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Abstract*

The co-evolution of technology and organizational structures is discussed through an historical analysis of the European Major Home Appliances industry and is related to the dynamics of selection processes, where geographically localized competition leads to local concentration, which in turn increases global competition and triggers global concentration.

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1. Introduction

In 1878 at the fifth World Industrial Expo in Paris several industrially produced mechanical devices, marketed as "the first real women's mechanical servants", designed to help women in daily activities were presented (Faravelli Giacobone et al., 1989). Steam-based kitchens ingeniously crafted to cook more than one dish at a time in iron cylinders hermetically closed and with a steam-exhaustion valves, predecessors of pressure cookers, or the portable hot-air oven, were only some of the revolutionary inventions presented to ease the burden of domestic life.

More than a century after that pioneering exhibit, in 1986, Motorola Inc. and the Frank Lloyd Wright foundation presented the results of a ten-year project started in 1977. At the core of the project was the realization of a new type of house with electronic technologies responsible for an harmonization of the inside and outside environment. Electronic devices were at the heart of the two story building near Phoenix in Arizona, where solar panels powered a centralized computer system controlling a set of localized microchips dedicated to specific appliances and to the general regulation of the different functional aspects (i.e. lighting, data communication from and to the house etc.).

As much as in 1878 the idea of a gas stove might have sounded bizarre, dangerous and far away from its adoption by a multitude of house-holds, in 1987 the computerized system controlling the lighting of the whole house and coupling it to the stereo devices and the phone systems still seemed more a solution for high-tech millionaires rather than a promising mass-market product. Yet, around 1885 gas stove began to be offered at affordable prices and started their diffusion challenged in the beginning of the 20th century by the substitution of gas with electricity. Similarly, remote-controlled systems to regulate the lighting of the apartments and coupled with the TV set and the stereo-system have recently reached the consumer market and are offered by high-end specialists.
The century between the Paris exhibition and the electronic house has clearly been characterized by important changes in the organization of the daily home activities in several ways and one industry has grown out of such changes: the home appliance industry. From its initial phases at the beginning of the century primarily in the U.S., the industry focused on the application of automated solutions to the execution of manual tasks in the daily life. Although not regarded as the industry of industries (Womack et al., 1990) the effects of the home appliance industry and of its products on the changes of lifestyles and daily activities have been probably as profound as the diffusion of the car as the private means of transportation. In 1991 48 millions of refrigerators and 41 millions of washing machines were produced in the world (United Nations, 1991). Together, U.S. and EU based companies account for 35% of production of refrigerators and 46% of production of washing machines. Japanese and Korean companies account for 11% and 7% respectively of production of refrigerators and for 14% and 7% of production of washing machines. Such impact of home appliances both in the private domain and in the industrial domain of the more advanced economies suggests to focus the attention further down on the industry itself. In particular, a deeper analysis of the evolution of the Major Home Appliance industry in Europe presents several elements of interest.\(^1\)

First, the structural changes of competition after the W.W.II show strong similarities among the different countries. From initially stable oligopolistic structures, the post-war years of reconstruction and investments coupled with the retreat of the major U.S. producers who decided to concentrate on their fast growing and much more homogenous internal market, favored several new entrants, often specialized on specific product lines and segments of the consumer market. This period of turmoil competition didn't last too long though, and was followed by national oligopolies in the late '60s and early '70s, when the internationalization of the industry from the

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\(^1\) The home appliance industry usually embraces two macro-subsectors: the Major Home Appliances industry and the Small Appliances industry. The Major Home Appliances industry comprises self-standing domestic electric appliances, namely refrigerators, washing-machines, dryers, dishwashers, stoves, ovens and cooking devices. The Small Appliances industry comprises all the small appliances from electric razors to coffee-grinders.
producer side started the process which led to the present oligopolistic structure at the European level, reached primarily by external rather than internal growth.

Second, despite the changes on the producers side, which were reflected in the consumer market through substantial price reductions, wider choice and brand proliferation, inter-country differences still remain quite consistent. The market of washing machines is a good example of such differences. Considering the two main product features of a washing machine, spin-speed and loading, European consumers still strongly differ in preferences, reflecting historical tendencies and habits and demonstrating resistance to the homogenization of consumption patterns (Baden-Fuller & Stopford, 1991). In France, top-loading models account for roughly 70% of the market, while in the rest of Europe they are mainly considered as niche markets. Northern countries prefer higher spin-speeds, between 600 and 800 r.p.m., most likely expressing the need for more effective spinning cycle to reduce drying times. On the contrary, southern countries address their choices towards front-loading machines with lower spin-speed and are still resistant to drying functions.

Third, these profound differences of local markets and the contemporary concentration on the producer side generate a puzzle for the theory of multinationals. On the one hand, the peculiarities of local markets would suggest a divisionalized structure with local SBUs and a centralized unit to coordinate and provide the central staff services. On the other hand, national volumes in many cases proved to be insufficient to sustain dedicated manufacturing facilities. While a pure globalization is frustrated by the fragmentation of the demand patterns, a classical internationalization mode faces the threats of higher costs and lower margins. Concentration and growth at the European level therefore occurs not through direct foreign investments but rather through acquisition of troubled competitors. Firms do not gain market share directly, but they buy it out indirectly and are then faced with a contingent proliferation of brands within the same group. Interesting solutions are found through more flexible organizational structures, with formal separation of technical and marketing function by product types and strong internal networking to achieve coordination (Goshal & Haspeslagh, 1990).
Fourth, the changing role of technology in the evolution of the industry represents on one side a paradigmatic case of product-process interaction, on the other side an important viewpoint to observe the co-evolution of technology and structures. From an initial effort on product features characterizing the early post-war years, investments in process technologies became fundamental to reach and exploit economies of scale factors and leverage cost advantages to expel less efficient players. With higher concentration and internationalization of operations, however, uncoupled innovation efforts on products and processes are not viable anymore. On the one hand, in fact, higher volumes require substantial investments in production capacity. On the other hand, these volumes are still all but homogenous in their technical characteristics. Coordinated efforts on both the product and the process side are therefore needed to achieve successful flexible specialization modes of production in order to concentrate production efforts and at the same time guarantee a differentiated offer. Structuring choices reflect these needs and process-based solutions emerge as the only viable alternative to reconcile the asymmetries.

In this paper, using publicly available data I present an history of the European Major Home Appliances industry exploring these different points. The second section is dedicated to a detailed analysis of the evolution of the Industry from the World War II to the beginning of the '90s. The third and the fourth sections analyzes respectively how technology and internal organizational structures co-evolved with changes at the industry level. The fifth and final section summarizes the elements highlighted and concludes with their implications.

2. The evolution of the industry

At first sight, the historical evolution of the European Major Home Appliances industry conforms to traditional life-cycle models (Utterback & Abernathy, 1975, Hannan & Freeman, 1977, Jovanovic, 1982). Initial stages are characterized by several new entrants and a high level of competition, subsequently followed by selection processes and increasing market concentration. Similarly to other industries, such as for example the Automobile industry or the Steel industry, limited potentials for growth emerge in the long run, constraining competitors to stagnant maturity
of products and markets. De-maturity phases are then reached through investments in product or brand differentiation. Despite commonalities in the stages of evolution, though, a more careful reading of the events unveils several interesting elements.

2.1 The fragmented post-W.W.II structure

The origins of the European Major Home Appliance industry are rooted in a pioneering phase at the beginning of the century. The experimentation of new technical solutions was coupled with wider considerations over the social impact of the new machines (Frederick, 1913). The geographical and political fragmentation of the European markets and the marked differences in the overall wealth distribution among its countries, however, constrained the industry to a national producer structure, with a diffuse presence of U.S. manufacturers as the dominant players.

After the W.W.II, U.S. manufacturers were still present in several European countries covering all the different product lines. Kelvinator’s refrigerators manufacturing facilities were located in the U.K. and in Italy, Frigidaire was present in the U.K., West Germany and France and Whirlpool produced refrigerators and washers in France. The overall scale of U.S. manufacturing units, however, was considerably limited if compared with their home-based plants. While the former did not exceeded 100,000 pieces per year, with an average of 50,000, the latter reflected heavy investment in manufacturing capacity with an average of 800,000 pieces per year (Paba, 1991b).

The limited scale of their European subsidiaries precluded to a substantial pull-out of U.S. manufacturers from European markets. Two main reasons were behind this choice. First, there were doubts about the potentials for growth in the demand for durable goods. Castellano (1965) quotes a report of General Motors of Switzerland indicating a generally low refrigeration consciousness which wouldn't have sustained further investments. Second, the patterns of demand within Europe appeared not only too diversified to justify scale-investment, but also too different from the fast growing U.S. market. Technical differences reflecting asymmetries between Europe
and the U.S. required a stronger effort in localized customization and made the mere transfer of product design from the home-base to the foreign subsidiaries unfeasible. U.S. manufactured products, for example, were generally too large in size for European homes, thus requiring a substantial re-engineering effort.

The fragmentation of European demand and its role in shaping the technological base of the whole industry would remain an underlying trait of the whole evolution of the Major Home Appliances industry in Europe and represented a valid concern for U.S. manufacturers. The lack of faith in markets growth, however, soon proved to be wrong. The direct consequences of the steadiness of established competitors generated up to the early '60s a rapid growth in the number of competitors. New entrants, as in the U.S. in the early 1900, came from industries where the technological base favored related diversification. Auto-makers such as FIAT in Italy already managed mass-production techniques and metal casting operations and were therefore facilitated in transferring their production know-how. Similarly, electric companies such as for example Philips in the Netherelands or Bosch in West Germany, found a natural expansion of their activities into the production of electrically powered devices.

The majority of the newly operating firms, however, were initiated by local entrepreneurs. In the U.K. between 1955 and 1964 16 new producers entered the washing machine sector and 15 in the refrigerator sector. In Italy, washing machine manufacturers totaled a high 50 in the late fifties. Similarly fragmented structures were also common to West Germany and France. Among the 67 major European producers operating in 1964, around 50 were of entrepreneurial origin and according to some estimates there were 130-150 other small firms with average volumes of 10,000 units per year accounting for roughly 15% of the overall market (Paba, 1991b).

Examples of entrepreneurial firms which would have then shaped the industry are common in every country. In the U.K. Wilkins and Mitchell specialized in washing machines and reached a high 12% of the national market by the '60s. In West Germany Miele quickly focused on high-end niches and established his brand as a high quality one. The more strikingly examples, though, are
represented by Italian firms, where several mechanically skilled entrepreneurs founded firms such as Zanussi, Ignis, Candy and Merloni which quickly became strong international competitors.

2.2 From local competition to national oligopolies

The high number of competitors supported by a growing demand generated intense levels of competition in all the different countries and favored greater intra-community trading. The high-cost, low volumes in small batches operating structures of most of local manufacturers were incompatible, though, with the changing patterns of international trade. In the late '50s Italian producers started to invest heavily in large scale automated plants focusing on narrow ranges of standardized products and quickly captured a substantial portion of the international markets leveraging on cost advantages.

At the beginning of the '60s, however, strong import tariffs within Europe were still sheltering local competitors and limiting selection processes within national boarders. Before the elimination of intra-European tariffs, Italy was imposing a 34% import tariff on electric products, France a 22% tariff and Germany a 8% tariff. Concentration on the producers side, therefore, occurred all around Europe at the national level and strong inter-country differences started to emerge.

A first comparison at the country level could be made along the width of the product line offered. While it is still too soon to observe clear benefits from a widespread presence on all the four main segments (refrigerators, washers and dryers, dishwashers, stoves and ovens) due to brand loyalty and stronger distribution power which will appear as critical in the 70's, European companies varied considerably in their choices (Paba, 1991a). On the one hand, British manufacturers tended to focus on specific products and invested in dedicated manufacturing capacity. On the other hand, in Germany, France and Italy the major competitors offered the whole line of products, with considerable size differences. The total 1964 annual production of the major French Major Home Appliances manufacturer, Thomson-Houston, was only half of the total
annual production of the first West German manufacturer, Bosch, and almost a third of the first Italian manufacturer Ignis, which was the largest producer in Europe. These profound scale asymmetries are confirmed by a wider comparison encompassing the other national producers (see table 1).

National differences also emerged with respect to market positioning choices. West Germany producers concentrated in the medium-high range, starting to establishing the base for a strong reputation for the quality and the reliability of their products. On the opposite verge, Italian manufacturers disregarded investments in market positioning and focused on cost-based strategies operating with own brands in the lower end of the spectrum. To saturate their production capacity, they also functioned as manufacturing subcontractors for several foreign producers selling under their own labels. The distinction between high vs. low end focusing was more blurred in the U.K. and in France where both strategies co-existed. This lack of focus, coupled with insufficient investments in production capacity, represented a profound weakness in the international competitive arena, which will ultimately led to a substantially limited role of U.K. firms outside their national market, and the demise of the French industry as a whole.

2.3 International competition

The low-cost strategy adopted by Italian firms reflected an inherent weakness of their brands. As late entrants in the market, based on entrepreneurial efforts to invest in a new and growing business they initially lacked both the resources and the expertise to promote effective brand strategies. They foresaw, however, the economic implications of technological investments in production technologies and heavily reinvested the initially high profits internally, concentrating on the rationalization and mechanization of the whole production process.
In the case of refrigerators, for example, Italians were the first to replace fiberglass insulation with rigid vacuum polystyrene liners and interstitial poliuretan foam (Owen, 1983). The substitution of fiberglass allowed major changes in the whole cabinet-making process, increasing its automation with fewer welding and the use of thinner walls and doors. New production technologies required larger scale to be exploited. According to some estimates, the minimum efficient scale for a refrigerator plant in 1965 was around 500,000 units, with an increase in the production costs of about 8% for a plant capacity of 250,000 (Pratten, 1971).^2

Regardless of a more fragmented structure of the internal competitive market, therefore, the cost advantage of Italian producers quickly translated into higher exports in all the different product segments of the industry. Figure 1 reports the export share of production of Italian firms by type of products between 1956 and 1975. With different lags, it shows a consistent pattern of increase in the exports from an average low 10/20% in the late '50s early '60s, to an extremely high 60/70% for refrigerators and 50% for washers in the early '70s.

The growing markets of the '60s and the increased intra-community trade due to the lowering of trade barriers facilitated a widespread growth of Italian manufactured products all around Europe. By the beginning of the '70s, country level market share data indicate a dominant position of Italian manufacturers for refrigerators in all the major countries (see table 2). Their market share in Germany grew from 7% in 1964 to 36% in 1970. In the same period, in France it went from 15% to 47%, and in the U.K. from 5% to 24%. Similar observations are possible for washers, although in this product segment competition was still high especially in some countries, like France or the U.K., where the demand patterns and the presence of specialized producers limited the effects of lower manufacturing costs.

^2 According to other authors, the minimum efficient scale at the plant level in the '70s was around 800,000 units per year (Scherer, 1975, Balloni, 1978) and 1.2 ml. units per year in the early '80s (Owen, 1983).
The widening of markets deeply affected the internal structure of national industries. While the lack of marketing expertise and the overall positioning of Italian brands in the lower range of the markets allowed high end producers to be sheltered from the general decrease in prices triggered by economies of scale effects, inefficiencies quickly led to exits in the absence of a strong brand reputation. By 1970, only 38 of the 71 Major Home Appliances manufacturer operating in 1964 were still present. The concentration process occurred homogeneously in all the different nations favoring the emergence of local oligopolies formed by some internationally oriented players and some highly specialized ones, mainly focusing within national boarders. Following the Italians' lead, growth processes were the results of investments in production capacity either directly, or through the acquisition of weaker competitors. While the concentration of manufacturing capacity will become a common denominator of the subsequent evolution of the industry, at this stage it did not encompass a direct acquisition of market share. The acquired brands were in fact generally very weak and they were soon substituted by those of the acquiring partners.

By the beginning of 1970 Hotpoint was the clear dominant player in the U.K. such as in France was the Thomson-Brandt group. The group was the result of the merger of Thomson-Houston and Hotchkins-Brandt and the acquisition of several smaller French manufacturers like Surmerlec and Sud Aviation backed by the Government attempting to consolidate the internal productive structure. West Germany and in Italy, on the contrary, lacked a clearly dominant player with the latter still characterized by a relatively high level of fragmentation.

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3 Both Hotpoint and Thomson-Brandt originated from GE European branches. In 1894 GE founded in the U.K. British Thompson Houston which, in 1926, after a merger with Metropolitan Vickers, became Associated Electrical Industries (AEI) whose division, Hotpoint, focused on home-appliances. In 1954, GE exited from AEI-Hotpoint. In the early '60s GE also exited from Thompson-Houston in France.
2.4 Maturity and the emergence of a European oligopoly

The growth in the demand for Major Home Appliances which characterized all the European markets for almost 20 years after the W.W.II finally ended with the beginning of the '70s. By 1972, the saturation level of the major markets, calculated as penetration in the households, was around 80% for refrigerators and around 70% for washers (see table 3). Dishwashers were still offering good potentials for growth, though, due to their later introduction in the market and the peculiarities of the acquisition patterns of home-appliances (Wells & Dossabhoy, 1993). The importance of substitution vs. first purchase demand increased accordingly in all product segments. By the early '80s, on average, 9 out of ten refrigerators and 8 out of 10 washers were bought to replace older models already present in the household (see table 3).

The changes in the structural characteristics of demand were soon reflected in the key sources of competitive advantage. The higher consciousness and familiarity of consumers with the products increased the role of quality and reliability features over price in the purchasing process. The marked decrease in prices occurred during the '60s, in fact, could not be matched any longer. Owen's estimates (1983) indicate a decrease in real term prices between 1956 and 1970 of almost 50% for refrigerators, and of almost 60% for washers. Product innovations and investments in advertising, customers assistance structures and direct control of distribution channels to insure the proper product positioning in the consumer market, therefore, quickly became the key for success, and the low-end producers started to be severely penalized.

The increasing importance of brand loyalty and reputation effects also increased the strategic value of a complete offer (Porter, 1976, Schmalensee, 1982). Buying patterns, in fact, showed that customers purchasing different home appliances tended to prefer brands they already owned not only when substituting old models, but also when purchasing different products (1991a).
Specialized producers leveraging on low production cost structures based on large manufacturing scale and weak brand positions suddenly faced a stagnant market with excess capacity and increasing brand loyalty, where the only feasible alternatives for survival were represented by product line integration (e.g. Candy (I)) or specialization on high-end segments (e.g. Scholtes (F), San Giorgio (I)).

The challenges presented by the new competitive scenario triggered profound changes in the structure of the industry. National competitors who had benefited in the past by the high level of demand and mainly operated as subcontractors for foreign manufacturers or for independent distributors were now suffering from cut-throat price competition and lacked negotiation power to reposition their offer. In addition to that, the entrepreneurial form typical of these firms which had represented a distinguished characteristic in their successful growth, seemed to be inappropriate to manage the transition (Balloni, 1978). The major national players, therefore, progressively eroded market share to the smaller players. Ultimately, a second wave of acquisitions and exits further increased the level of concentration at the national scale.

Concentration processes, however, were not limited within national borders. On the contrary, the process of international consolidation finally realized during the '80s finds its roots during the '70s. Zanussi of Italy quickly became the major European manufacturer in term of production capacity through a series of acquisitions in the internal market and an alliance with the West German Aeg-Telefunken which acquired 20% of its shares. Philipps of Netherlands acquired Ignis of Italy in a major operation which made the Dutch producer the second European group with a market share of about 11% in 1976. In West Germany Bosch, specialized in refrigerators, and Siemens, specialized in washers, merged in 1972 forming the fourth European group which in 1976 accounted for roughly 8% of total production and covered the whole product range. Aeg-Telefunken completed its restructuring efforts through the acquisition of Zanker in 1971 and the home-appliance division of BBC of Switzerland in 1973. By 1976 it was the 6th European producer accounting for 6.1% of total volumes. The fifth producer in 1976 was Thomson-Brandt

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4 The alliance will be ultimately terminated in 1979 when Zanussi bought back its shares.
of France with 7.6% of total volumes. After the exit from the market of Frigidaire and Vendome and the acquisition of Arthur Martin by Electrolux in 1976, the Thomson-Brandt group remained the only large integrated French producer in the European market.

At the beginning of the '80s the European Major Home Appliances industry was therefore characterized by its highest level of concentration, with the first three producers accounting for roughly 35% of the market and the first ten for roughly 48% of the market (see table 4). Despite the sensible changes with respect to the past, however, the industry still suffered from excess capacity and its concentration levels were far below the U.S. ones, where the first three producers accounted for 85% of the market. While growth by internal investments was clearly not an option anymore, the structural inefficiencies of several players offered further opportunities for growth by acquisitions.

Electrolux history is exemplary in this sense. Through a series of aggressive acquisitions of troubled competitors in Europe and in the U.S., the Swedish conglomerate became the second largest Major Home Appliances manufacturer in the world and the first in Europe with a 23% market share in 1988. Similarly, Philips acquired several small producers and, in 1982 and 1983 the West German producers Lepper and Bauknecht becoming the second largest European manufacturer by 1988. Aggressive moves were also made by three Italian firms, Merloni, Candy and, more recently, Ocean. Merloni started at the end of the '70s to invest directly in manufacturing operations in Portugal and with targeted acquisitions in the U.K.. In 1988 it then acquired Indesit (I), the third European producer in 1976, and Scholtes (F), strengthening its position in the medium-low range and opening a window in the high range. Candy also moved both within and outside the national borders and by 1988 controlled 7% of the European market. Finally, Ocean first merged with San Giorgio (I), an Italian producer specialized in refrigerators. In 1992 it then
bought SGS-Thompson (once Thomson-Brandt) in an operation which finally marked the demise of the French industry, becoming the fourth European producer.

The '80s were also the years during which U.S. manufacturer re-entered the European market in a move which, coupled with the Electrolux acquisition of the American White Consolidated Industries, marks a concentration of the Major Home Appliances manufacturers at the global scale. In 1988 Philips and Whirlpool formed a joint venture which ultimately dissolved in 1991 with the acquisition of Philips home-appliance division by Whirlpool, making the U.S. manufacturer the largest in the world. In 1985 the U.S. company Chicago Pacific acquired the British Hoover, leader in the washing sector, and was further acquired in 1989 by Maytag. After the acquisition, the group Maytag-Hoover became the 5th world producer.

At the beginning of the 90's, the competitive structure of the industry therefore sees a well identified set of European producers (Electrolux-Zanussi, Bosch-Siemens, Merloni, Ocean-Thompson, Candy) which have survived through the different evolutionary stages and have now reached a substantially critical mass. They have been re-joined in the competitive arena by U.S. manufacturers (Whirlpool, Maytag, GE) who initially dominated the market and pulled out just after the W.W.II considering not promising the growth opportunities of the European markets, and have re-entered through targeted acquisition of troubled large manufacturers such as Philips and Hoover who were not able to make the final transition.

3. The role of technological innovation

Product innovations in the Major Home Appliances evolved around dedicated mechanical solutions and more recently were impacted by the introduction of electronics. Process innovations showed high level of technological inter relatedness and benefited from cross-industry transfers (Rosenberg, 1982). Advancements in the technical characteristics of the products have therefore been less visible to the end-users who have mainly experienced improvements in the satisfaction of
a well defined set of needs. Moreover, product innovations have traditionally been strongly coupled with changes in process technologies.

Aside from any specific case and considering the idiosyncrasies of each different product, however, the technological evolution in the industry up until the '80s could be modeled using established frameworks (Utterback&Abernathy, 1975, Dosi, 1982, Tushman & Anderson, 1986). Product innovation stimulated by new entrepreneurial firms preceded process innovations which became dominant with the increasing role of economies of scale and price competition. The appropriability regimes of process innovation remained weak and different alternatives were experimented by the established competitors. Late movers, however, soon lacked the financial resources and the managerial capabilities to restructure their activities and soon suffered from market saturation. The subsequent concentration process first at the national scale and then at the international scale further triggered systemic changes aimed at better coordinating product and process changes.

Innovations in refrigerators are a good case in point. Already in the '50s, the basic features and technical characteristics had been established for a while. Metal frames were used to support the inner cabin insulated from the outside by fiberglass sheets and containing the heavy compressors used for the refrigeration process. A large size and generally bulky look were the consequences of the size of compressor and the use of fiberglass as insulating material. The first product innovation which deeply affected the product was originally introduced in the U.S. and adopted in the late '50s first by Italian manufacturers. Polystyrene liners were put between the external frame and the inner cell instead of fiberglass, and a polyurethane foam was used to complete the insulation and insure a perfect adhesion among the two. By using dedicated cooking cells to complete the polymerization and further cooling down the assembled product, insulation levels were improved and the overall product size was sensibly reduced. The external frame, in fact, was not supporting the whole refrigerators and thinner panels using fewer welds allowed for smaller units.
The impact of the new technology was increased by the simultaneous changes in manufacturing techniques. Polystyrene was already used by U.S. plants where polymerization occurred in the final phases of the assembly line and represented a bottle-neck for the whole process. The phase required around 8 minutes for each product and intermediate warehouses were used to feed the polymerization cells. The inconvenient was first solved by Ignis in the early '60s by placing the cooking cells on a revolving carousel. Each assembled product was placed in a cell and the foam inserted. The speed of the carousel reflected the polymerization time and allowed for continuous loading, polymerization and unloading, speeding up the whole process.

Paba (1991b) presents a detailed example for refrigerators manufacturing of the coexistence of alternative choices in process technologies and the organization of the work flows (see figure 2). In one case, there was a clear separation among the different phases and production was highly standardized following a Fordist model of line automation. A u-shaped frame was casted and assembled with a back and a top panel, painted and assembled to the inner cell, which was coming from a separate line, then moved to the polymerization phase. External panels and doors were finally added. This method benefited from high economies of scale in each phase but was very rigid.

Insert Figure 2 about here

In a second type of manufacturing process, the external frame was built by using separate panels, thus reducing the complexity of the casting phases and increasing the overall flexibility. Changes could have been arranged by working on the initial cutting and shaping phases where more general purpose equipments were used, making re-tooling easier and faster. An additional phase was required before the insulation one to pre-assemble the external frame. Finally, in the third alternative, pre-painted plastic panels substituted metal ones, eliminating altogether casting and painting phases. In a pre-assembly stage the sides, the bottom and the top panels were put together and the refrigeration cell inserted in the frame for the subsequent foaming and
polymerization. Flexibility was further increased and smaller batches became economically feasible.

The emphasis on flexibility of the third manufacturing process anticipated the next technological challenge faced by the industry. Up to the '70s, in fact, innovation occurred through an interplay of market opportunities and the availability of technical solutions. As much as product innovations in the '50s and in the '60s were favored by a growing demand, cost-reducing innovations in the '70s were the direct consequences of the increased role of internal efficiency in shaping the competitive structure of the industry. Despite its profound changes on the producers side, however, the industry remained substantially stable on the demand side. Preferences in regional markets\(^5\) are still marked. Differences in washing\(^6\) and eating habits,\(^7\) climate,\(^8\) household characteristics and demographics are reflected in persistent heterogeneity among markets and groups of consumers.

The role and direction of technological change, therefore, ceases to be clearly identified in the product or in the process domain. Rather, the interplay between the two becomes the critical path to be explored to leverage on technology and impacts profoundly the internal organizational structure. While a focus on products or processes previously identified the organizational locus of innovation, their interrelatedness challenges existing solutions. The goal is therefore to design organizational structures able to promote the systemic changes required by the contrasting evolutionary patterns of offer and demand.

The producers' response over the years has been a switch from mass production to exploit economies of scale in manufacturing, to flexible automation to promote quick product turn-over and shorter life-cycles. Table 5 reports the number of brands, models and models per brand in the

\(^5\) Regional market usually overlap with national ones, with the exception of Northern Germany, Belgium, Denmark and the Netherlands which show homogeneity of demand patterns.

\(^6\) Southern countries tend to prefer lower spin-speed and to use cold rather than hot water cycles. Northern countries are more environmental conscious and sensible to energy and detergent savings (Pepe, 1988, Baden-Fuller&Stopford, 1991).

\(^7\) Frozen foods market penetration, although increasing, is still quite low in southern countries like Italy or Spain were consumers tend to prefer fresh foods (Marketing in Europe, 1986).

\(^8\) Market penetration of dryers and washer-dryers in southern Europe tend to still be fairly limited. In Italy, for example, recent estimate indicate values around 5% (Marketing in Europe, 1994).
UK washing machine market between 1976 and 1987. It shows that within ten years the number of models per brand increased from 2.4 to 5.6, despite an increase in the number of brands from 22 to 36.

Insert Table 5 about here

In a recent study on the computer industry Pine (1993) used the term mass-customization to identify these seemingly contrasting evolutionary patterns of offer and demand. On the one hand, the structure of the offer is shaped by the increasing role of technological intensity. On the other hand, demand becomes more sophisticated and heterogeneous, or like in the European Major Home Appliances industry maintains these characteristics typical of initial stages. To successfully face this environment, producers need to switch from scale to flexibility on the manufacturing side and to invest accordingly in product development activities. Small batches and shorter life-cycles represent the boundaries of development activities which have to privilege product families with a long-lasting technological core to be "re-freshed" periodically through subsequent minor changes. Self-cannibalization of products becomes not only theoretically justified, but operationally optimal to saturate manufacturing capabilities.

4. The changes of organizational structures

The structural evolution of the industry and the changes in the sources of competitive advantage are reflected to a great extent in the evolution of the organizational forms adopted by Major Home Appliances manufacturers. After the determinant role of entrepreneurial new entrants filling the gap generated by the contemporaneous market growth and the exit of the major U.S. manufacturers...
multinationals, the increasing importance of scale efficiencies and the following national concentration of producers initiated a series of profound organizational changes. Internationally oriented groups started to emerge leveraging on a strong home-based position. Divisionalized forms able to cope with a widened product line and to face inter-country differences in marketing operations were quickly adopted by all major competitors.

In general, however, all the major groups were strongly localized during the '70s. Integrated producers tapping more aggressively international markets were still relying on highly centralized staffs located in the original home-base where, frequently, also manufacturing activities continued to be concentrated due to the relatively low transportation costs. Such strongly localized structure was even more evident in the case of niche producers, which were also characterized by a naturally lower level of functional articulation.

An exception to these patterns was Electrolux. Characterized by a traditionally weak position in the European markets because of a limited internal market which did not foster investment in manufacturing, the Swedish group started to grow through a series of strategic acquisitions during the '70s. This strategy ultimately led to the acquisition of Zanussi in Europe and of White Consolidated Industries in the U.S. making Electrolux the second world producer of home-appliances. Within this success story apparently simple in its main elements lay several interesting elements for a deeper analysis of the organizational implications of the evolution of the industry.

By 1984, the first three producers accounted for 48% of the European market, while in 1970 they accounted for 34% of the market and in 1964 for only 19% of the market. The increased concentration, however, did not occur through aggressive internal investments. On the contrary, firms gained market share by directly buying weaker competitors. This process of growth is typical of mature oligopolies where sunk costs represent significant barriers to exit even for highly inefficient firms. While short term fluctuations are possible, in fact, long term stability of market share distribution is characteristic of this type of industry structure, making market share the main tradable asset. The acquisition process of Philips by Whirlpool through a creation of a Joint
Venture subsequently bought out by the U.S. partner is a recent example. The pattern, however, is common to all the major competitors still operating in the industry. Table 6 reports data on the changes in market share of the first ten companies in 1990 over the last two decades distinguishing between internal and external growth and shows the absolute relevance of this mode of growth.

The organizational consequences of the growth through external acquisitions are reflected in major restructuring actions. On the one hand, the excess of manufacturing capacity requires post acquisition rationalization of production activities. On the other hand, similar actions are more difficult with respect to brands. The main motivation of external growth, in fact, is the acquisition of such assets. The consequent proliferation of brands is common to all groups and indirectly reflects the impact of a localized and fragmented demand on the internal organization of the multinational. Group-level brands co-exist with national ones and marketing activities are in between a centralized organizational model more typical of globalized businesses and the geographically localized ones, typical of traditional multi-national structures. Macro-organizational structures therefore present high levels of integration of technical functions (R&D, Product and Process Development units, Manufacturing) usually grouped by product lines (e.g. washers, refrigerators, cookers), and a more dispersed marketing structure, with central units responsible for brand strategies and local units in charge of specific geographic areas. Such structures might also be strongly geographically localized (i.e. Merloni) or more widespread around Europe (i.e. Electrolux).

The implementation of these organizational structures represent a major challenge. Competitive analysis shows not only the importance of internal efficiency in the new scenario, but also the role of flexibility, to reach a widespread market presence, and creativity, to quickly and constantly rejuvenate the offer. Internal and external coordination mechanisms are therefore the central elements to be leveraged (Ghoshal & Bartlett, 1993). In particular, product development
activities become the institutional environment for the experimentation and the implementation of such coordination mechanisms which have to be necessarily cross-functional both vertically and horizontally.

On the one hand, in fact, product and process development need to be pursued jointly to form the technical base of a diversified offer with life-cycles shifted to the family level and series of product substitutions anticipated to direct manufacturing investments. New products not only need to be modular in concept, but also their modules needs to be considered as potential sources for further innovation. Architectural changes (Henderson & Clark, 1990), therefore, become the natural evolutionary trajectory.

On the other hand, such technical considerations need to be directed by strong market feedback reflecting marked geographical differences. Such variations become a source of ideas and stimuli and at the same time indicate the necessary boundaries of the developmental activity. Contrary to traditional models of multinationals (Stopford & Wells, 1972, Hennart, 1982), though, inter-unit contacts cannot be identified unequivocally as hierarchically determined. Rather the changing nature and interdependence of the tasks requires structuring investments in coordination mechanisms such as inter-country/inter-functional personnel rotation, specific groups devoted to foster internal knowledge and the like (Ghoshal & Westney, 1993). Structural flexibility promoting internal learning processes is therefore the result of process rather than structure design to tackle the increased level of internal and external interdependency.

5. Conclusions

In this paper I presented the structural evolution of the European Major Home Appliance industry through four phases: (1) the *entrepreneurial* phase from after the W.W.II to the late '50s, when demand growth, inter-country trade barriers and the pull-out of U.S. companies favored the entrance of several new companies, (2) the *national concentration* phase in the '60s, when concentration processes occurred in all the major countries, (3) the *internationalization* phase in the
'70s, where increased market saturation and lower trade barriers favored scale-based competition and widened the geographical areas targeted, (4) the international concentration phase during the '80s, where the established competitors reached the current Europe-level oligopolistic structure through aggressive acquisitions and internal re-organization.

The analysis highlighted several academically and managerially interesting elements. First, the industry at the inter-country level evolved according to dynamic models usually observed at the country (Carroll & Swaminathan, 1992), or at the regional level (Baum & Mezias, 1992). Inter temporal differences characterized the emergence of evolutionary patterns first at a national level and then at an international level with changes in the structural characteristics of the environment (e.g. lower trade barriers) showing interdependencies with the organization of economic activities. Moreover, the process seemed to favor first local optimization and subsequently general optimization, suggesting to investigate evolutionary processes not only over time, but also over space and to focus on the importance of enlargements or restrictions in the competitive space. Together with additional insights on evolutionary-base models, such evidence will provide important insights for policy-makers involved in the identification of new institutional framework to govern the geographical extension of markets.

Second, the role of technological innovation in addressing organizational choices confirmed the cyclical interactions between product and process innovation. Yet, it also provided additional evidence for the need for better frameworks to encompass the management of innovation processes facing at the same time the constraints of large scale manufacturing, and the opportunities of creative product differentiation. Regardless of its functional source, whether on the demand or on the technology side, mature mass-markets seem to converge consistently towards highly fragmented and temporarily unstable patterns of consumption. Contingency approaches to environment characteristics are therefore challenged by the interdependence of previously orthogonal dimensions.

Third, the response of European Major Home Appliances manufacturers to these challenges has been a constant shaping of internal structures around the technological base required to achieve
competitive advantage. Failures along these strategies resulted in exits at different times. At present, the element to be learned from this specific case lay on the focus of managerial intervention. Structures cease to be focus of organizational design in favor of processes. The contemporary need for size and scope is not achieved merely by functional or geographical separation, but is rather fostered through increased inter-unit coordination. Electrolux for example, has organized its Major Home Appliances business around three product divisions (the "wet", the "cold" and the "hot" divisions) which are responsible for the whole development process and for the subsequent manufacturing, and have to coordinate with separate marketing units organized geographically and responsible for the distribution, advertisement and post-sales assistance, which respond to the central strategic marketing unit. Specific activities, such as product development, where all the different and frequently contradictory task characteristics are conveyed become the institutional environment to shape the internal structure of the organization and to adapt it to the changed nature of the external environment.
References


Il Solre 24-Ore. 1992. La Zanussi accelera la corsa tecnologica, 30/7.


Marketing in Europe. 1994. Washing machines, tumble-dryers and dishwashers in Italy. 50-64.


## TABLE 1

Size differences of national producers in 1964 (thousands of units)

<table>
<thead>
<tr>
<th></th>
<th>France</th>
<th>West Germany</th>
<th>Italy</th>
</tr>
</thead>
<tbody>
<tr>
<td>First producer</td>
<td>300</td>
<td>600</td>
<td>820</td>
</tr>
<tr>
<td>First three producers average</td>
<td>247</td>
<td>550</td>
<td>690</td>
</tr>
<tr>
<td>First ten producers average</td>
<td>178</td>
<td>315</td>
<td>375</td>
</tr>
<tr>
<td>Overall average</td>
<td>107</td>
<td>185</td>
<td>196</td>
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</table>

## TABLE 2

Italian manufacturer's market share in refrigerators and washers: 1964-1970

<table>
<thead>
<tr>
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<td></td>
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<tr>
<td>West Germany</td>
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<td>18</td>
<td>27</td>
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<tr>
<td>France</td>
<td>15</td>
<td>34</td>
<td>41</td>
<td>47</td>
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<td>U.K.</td>
<td>5</td>
<td>10</td>
<td>26</td>
<td>24</td>
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<tr>
<td><strong>Washers</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>West Germany</td>
<td>-</td>
<td>14</td>
<td>26</td>
<td>28</td>
</tr>
<tr>
<td>France</td>
<td>-</td>
<td>11</td>
<td>14</td>
<td>14</td>
</tr>
<tr>
<td>U.K.</td>
<td>-</td>
<td>3</td>
<td>8</td>
<td>8</td>
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Source: (Paba, 1991b)
### TABLE 3
Refrigerators and Washers Market saturation levels (%) by country: 1956-1984

<table>
<thead>
<tr>
<th></th>
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<td></td>
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<tr>
<td>Italy</td>
<td>2.8</td>
<td>48.0</td>
<td>62.0</td>
<td>74.0</td>
<td>83.0</td>
<td>90.0</td>
<td>94.0</td>
<td>97.0</td>
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<td>53.0</td>
<td>63.0</td>
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<td>83.0</td>
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<td>n.a.</td>
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<td>n.a.</td>
<td>71.0</td>
<td>93.0</td>
<td>98.0</td>
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<td><strong>Washers</strong></td>
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<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
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<td>68.0</td>
<td>90.0</td>
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<td>40.0</td>
<td>44.0</td>
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<td>60.0</td>
<td>80.0</td>
<td>84.0</td>
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<tr>
<td>West Germany</td>
<td>16.0</td>
<td>46.0</td>
<td>56.0</td>
<td>66.0</td>
<td>74.0</td>
<td>78.6</td>
<td>89.0</td>
<td>90.0</td>
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<tr>
<td>U.K.</td>
<td>24.6</td>
<td>58.0</td>
<td>n.a.</td>
<td>64.0</td>
<td>n.a.</td>
<td>67.0</td>
<td>79.0</td>
<td>80.0</td>
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### TABLE 4
Concentration indexes of the European White Goods Industry: 1964-1984

<table>
<thead>
<tr>
<th>Index</th>
<th>1964</th>
<th>1970</th>
<th>1976</th>
<th>1984</th>
</tr>
</thead>
<tbody>
<tr>
<td>Herfindhal-Hirschman</td>
<td>0.0276</td>
<td>0.0583</td>
<td>0.0689</td>
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<td>First producer share</td>
<td>7.30</td>
<td>15.29</td>
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<tr>
<td>First 3 producers share</td>
<td>18.65</td>
<td>34.08</td>
<td>35.18</td>
<td>47.63</td>
</tr>
<tr>
<td>First 10 producers share</td>
<td>45.14</td>
<td>61.57</td>
<td>70.89</td>
<td>82.14</td>
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</table>

Source: Paba, 1991b.
### TABLE 5

<table>
<thead>
<tr>
<th>Year</th>
<th>Brands</th>
<th>Models</th>
<th>Models per Brand</th>
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</thead>
<tbody>
<tr>
<td>1976</td>
<td>22</td>
<td>52</td>
<td>2.4</td>
</tr>
<tr>
<td>1977</td>
<td>23</td>
<td>67</td>
<td>2.9</td>
</tr>
<tr>
<td>1978</td>
<td>23</td>
<td>68</td>
<td>3.0</td>
</tr>
<tr>
<td>1979</td>
<td>25</td>
<td>73</td>
<td>2.9</td>
</tr>
<tr>
<td>1980</td>
<td>28</td>
<td>77</td>
<td>2.8</td>
</tr>
<tr>
<td>1981</td>
<td>34</td>
<td>107</td>
<td>3.2</td>
</tr>
<tr>
<td>1982</td>
<td>34</td>
<td>121</td>
<td>3.6</td>
</tr>
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<td>1983</td>
<td>38</td>
<td>140</td>
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</tr>
<tr>
<td>1984</td>
<td>37</td>
<td>152</td>
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<td>5.1</td>
</tr>
<tr>
<td>1987</td>
<td>36</td>
<td>201</td>
<td>5.6</td>
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</table>

Source: U.K. Consumers' Association Reports (reported in Baden-Fuller and Stopford (1991)).

### TABLE 6

<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td></td>
<td>mkt. share</td>
<td>mkt. share</td>
<td>Δ ext.</td>
</tr>
<tr>
<td>Electrolux</td>
<td>1.78</td>
<td>2.29</td>
<td>0.87</td>
</tr>
<tr>
<td>Philips-Whirlpool</td>
<td>0.59</td>
<td>10.72</td>
<td>9.49</td>
</tr>
<tr>
<td>Bosch-Siemens</td>
<td>5.33</td>
<td>8.20</td>
<td>1.83</td>
</tr>
<tr>
<td>Merloni</td>
<td>2.37</td>
<td>2.24</td>
<td>0.00</td>
</tr>
<tr>
<td>Candy</td>
<td>3.73</td>
<td>3.85</td>
<td>0.12</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>mkt. share</th>
<th>Δ ext.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrolux</td>
<td>22.73</td>
<td>18.84</td>
</tr>
<tr>
<td>Philips-Whirlpool</td>
<td>13.18</td>
<td>2.46</td>
</tr>
<tr>
<td>Bosch-Siemens</td>
<td>12.27</td>
<td>0.00</td>
</tr>
<tr>
<td>Merloni</td>
<td>11.36</td>
<td>9.12</td>
</tr>
<tr>
<td>Candy</td>
<td>6.36</td>
<td>1.44</td>
</tr>
</tbody>
</table>


*Δ ext.* Estimated percentage growth through external acquisition.
FIGURE 1
Percentage of Italian exports over total production by product type: 1956-1975

FIGURE 2
Three different refrigerators manufacturing processes in the '70s