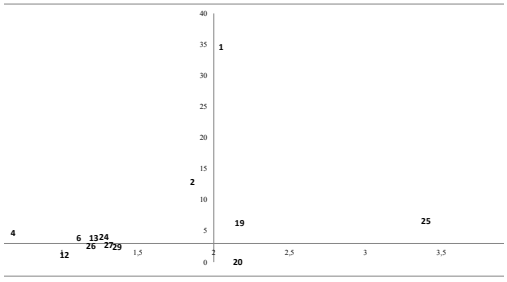
Sulzer



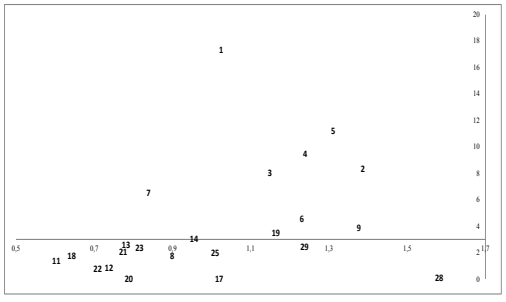
Tatung



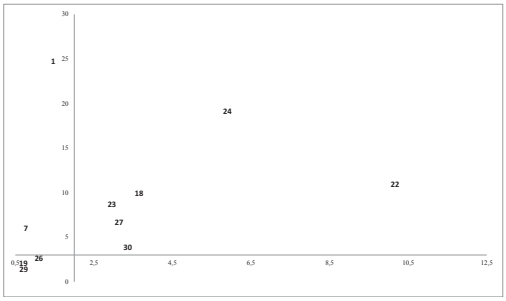
TECO



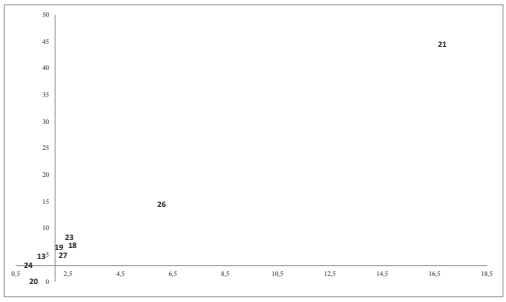
Toshiba



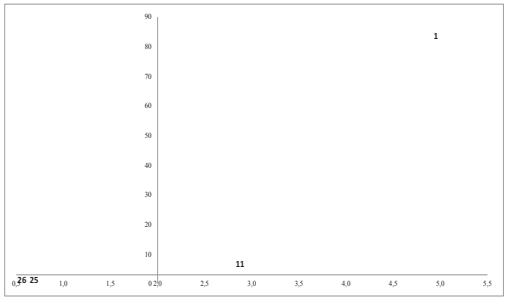
VA Tech



Voith



WEG



Annex III
Table 2. Revealed Technology Advantage's indicator by companies and technological fields

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
A.O. Smith	50,0	0,0	0,0	0,0	0,0	0,0	8,3	0,0	0,0	0,0	0,0	0,0	0,0	25,0	0,0	0,0	0,0	0,0	8,3	0,0	0,0	0,0	0,0	0,0	0,0	8,3	0,0	0,0	0,0	0,0
ABB	32,2	0,3	3,7	4,6	1,4	0,3	13,0	0,1	1,2	0,4	0,3	0,5	1,7	2,0	0,1	0,0	0,0	6,5	3,1	0,0	0,9	0,9	1,8	5,6	8,0	6,1	3,4	0,0	0,4	1,5
Alstom	18,1	0,1	0,7	0,9	0,4	0,1	7,1	0,0	0,1	0,0	0,1	0,3	1,6	2,7	0,0	0,0	0,0	5,6	0,2	0,0	0,4	2,2	3,4	23,9	13,9	5,4	11,2	0,0	0,5	0,9
AREVA	33,6	0,1	0,2	1,2	0,2	0,3	10,0	0,1	33,3	0,6	0,2	1,0	1,0	2,9	0,0	0,5	0,0	4,6	1,0	0,0	0,3	0,7	1,5	0,3	3,6	2,1	0,2	0,0	0,2	0,3
Baldor	49,2	3,3	6,6	0,0	0,0	0,0	1,6	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	3,3	13,1	0,0	21,3	0,0	0,0	1,6	0,0
CMG	18,2	0,0	9,1	7,3	0,0	0,0	1,8	0,0	0,0	0,0	0,0	0,0	0,0	1,8	0,0	0,0	0,0	0,0	0,0	0,0	7,3	0,0	10,9	5,5	0,0	14,5	1,8	0,0	5,5	16,4
Dresser-Rand	0,6	0,0	0,0	1,3	0,0	0,0	1,6	0,0	0,1	0,1	0,0	0,6	0,3	0,0	0,0	0,0	0,0	7,0	0,0	0,0	0,4	0,4	4,0	45,7	2,1	31,7	0,7	0,0	0,7	2,5
EBERLE S.A.	27,5	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	5,0	55,0	0,0	0,0	2,5	0,0	10,0	0,0
Emersom	39,8	0,3	1,0	0,6	0,1	0,2	8,6	0,3	0,1	0,0	0,0	0,1	0,4	0,3	0,0	0,3	0,5	7,5	1,3	0,8	0,9	0,3	8,4	1,6	7,8	7,4	0,4	0,8	7,1	3,0
Fuji Electric	36,8	5,0	5,6	3,9	15,0	1,5	14,0	0,3	1,4	0,2	0,3	0,6	2,1	1,9	0,2	0,0	0,1	1,5	1,5	0,1	0,7	1,1	1,2	0,8	1,0	0,5	0,7	0,0	1,4	0,4
General Electric	14,8	1,8	2,7	3,9	2,6	1,9	8,3	3,2	3,2	2,8	8,1	3,4	6,2	4,8	0,1	0,4	0,0	3,7	0,7	0,1	4,4	0,7	3,6	8,3	2,1	3,0	2,6	0,2	2,1	0,5
Hitachi	14,5	8,3	5,8	7,9	9,8	4,3	6,5	1,2	2,4	0,5	2,8	1,3	3,7	3,8	0,3	0,0	0,0	3,0	3,5	0,1	2,5	1,5	3,5	2,7	1,8	2,3	2,0	0,0	2,0	1,8
Krebs & Aulich	50,0	0,0	0,0	0,0	0,0	0,0	35,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	5,0	0,0	5,0	0,0	0,0	5,0	0,0	0,0	0,0
Leroy-Somer	71,5	0,0	0,0	0,0	0,0	0,0	3,1	0,0	0,0	0,0	0,0	0,0	0,0	1,5	0,0	0,0	0,0	0,0	3,8	0,0	0,8	0,0	0,0	2,3	3,1	6,9	6,9	0,0	0,0	0,0
Loher	57,9	0,0	2,9	0,0	0,0	0,0	6,8	4,7	0,0	0,0	0,4	0,4	0,0	4,3	0,0	1,8	1,1	0,7	3,2	0,0	6,8	0,7	0,0	5,0	0,7	1,8	0,7	0,0	0,0	0,0
Marathon	3,4	0,2	1,0	3,8	0,0	0,0	6,1	0,0	0,0	9,5	6,6	14,8	0,9	2,5	0,0	0,7	0,0	7,0	2,8	0,1	1,6	1,1	2,0	0,5	1,2	2,8	1,5	0,2	0,6	29,1
Mitsubish	7,6	0,0	0,8	0,0	6,1	3,8	6,9	0,8	13,0	1,5	8,4	5,3	8,4	1,5	0,0	3,8	0,0	5,3	3,8	0,0	3,8	0,0	1,5	6,9	0,8	0,0	9,2	0,0	0,8	0,0
Mitsubish Electric	0,0	0,0	16,7	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	16,7	0,0	0,0	0,0	0,0	0,0	16,7	0,0	0,0	0,0	0,0	0,0	50,0	0,0	0,0	0,0	0,0	0,0	0,0
NIDEC	38,6	9,7	0,1	4,0	1,8	8,0	4,5	0,2	0,0	0,0	0,0	0,3	0,3	0,1	0,0	0,0	0,0	0,8	2,8	0,0	0,5	0,0	1,4	11,7	0,3	13,7	0,2	0,0	0,8	0,2
Regal Beloit	57,7	0,0	0,0	3,3	0,0	0,0	7,3	0,0	0,0	3,3	0,0	2,4	0,0	0,0	0,0	0,0	0,0	8,9	0,0	0,0	0,0	0,0	0,8	5,7	2,4	4,1	0,0	0,0	4,1	0,0
Reliance	31,6	0,5	4,7	4,3	0,4	1,1	15,6	0,1	0,2	0,0	0,2	0,0	1,6	1,1	0,0	0,0	0,0	0,5	5,3	0,1	0,6	0,0	2,5	1,6	0,6	24,4	1,2	0,3	0,8	0,7
Schneider Electric	75,4	0,6	5,0	3,4	1,0	0,7	7,0	0,1	0,1	0,1	0,1	0,1	0,3	0,1	0,0	0,2	0,0	0,1	0,5	0,0	0,2	0,1	0,2	0,2	0,1	2,0	0,2	0,1	1,0	1,0
Schorch	67,5	0,0	0,9	0,0	0,0	0,0	6,8	0,0	0,0	0,0	0,0	0,0	0,0	3,4	0,0	0,0	0,0	0,9	0,0	0,0	0,0	2,6	5,1	0,0	1,7	0,9	1,7	0,0	0,0	8,5
Siemens	17,4	4,4	12,6	8,1	4,8	3,1	11,9	4,3	2,3	0,2	0,6	0,5	2,4	1,8	0,2	0,2	0,0	2,2	2,4	0,0	1,4	0,7	2,2	4,7	1,4	3,3	4,6	0,0	1,4	0,9
Sulzer	3,1	0,0	0,0	0,1	0,0	0,0	0,3	15,9	1,6	0,5	0,4	0,4	9,7	3,5	0,1	0,8	0,4	16,6	4,1	0,2	23,9	1,1	4,5	5,8	1,8	3,8	0,5	0,0	0,4	0,5
Tatung	23,6	14,8	9,7	18,9	2,4	2,1	2,0	1,4	0,0	0,4	0,2	0,8	2,4	2,8	1,8	0,5	0,1	1,8	2,1	0,1	1,0	0,0	0,6	1,0	1,3	2,1	1,0	0,0	2,7	2,3
TECO	34,7	12,9	2,3	4,7	1,7	3,9	3,2	0,1	0,0	0,3	1,1	1,2	4,0	1,7	0,0	0,0	0,0	0,8	6,3	0,1	0,9	0,1	1,2	4,1	6,7	2,7	2,8	0,0	2,5	0,0
Toshiba	17,3	10,0	8,1	9,5	11,2	4,6	6,5	1,8	3,9	0,1	1,4	0,9	2,6	3,1	0,1	0,0	0,0	1,7	3,5	0,0	2,1	0,8	2,4	1,3	2,0	1,2	0,9	0,1	2,5	0,5
VA Tech	24,8	0,0	0,2	0,5	0,0	0,0	6,0	0,5	0,2	0,2	0,0	0,0	0,0	1,2	0,0	0,0	0,0	9,9	2,1	0,0	0,2	11,0	8,7	19,1	0,7	2,7	6,7	0,0	1,4	3,9
Voith	1,2	0,1	0,1	0,3	0,0	0,1	1,8	0,1	0,0	0,0	0,2	0,2	4,9	0,1	0,0	0,0	0,0	7,3	6,5	0,1	44,6	0,5	7,7	3,2	0,4	14,6	4,9	0,0	0,6	0,3
WEG	84,9	0,0	0,0	2,7	0,0	0,0	1,4	0,0	0,0	0,0	6,8	0,0	1,4	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	1,4	1,4	0,0	0,0	0,0	0,0

Source: made up by the author.

Table 3. Firm's patent share according to technological fields

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
A.O. Smith	3,0	0,0	0,0	0,0	0,0	0,0	1,1	0,0	0,0	0,0	0,0	0,0	0,0	7,7	0,0	0,0	0,0	0,0	2,8	0,0	0,0	0,0	0,0	0,0	0,0	3,5	0,0	0,0	0,0	0,0
ABB	1,9	0,0	0,5	0,6	0,2	0,1	1,7	0,0	0,4	0,7	0,1	0,4	0,5	0,6	0,3	0,4	0,2	2,4	1,0	0,3	0,3	0,8	0,6	1,7	4,1	2,5	1,6	0,3	0,2	1,3
Alstom	1,1	0,0	0,1	0,1	0,0	0,0	0,9	0,0	0,0	0,1	0,0	0,3	0,5	0,8	0,1	0,2	0,3	2,1	0,1	0,7	0,1	2,0	1,2	7,4	7,1	2,2	5,2	0,3	0,3	0,8
AREVA	2,0	0,0	0,0	0,2	0,0	0,1	1,3	0,0	11,8	1,2	0,1	0,9	0,3	0,9	0,0	5,0	0,0	1,7	0,3	0,4	0,1	0,6	0,5	0,1	1,8	0,9	0,1	0,0	0,1	0,3
Baldor	2,9	0,5	0,9	0,0	0,0	0,0	0,2	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	1,1	4,0	0,0	8,8	0,0	0,0	0,8	0,0
CMG	1,1	0,0	1,3	0,9	0,0	0,0	0,2	0,0	0,0	0,0	0,0	0,0	0,0	0,6	0,0	0,0	0,0	0,0	0,0	0,0	2,7	0,0	3,7	1,7	0,0	6,0	0,8	0,0	2,8	14,1
Dresser-Rand	0,0	0,0	0,0	0,2	0,0	0,0	0,2	0,0	0,1	0,3	0,0	0,5	0,1	0,0	0,0	0,0	0,0	2,6	0,0	0,0	0,2	0,4	1,4	14,1	1,0	13,1	0,3	0,0	0,4	2,2
EBERLE S.A.	1,6	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	1,7	17,0	0,0	0,0	1,2	0,0	5,0	0,0
Emersom	2,4	0,0	0,1	0,1	0,0	0,1	1,1	0,2	0,0	0,0	0,0	0,1	0,1	0,1	0,0	3,3	13,7	2,8	0,4	12,4	0,3	0,2	2,9	0,5	4,0	3,1	0,2	12,4	3,6	2,6
Fuji Electric	2,2	0,7	0,8	0,5	1,8	0,4	1,8	0,1	0,5	0,3	0,1	0,5	0,6	0,6	0,9	0,1	3,0	0,6	0,5	1,1	0,3	1,0	0,4	0,2	0,5	0,2	0,3	0,4	0,7	0,4
General Electric	0,9	0,2	0,4	0,5	0,3	0,5	1,1	1,6	1,1	5,3	3,5	2,9	1,9	1,5	0,3	4,3	0,5	1,4	0,2	0,9	1,7	0,6	1,2	2,6	1,1	1,2	1,2	3,0	1,1	0,4
Hitachi	0,9	1,2	0,8	1,0	1,1	1,1	0,8	0,6	0,9	1,0	1,2	1,1	1,1	1,2	1,7	0,4	1,1	1,1	1,2	1,3	0,9	1,4	1,2	0,8	0,9	1,0	0,9	0,4	1,0	1,6
Krebs & Aulich	3,0	0,0	0,0	0,0	0,0	0,0	4,5	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	4,6	0,0	1,5	0,0	0,0	2,3	0,0	0,0	0,0
Leroy-Somer	4,2	0,0	0,0	0,0	0,0	0,0	0,4	0,0	0,0	0,0	0,0	0,0	0,0	0,5	0,0	0,0	0,0	0,0	1,3	0,0	0,3	0,0	0,0	0,7	1,6	2,9	3,2	0,0	0,0	0,0
Loher	3,4	0,0	0,4	0,0	0,0	0,0	0,9	2,4	0,0	0,0	0,2	0,3	0,0	1,3	0,0	19,9	28,1	0,3	1,1	0,0	2,6	0,7	0,0	1,6	0,4	0,7	0,3	0,0	0,0	0,0
Marathon	0,2	0,0	0,1	0,5	0,0	0,0	0,8	0,0	0,0	18,0	2,8	12,5	0,3	0,8	0,0	7,5	1,0	2,6	0,9	1,2	0,6	1,0	0,7	0,2	0,6	1,2	0,7	2,3	0,3	25,1
Mitsubish	0,5	0,0	0,1	0,0	0,7	1,0	0,9	0,4	4,6	2,9	3,6	4,5	2,5	0,5	0,0	42,2	0,0	2,0	1,3	0,0	1,4	0,0	0,5	2,1	0,4	0,0	4,3	0,0	0,4	0,0
Mitsubish Electric	0,0	0,0	2,4	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	14,1	0,0	0,0	0,0	0,0	0,0	6,1	0,0	0,0	0,0	0,0	0,0	15,4	0,0	0,0	0,0	0,0	0,0	0,0
NIDEC	2,3	1,3	0,0	0,5	0,2	2,2	0,6	0,1	0,0	0,0	0,0	0,3	0,1	0,0	0,0	0,0	0,0	0,3	0,9	0,0	0,2	0,0	0,5	3,6	0,2	5,7	0,1	0,0	0,4	0,2
Regal Beloit	3,4	0,0	0,0	0,4	0,0	0,0	0,9	0,0	0,0	6,2	0,0	2,1	0,0	0,0	0,0	0,0	0,0	3,3	0,0	0,0	0,0	0,0	0,3	1,8	1,2	1,7	0,0	0,0	2,1	0,0
Reliance	1,9	0,1	0,7	0,6	0,0	0,3	2,0	0,0	0,1	0,0	0,1	0,0	0,5	0,3	0,0	0,0	0,0	0,2	1,8	1,3	0,2	0,0	0,8	0,5	0,3	10,1	0,6	4,8	0,4	0,6
Schneider Electric	4,5	0,1	0,7	0,4	0,1	0,2	0,9	0,0	0,1	0,2	0,0	0,1	0,1	0,0	0,1	1,9	0,8	0,0	0,2	0,5	0,1	0,1	0,1	0,1	0,0	0,8	0,1	0,9	0,5	0,9
Schorch	4,0	0,0	0,1	0,0	0,0	0,0	0,9	0,0	0,0	0,0	0,0	0,0	0,0	1,1	0,0	0,0	0,0	0,3	0,0	0,0	0,0	2,4	1,7	0,0	0,9	0,4	0,8	0,0	0,0	7,4
Siemens	1,0	0,6	1,8	1,1	0,6	0,8	1,5	2,2	0,8	0,5	0,3	0,4	0,7	0,6	0,9	1,8	0,2	0,8	0,8	0,4	0,5	0,7	0,8	1,4	0,7	1,4	2,1	0,7	0,7	0,8
Sulzer	0,2	0,0	0,0	0,0	0,0	0,0	0,0	8,0	0,6	1,0	0,2	0,4	2,9	1,1	0,3	9,0	9,7	6,1	1,4	2,9	9,0	1,0	1,5	1,8	0,9	1,6	0,2	0,0	0,2	0,4
Tatung	1,4	2,0	1,4	2,5	0,3	0,6	0,3	0,7	0,0	0,8	0,1	0,7	0,7	0,9	8,9	5,3	1,6	0,7	0,7	1,9	0,4	0,0	0,2	0,3	0,6	0,9	0,5	0,0	1,4	2,0
TECO	2,0	1,8	0,3	0,6	0,2	1,0	0,4	0,1	0,0	0,5	0,5	1,0	1,2	0,5	0,0	0,0	0,0	0,3	2,1	2,2	0,4	0,1	0,4	1,3	3,4	1,1	1,3	0,0	1,3	0,0
Toshiba	1,0	1,4	1,1	1,2	1,3	1,2	0,8	0,9	1,4	0,1	0,6	0,7	0,8	1,0	0,4	0,4	1,0	0,6	1,2	0,8	0,8	0,7	0,8	0,4	1,0	0,5	0,4	1,6	1,2	0,4
VA Tech	1,5	0,0	0,0	0,1	0,0	0,0	0,8	0,3	0,1	0,3	0,0	0,0	0,0	0,4	0,0	0,0	0,0	3,7	0,7	0,0	0,1	10,2	3,0	5,9	0,4	1,1	3,1	0,0	0,7	3,4
Voith	0,1	0,0	0,0	0,0	0,0	0,0	0,2	0,0	0,0	0,0	0,1	0,2	1,5	0,0	0,1	0,1	0,6	2,7	2,2	1,2	16,8	0,4	2,6	1,0	0,2	6,1	2,3	0,0	0,3	0,3
WEG	5,0	0,0	0,0	0,4	0,0	0,0	0,2	0,0	0,0	0,0	2,9	0,0	0,4	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,7	0,6	0,0	0,0	0,0	0,0

Source: made up by the author.