Resource coordination and Business Model Renewal process.
A System Dynamics analysis of the Aluminium Downstream Industry

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Abstract

The paper analyses processes of business model redefinition, in particular it explores the effects of resource coordination mechanisms between firms and their strategic suppliers in a certain industry. The paper presents a System Dynamics model built on an extensive empirical set represented by the Italian window industry and it explores business model renewal of aluminium window producers supported by aluminium systems suppliers.

1. Business model redefinition and resource dynamics

Process of business model redefinition attracted the attention of strategic management scholars, in particular of those interested in the understanding of strategy renewal processes of established firm operating in mature businesses [Baden-Fuller and Pitt, 1995, Markides, 1999]. Strategy renewal process implies the redefinition of business model, because it determines certain structural change in the organization and the processes and requires durable changes in the resource set on which the firm builds its competitive advantage [Helfat et others, 2007].

Strategic innovation and business model redefinition are the result of precise firm's choices. According to some scholars firms are inert to adapt and thus, after an environmental change, only the appropriate organizational forms will fit the environment [e.g. Hannan and Freeman, 1989], while other retain that that firms are able to transform and match the environmental change, eventually to influence industry structure evolution [D'Aveni 1995, Markides 1997 and 200].

The redefinition of positioning with innovative strategies can bring, in the long run, to promote industry structural changes. Generally process of imitation of the innovator's strategies act as a reinforcing loop that spread business model redefinition process among competitors [D'Aveni 1999].

Business model redefinition process are strictly related with process of new resource development [Grant, 1996, Teece, 1997]. The innovators that start a competitive escalation try to destroy the position of an industry leader by changing the industry's critical success factors to make the leader's resources obsolete [Collis, 1991].

Innovative strategies are based on the ability of the firm to leverage on resources and competencies to generate innovation in products and processes [Cockburn and Henderson, 1994; Zott, 2003]. A strategic innovator must develop a set of resources that in some way can anticipate the evolution of industry and so the evolution of the critical resource set [Mahoney, 1995]. Cockburn, Henderson and Stern [2000] argued that the ability of the firm to generate new strategy is related to the possession of a distinctive set of resources. Once the new strategy has been implemented followers quickly start to develop a set of resources to develop the successful strategy, so the innovator's original set of resources becomes obsolete and the company must renew it [Helfat and Peteraf, 2003]. Teece [2007] argues that in order to sustain the competitive advantage in rapidly changing environments a firm should own not only inimitable and no-substitutable resources, but also difficult-to-replicate dynamic capabilities that allow resources combination.

Resource development is a critical issue in business model redefinition process, usually firms can develop resources internally or can acquire them from competitors or from the market, or, finally they can develop leveraging on collaborations with competitors, suppliers, or customer. Collaboration implies the implementation of certain coordination mechanisms to discipline critical aspects like: information exchange, co-investment, human resources mobility. Resource coordination effects on business model renewal are a quite intriguing question. In particular we are interested in understanding if resource development coordination can enable the company to renew more effectively its business model. To investigate the issue we developed a System Dynamics model [Forrester 1961, 1968; Sterman, 2000] to represent the evolution of a certain industry and to investigate the business model renewal process inside of specific group of firms (strategic group). The choice of modeling (and in particular of System Dynamics methodology) has been determined by the following reasons: first business model evolution and industry transformation are dynamic processes characterized by self reinforcing mechanisms, secondly the model allows us to simulate the effect of strategic alternatives, in particular we can explore if collaboration helps competitors to renew the business model, and what kind of collaboration is the most effective for the business model renewal.

The paper is structured as follow: after the illustration of the empirical context of the study, we present the structure of the model, then we focus on simulations results, the last part is dedicated to the discussion of strategic implication of the simulations.

2. The empirical context

The empirical context on which we have built our System Dynamics model is the Italian window market for residential and non residential buildings. The market is characterized by the presence of 4 strategic groups of companies specialized in a particular material for window making: aluminium (alu), wood, PVC and aluminium-wood (alu)-wood windows manufacturer. In particular we focused on the business model renewal of the strategic group of alu window manufacturers, that, have the second largest market share in the industry and the highest profitability, however they are under the threat of PVC window manufactures.

The model was built on data provided by an in-depth industry analysis. We created a sample of 152 firms (manufacturers of alu, wood, alu-wood or PVC windows) that represents the 15% of the global window industry in Italy, we collected and analyzed 9 year of balance sheet and profit and loss report for all firms in the sample. Using the economic data we performed the following analysis: profitability, grow, financial structure, investments, cost structure.

We collected the same data for the strategic suppliers in the alu and PVC market the so-called system suppliers (system are the profiles made of alu or of PVC used to build the window frames), we analyzed a sample of 7 alu-system suppliers (that represent an estimated 70% of the alu system Italian market) and a sample of 4 PVC system suppliers (that represent an estimated 90% of the PVC system Italian market). We focused on cost structure, growth and profitability analysis for system suppliers. We collected qualitative data on alu window manufacturer through an extensive questionnaire filled by 94 firms. 8 semi structured interviews with industry expert where used to assess the model structure. We collected data on window prices through 22 structured interviews to producers and dealers.

2.1. Industry long term evolution and the rise of PVC windows

The market long term evolution shows an extraordinary progression of PVC that, in few years, increased its penetration in the Italian market from 10 to 15% with a growth rate from 2002 to 2009 of 83% respect to the 43% of alu and the 37% of wood (Figure 1).

PVC windows were introduced in Italy at the end of ‘90s and become wide diffused specially in the final consumer market (in residential new buildings and renovation) thanks to an efficient distribution network of independent dealers (showrooms). Actually PVC products are encountering a positive diffusion trend also among the business consumers (in residential and non residential buildings new and renovation). Business consumer are served directly from PVC windows manufacturers and through the distribution network.

PVC windows have a strong price advantage 350 Euros per window unit (final price to the final customer), against 450 of alu and of alu-wood windows and 400 Euros of wood windows. Because of better thermal insulation performance of PVC, with the increase of thermal standard regulation the price advantage of PVC windows will increase especially with respect to aluminium products.

2.2. Business models comparison

In the Italian market the alu production system is characterized by the presence of more than 12.000 small firms that produce alu windows, for an estimate turnover in 2009 of around 2.6 million, only 350 firms have relevant dimensions (an average of 14 employees) and a well established industrial structure. Alu window manufacturers are characterized by a business model that can be defined “flexible business model”, for this they produce mainly windows, but also have a relevant production of curtain walls and metal works, they also produce or sell complementary products like steel windows, however alu windows and curtain walls represents more than 60% of their turnover. Alu window producers adopt a direct distribution structure (they don’t use intermediaries) and sell product mainly on local and regional basis serving residential and non residential market, retail customers (final consumers) or business customers.

PVC, wood and alu-wood producers, adopted a different business model, they have, on the average, greater dimensions with respect to alu windows manufacturers (24.000 window unit produced per year against 17.000 of wood manufacturers and 9.000 of alu window manufacturers) they have a strong a production specialization on a well defined product line. They invested in mass automated production and in marketing to develop a proprietary brand, they operate on the entire national market, sometimes on the international market, with a network of independent or controlled dealers.

The relation between strategic supplier (supplier of profile systems) and window producers present some interesting differences. Alu system suppliers has an important role because they design not only aluminium profiles but also a dedicated assembling technology (proprietary fittings) and they provide an infinite number of design variants to alu window manufactures that enable them to make customized products. On the average alu system suppliers are 10 times larger of alu manufactures and they have a profitability (EBIT) higher of 30% than their customers.

Wood, alu-wood producers and some PVC producers usually have their own profile systems and use commercial assembling technology (commercial fittings) so they do not have to rely of system suppliers, they externalize the system production but not the design and the technology. A large number of PVC manufactures adopt PVC systems designed by few large suppliers, however the PVC system are much more standardized than alu-one, they are sold with few customization possibilities and they can be assembled with commercial assembling technology not provided by system suppliers.

The relation with system suppliers has important implications on the cost structure. In terms of unitary cost structure breakdown the alu windows evidences a strong difference in the unitary cost of raw materials (profile systems, fittings and glass) with respect to PVC and wood. For example: for an 800X1300 mm standard window the cost of raw material in the case of PVC is around 90 Euros, 60 of which for the profiles, against more than 200 Euros for the alu windows, 130 of which for alu profiles. A wide portion of the alu window value chain is out of the control of windows manufacturers and is managed by alu system producers, this limits the possibility of alu window manufacturers to reduce industrial cost and to devote major resources to the development of a distribution network.

2.3. Towards a new business model for alu window manufacturers

Alu window manufacturers can renew their business model to effectively compete with other materials and in particular with PVC manufacturers improving their production efficiency and investing in commercial development. Alu windows manufacturers should increase the firm dimension to exploit the opportunities given by mass production ad automation, however this innovation can have significant effects on unitary production costs only if it is combined with a complete redefinition of the alu systems that should be optimized for mass production (eventually scarifying the customization possibilities). This technical optimization should bring to the reduction of raw material cost per window unit. The reduction of unitary industrial costs will enable the alu window producers to invest in commercial development and to leverage on price to sell to business consumers (construction companies and real estate developers).

The alu window manufacturer business model renewal implies the active involvement of alu system producers also establishing alliances and joint ventures. In any case the process requires resource sharing, first of all of technical (product and process) know-how. Window producers should guide system producers in the redefinition of system characteristics to be more compatible with mass automatic production. System producers should have tangible advantage if they support the renewal of their customers' business model, because this process will bring to have less alu-window manufacturers but of larger dimensions, that should be able to defend and acquire market share versus PVC and Wood.

In this context clearly emerges the critical importance of resource coordination for an effective business model renewal process, our model tries to investigate the issue showing effects on profitability and on growth of coordination strategies.

3. The structure of model

The model has the objective of analyzing the impact of a coordination strategy between manufacturers of aluminium windows (alu window manufacturers) and producers of aluminium systems (alu system producers), aimed at increasing the penetration of aluminium windows and the operating profitability of companies in the aluminium sector.

The data used for the construction of the model refers to the above mentioned sample of companies that manufacture windows (Aluminium, Wood, PVC and Aluminium-Wood). From this point of departure, income statements by company-type in the different sectors were reconstructed: Aluminium, Wood, PVC and Aluminium-Wood. Subsequently, the impact on income statements and market share of two types of events was simulated:

1. a change of configuration of the competitive environment;
2. a change of the competitive strategy of manufacturers of aluminium windows.

The model consists of five macro areas (Figure 2):

1. the market;
2. the Aluminium window supply system (alu-windows);
3. the Wood window supply system (wood windows);
4. the PVC window supply system (PVC windows);
5. the Aluminium-Wood window supply system (alu-wood windows).

The four macro areas that encompass the supply system can be further divided into (Figure 3):

1. a section that describes the production policies;
2. a section that describes the marketing policies.

The "production policies" sub-section includes three potential areas for action:

1. definition of the production scale;
2. definition of investments in industrial automation;
3. definition of investments in the industrialization of the semi-processed product (alu system profiles).

The “marketing policies” sub-section has two possible areas of intervention:

1. definition of marketing investments aimed at building the brand;
2. construction of a distribution network through a commercial intermediary.

The supply systems relating to the various products are compared on the market, providing a response in terms of differential advantages in respect to alternative products. This response consists in the acquisition or loss of market share. The response received from the market constitutes essential feedback to steer strategic behaviour for two reasons:

1. A positive response provides resources to strengthen a particular strategy
2. A negative response provides information to adjust the strategy

Two stock variables, representing the potential market and users of windows, constitute the market. The purchasing rate moves potential users from the Potential Market stock to the User stock. The disposal rate of the product, which depends on its average lifetime, moves users from the User stock to the Potential Market stock because when users dispose of the product they become potential users once again (Figure 4).

Elasticity of demand is used to transform the relative performance of different products on the market into differential advantages that accordingly influence the market share dynamic. Elasticity of demand explains how purchasing behaviours react to the differences that consumers perceive between competing products (Figure 5).

Extending the concept of elasticity of demand to price, in the model we also consider elasticity of demand in relation to the relative change in other aspects of the offer:

1. elasticity to changes in thermal performance (thermal insulation performance);
2. elasticity to changes in investments in building a product brand;
3. elasticity to changes in investments in the construction of a distribution network for the product.

The model allows modifying the hypotheses on the relative weight that consumers assign to the various aspects of the offer by changing the relative weight of the various elasticities. To vary the relative weight of the different elasticities a parameter α was created that expresses the relative weight of each form of elasticity.

3.1. Feedback loops

The analysis of the equations model constructed highlights several feedback loops that are responsible for key strategic dynamics. In particular, these loops highlight the trade-off between the effects of strategic decisions that unfold over the long term and effects that occur in the short term.

The analysis of the feedback loops suggests that some strategic decisions necessary for the construction and defence of competitive advantage in the aluminium window sector generate the desired effects only in the long run, instead producing negative effects in the short term. This temporal distribution of the consequences of decisions could discourage the development of strategies that would instead be desirable.

The simulation model allows assessing to what extent and how quickly these strategic decisions produce positive effects.

Producing a temporal distribution of the consequences of certain strategic decisions, the simulator allows us to understand to what extent the deterioration of economic-financial indicators is functional to the improvement of competitive positions in the long run.

Short-term negative feedback loops

To survive competitive pressure from replacement products in the short term, manufacturers of aluminium windows are facing the need to invest in product technology, in production scale and in marketing.

These investments translate in the short term into higher costs (in terms of amortization), which reduce company revenue, decrease liquidity and, consequently, self-financing capacity (Figure 6).

Long-term reinforcing feedback loops

In the long run, investments in technology (e.g., automation of industrial processes), in production scale and in marketing, produce returns that result in the company's more competitive cost structure (Figure 7).

The most efficient cost structure sustains firm profitability and increases its self-financing capacity.

Self-financing capacity leads the firm on a path of virtuous growth
EBIT → self-financing → investment → efficiency → EBIT.

4. The scenarios and simulations

The model aims to investigate, by means of specific simulations, how a medium to long-term coordination strategy between window manufacturers and system producers can be achieved, taking into account that the short-term investments needed to implement such a strategy could affect both the turnover and profitability of the actors involved.

Our model is a causal descriptive model built on empirical data, so we conducted with positive outcomes s certain structure-oriented behaviour tests to assess the internal validity of the model [Barls, 1989]. Once the validity has been assessed the simulation took different scenarios into consideration, we choose to discuss the base scenario and the industrialization scenario (Figure 8).

Base Scenario, The evolution of energy saving regulations

First, tougher standards for energy efficiency were simulated that would force window manufacturers to develop new products and eliminate some of the products currently on offer. This simulation showed that due to the unfavourable cost structure of aluminium windows compared to PVC and Wood, the manufacturers of aluminium windows and aluminium system producers would suffer a drastic reduction in operating profits. The increase in the cost of materials needed to adjust the thermal performance of aluminium windows from 1.8 Uw to 1.6 Uw was analyzed (Uw is the unit of measure of the thermal insulation of a construction product, the lower is the level, the lower must be the thermal dispersion/emissions). In the pessimistic hypothesis, the cost of materials increases by around 16%, while in the optimistic hypothesis this increase is contained to just under 10%. In the pessimistic hypothesis, the average operating income of companies producing window frames will decrease by 120%, producing, in the absence of adjustments, an operating loss. In the optimistic hypothesis, however, the average operating income will decrease by 60% (Figure 9). Taking this as the baseline of reference, an industrialization scenario was developed that considers the implementation of coordination strategies between manufacturers of aluminium windows and aluminium system producers.

Industrialization scenario. Adoption of growth strategies and product industrialization

The scenario foresees that companies producing aluminium windows increase their production capacity and invest in manufacturing automation processes.

At the same time, we consider the hypothesis that aluminium system producers invest in redesigning the alu profile systems with the aim of making the production processes of window manufacturers more efficient. In this scenario, we introduce the concept of technological benchmarks. The technological benchmark indicates the maximum level of technological innovation of the production processes that can reasonably be achievable by the firms.

The technological benchmark was defined through a field analysis of the production processes and interviews with industry experts. Based on these interviews and the direct analysis of the processes, we defined the possible evolution of the technology and the possible impact of these investment processes on the cost structure of the business in the long and short term. In particular, we started by identifying the most advanced technology adopted by firms and used that technology as the benchmark. The distance between the technological benchmark and the current level of technology is estimated by evaluating the effort required by the firm, both financial and organizational, to reach the benchmark.

4.1. Hypotheses characterizing the industrialization scenario

The hypotheses that characterize the industrialization scenario can be summarized as follows:

Hypothesis 1.

Window manufacturers can increase production capacity up to 30,000 window units per year and do so according to a specific growth curve (Figure 10) this will reduce the incidence of their fixed costs from 27% of their turnover to the 20% of their turnover as effect of scale economy, we calculated the data observing the five largest wood windows manufacturers in our sample that have a production scale of around 30.000 windows per years.

Hypothesis 2.

Aluminium window manufacturers can vary their technological investments in automation processes and are able to reach the technological benchmark in the course of a year. The automation benchmark expresses the maximum level achievable during the course of automation of the production processes. The distance between the technological benchmark and the current level is estimated by evaluating the effort, financial and organizational, needed by a firm to reach the benchmark. In the graph (Figure 11), covering the distance between 0 and 1 therefore means having conferred all the financial and organizational efforts required to reach the benchmark. The investment in industrial automation reduces the percentage weight of labour costs as hypothesised herewith:

- OPTIMISTIC HYPOTHESIS: Possible cost reductions up to 40%;
- PESSIMISTIC HYPOTHESIS: Possible cost reductions up to 15.

Hypothesis 3.

Aluminium system producers can make technological investments in the industrialization processes of the semi-processed product (alu-profiles) aimed at reducing the unit cost of materials in the following ways (Figure 12):

- OPTIMISTIC HYPOTHESIS: Possible cost reductions up to 40%;
- PESSIMISTIC HYPOTHESIS: Possible cost reductions up to 10%.

The benchmark for industrialization of the semi-processed product expresses the maximum level reached in the course of integrating upstream and downstream production processes. We refer to investments by system producers to facilitate the integration of their semi-processed product in the window manufacturers' production process. The distance between the technological benchmark and the current level of technology is estimated by evaluating the effort, financial and organizational, needed by the company to reach the benchmark. In the graph (figure), covering the distance between 0 and 1 therefore means having conferred all the financial and organizational efforts required to reach the benchmark.

Hypothesis 4.

In analyzing the implications of a growth and industrialization strategy, we evaluate two hypotheses concerning coordination between the technological investments of window manufacturers and system producers.

1. COORDINATION HYPOTHESIS: Window manufacturers and system producers meet their respective technological benchmarks between the first and second year in a coordinated manner. Specifically, system producers

reach the semi-processed product industrialization benchmark and window manufacturers reach the automation benchmark.

2. NON-COORDINATION HYPOTHESIS: System producers reach the semi-processed product industrialization benchmark between the second and third year while window manufacturers reach the automation benchmark between the first and second year.

Hypothesis 5.

The model considers that consumers (in all segments of the market) give equal weight to all aspects of the offer (price, tradition, brand, role of the intermediary, thermal performance). In particular, we hypothesized that in the first year of simulation, the market moved from a situation in which consumers adopt purchasing behaviour induced by tradition (i.e., repeating previous buying patterns) to a situation where consumers are beginning to carefully consider all the aspects of the offer and assign them the same weight. Of course, among the aspects considered tradition is still included, which operates through the pressure that the differential diffusion of the various products (word of mouth and imitation of consolidated purchasing behaviours) exerts on the purchasing decision.

In this scenario, different pricing strategies were tested by varying the price of the finished aluminium product specified by window unit.

4.2. Results of the simulation of the industrialization scenario

To observe the possible evolutions of the growth and industrialization strategy a series of simulations were carried out by assigning different values to the parameters of the model.

In particular, attention was focused on three elements:

- different hypotheses on the cost structure (optimistic, pessimistic);
- different hypotheses on the pricing strategy of windows (p= €350 per window unit and p= €450 per window unit), where p=€350 is the reference price of PVC window unit;
- level of coordination (coordination present or absent) between the technological investments of window manufacturers and system producers.

Average company turnover and operating income (price = 450)

The simulations obtained by alternating the optimistic and pessimistic scenarios and maintaining the same price strategy (p= €450) were compared (Figure 13). As in the three scenarios only the cost structure varied, turnover remains the same while the operating income changes. To be noted is that the operating income decreases drastically and becomes negative in the period of adjustment in which the amortization cost of investments and increased overhead and personnel costs resulting from increased production capacity are manifested. This decrease is the same in both scenarios. The difference between the scenarios emerges when the operating income begins to rise again as the scenarios differ precisely in the capacity attributed to the company to increase efficiency following the investments.

The conduct of average turnover can be explained by referring to two ongoing processes. In the first quarter of the simulation, the average turnover slightly reduces due to the loss of one percentage point of market share as a result of competition from other materials.

Subsequently, average turnover starts to rise again because of the selection that takes place in the aluminium window manufacturer sector, where, due to the increase in average production capacity and increased competitive pressure, the number of firms decreases and thus the average revenue increases of firms that survive in the sector.

Market share (price = 450)

In the first quarter of the simulation, market share of the four products substantially converge (Figure 14). In particular, Wood loses market share and market share of aluminium windows decreases by around one percentage point. This evolution is the result of the simulated situation where we hypothesized reducing the weight that consumers ascribe to tradition. In other words, consumers tend to focus greater attention on the aspects of the offer (price, thermal performance, brand) while reducing the inertia that leads them to repeat past purchasing behaviours. This market share reorganization follows the hypothesis that consumers evaluate the price, tradition, brand and thermal performance characteristics in the same way. From this perspective, the Wood product has no particular advantages and, therefore, can not maintain its competitive position in light of the fact that the selling price is higher than, for example, that of the PVC product. In other words, if we eliminate from our analysis the role of tradition, the advantage increases of those products that are newly introduced on the market and that are (as in the case of PVC) competitively priced. In this sense, the loss of market share of the aluminium product that is priced much higher than the PVC product is explained.

Evolution of the number of firms (price = 450)

As concerns the demographic dynamics of the firms, the aluminium sector is certainly the most penalized. Aluminium window manufacturers are either small or very small in size and are much more numerous compared to producers of Wood, PVC and Aluminium-Wood windows. The average production capacity of aluminium window manufacturers is around 9,000 units per window per year against the average of Wood, PVC and Aluminium-Wood window manufacturers that ranges between 15,000 and 30,000 units per window per year (Figure 15).

The increase in average production scale thus triggers a selection process among aluminium window manufacturers leading to the disappearance of 70% of companies and causing this segment to resemble competitors more closely in terms of both average production capacity and number of manufacturers on the market.

Average turnover and operating income (price = 350).

The reduction in price of aluminium windows is a feasible scenario in light of the strategies implemented in the sector by some PVC and Wood window manufacturers and due to the reduction in demand linked to the slowdown in the construction industry. The voluntary price cut from €450 to €350 per window unit results in a dramatic decrease of revenue and operating income, becoming negative for a much longer period of time with respect to adopting a p=€450 price strategy (Figure 16). With the p=€350 price strategy per window unit, in the case of the pessimistic hypothesis on cost structure, we return to a similar operating income level to that at the start, namely, before the investment processes in increasing production capacity and in technology. In this pessimistic case, therefore, the investment strategy would appear to be the way to maintain the current level of income in a sector that is undergoing a profound process of transformation.

Market share (price = 350)
The price decrease would result in a substantial holding of market share for aluminium products (Figure 17). Compared to the p=€450 price strategy case, price reduction renders aluminium more competitive and allows maintaing the relative original position with respect to PVC and Aluminium-Wood windows.

Evolution of the number of firms (price = 450)
Price reductions do not favor industry concentration since a larger number of smaller businesses would remain operative compared to those that would be operative if prices remained at current levels (figure 18).

5. Conclusion and strategic implications
From the simulations, the role of the pricing strategy clearly emerges. From the window manufacturers' perspective, given the preferences of the market segments represented, maintaining the current price makes it possible to maintain the value of sales and sustain the operating income that increases, in the case of the optimistic hypothesis, reaching an average of just under €4,000,000 and in the pessimistic hypothesis just under € 3,000,000 (Figure 19).

The pricing strategy also has important implications on the producers of semi-processed products, the system producers. The p=€450 price strategy is in fact preferable for window manufacturers but not for system producers who would see a fall in total consumption of aluminium following a decrease in market share. In the case of the p=€450 price strategy, at the beginning of the simulation, a dramatic decrease in expenditure in aluminium is manifested following a decline in market share explained by the uncompetitive price (Figure 20). Subsequently, expenditure increases as companies grow in size and purchase more. Towards 2011, the value of expenditure begins to decline because the selection process is beginning to decrease the number of companies in the market. However, it is interesting to note that in the case of the p=€350 price strategy the value of expenditure in aluminium stabilizes at a slightly higher level than the initial level while with the p=€450 price strategy, the level of expenditure, after a peak between 2010 and 2011, stabilizes at a slightly lower level than the initial level.

The results obtained depend heavily on the hypotheses made on the elasticity of demand to product price. In the case considered, it is assumed that consumers, in their purchasing choice, pay attention to the price of the product, but it also assumes that the price has the same weight as other aspects of the offer on the basis of which the consumer selects the product (brand, thermal performance, intermediation, tradition).

Therefore, hypothesizing that products are on a par as concerns brand recognition and thermal performance, the price difference between an aluminium product and, for example, a PVC product is not sufficient to bring down demand for aluminium windows, albeit generating a slight decline in market share. Further simulations with different hypotheses on the elasticity of the market sector to price could create situations where maintenance of the p=€450 price strategy would manifest a sharp reduction in average turnover in such a way as to not permit covering investments and resulting in lower operating income with respect to the p= €350 price strategy

Managerial implications specific for the industry concern the collaboration strategy between alu system suppliers and alu windows manufacturers. System suppliers, according to simulation results, should accept a reduction of sales in the short period to develop a more in depth collaboration with a limited number of alu window producers that will generate and increase in sales in the long run. Alu window manufacturers must redefine their business model leveraging on the development of two specific resources: tangible resources (production plants) and intangible resources (technical know-how). The suppliers-customers collaboration is essentially based on the resource sharing in particular of intangible resources (technical know-how) that should be co-developed by alu window manufacturers and system suppliers, coordinating R&D efforts and, eventually, investments.

Theoretical findings are strictly connected with managerial implications. The simulations highlight that if the necessary know-how coordination between window manufacturers and system producers is not actualized, industrial automation investments will not generate the desired effect because they are not adequately supported by the production of alu profiles systems specifically designed for use in automated processes. Inter-firm resource development has been investigated by Davis, Eisenhardt and Bingham [2009] and Cockburn, Henderson and Stern [2000], that evidenced the effects of appropriate resources sharing on the innovation process. Our findings evidence the critical role played by coordination in achieving a quick business model redefinition, a similar issue has been partially explored by early studies on resource development in turbulent competitive environments [Eisenhardt 1989]. The simulation evidence that the consequences of a lack of coordination could be very serious since investments in industrial automation do not generate the planned increases in efficiency and the weight of investment costs is not adequately offset by lower operating costs. This situation produces an operating loss even in the optimistic hypothesis. Coordination in resource development between firms connected by a supplier-customer relation is the critical attribute of the process of business model redefinition, that should be explicitly managed by top managers to achieve desired competitive performances.

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Figures

Figure 1. Evolution of market shares (% of aggregate turnover)

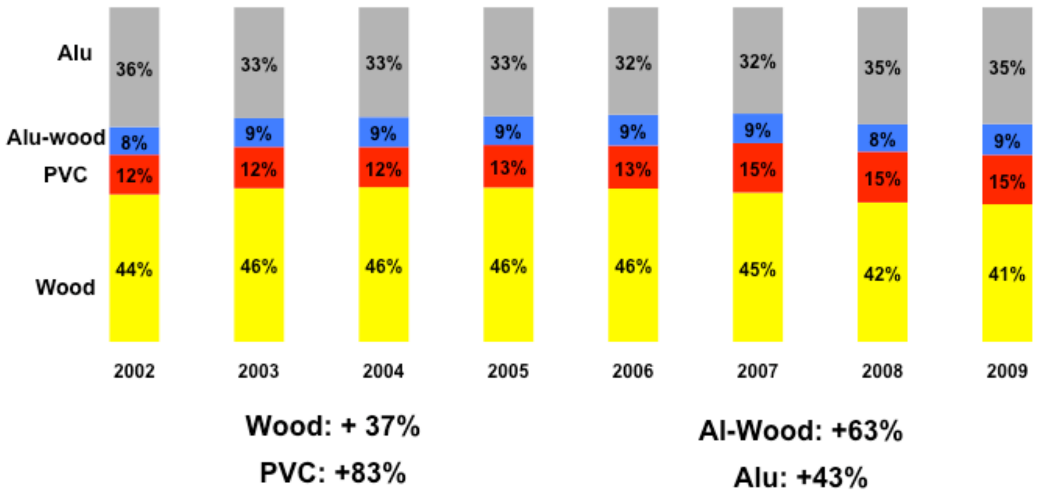
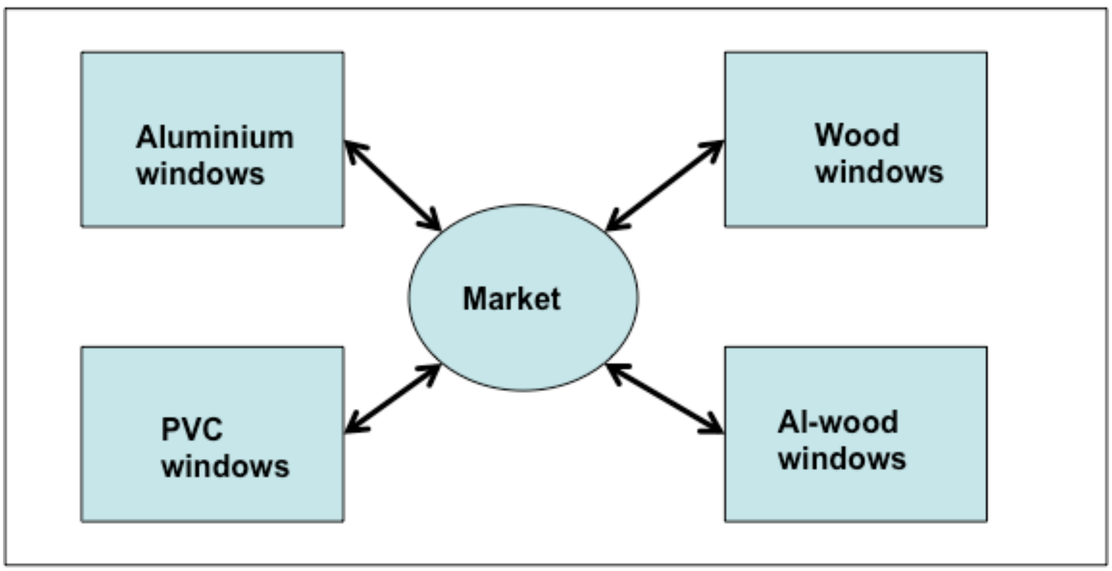


Figure 2



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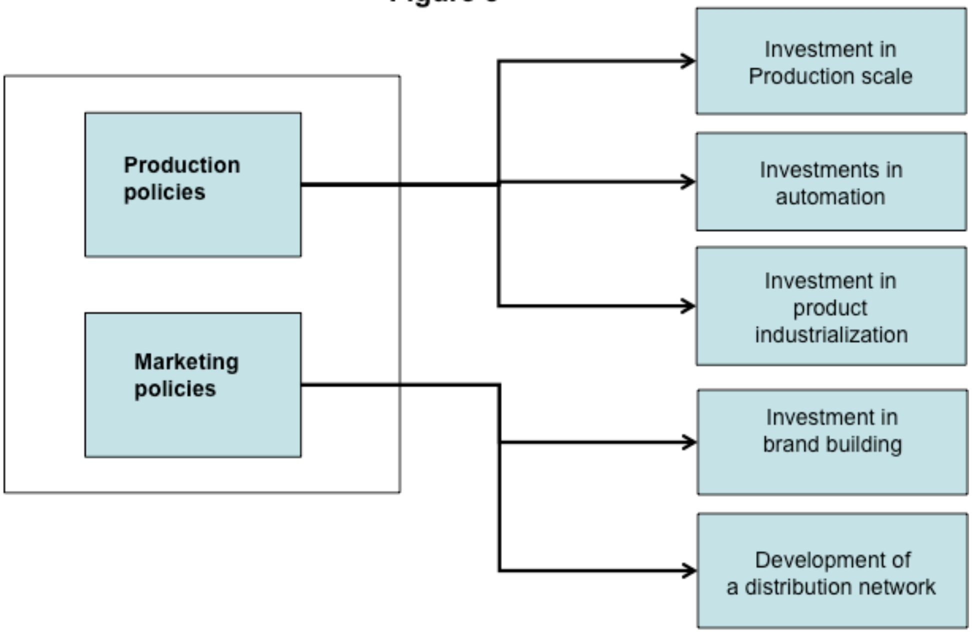

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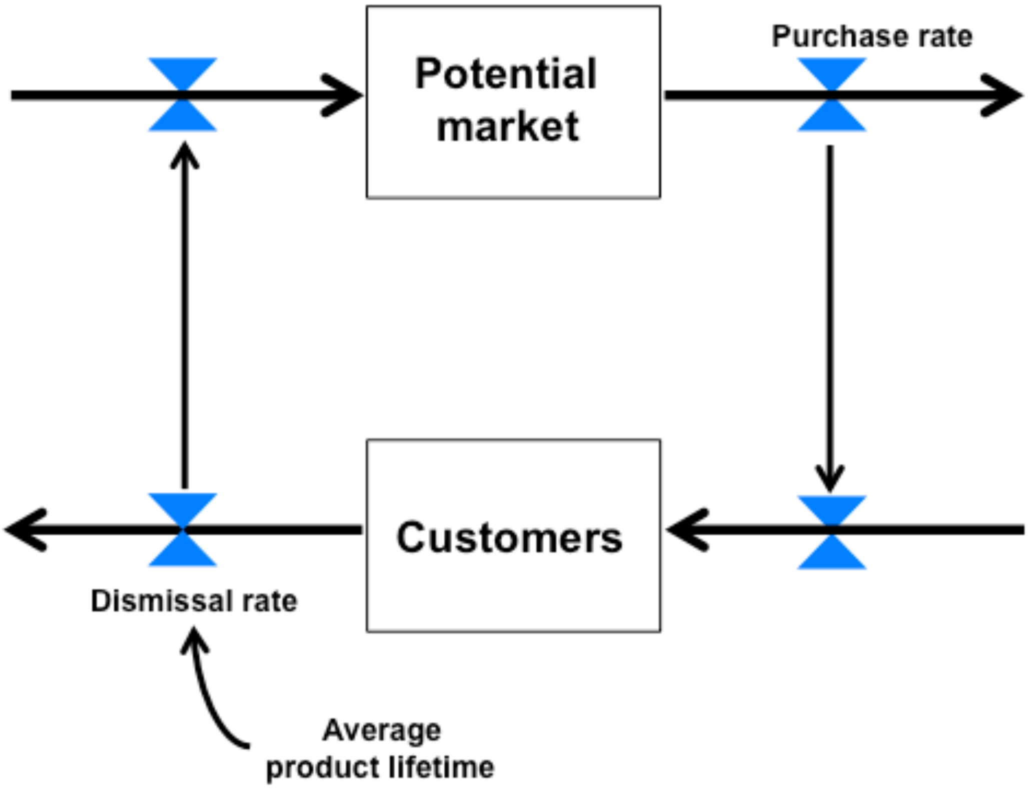

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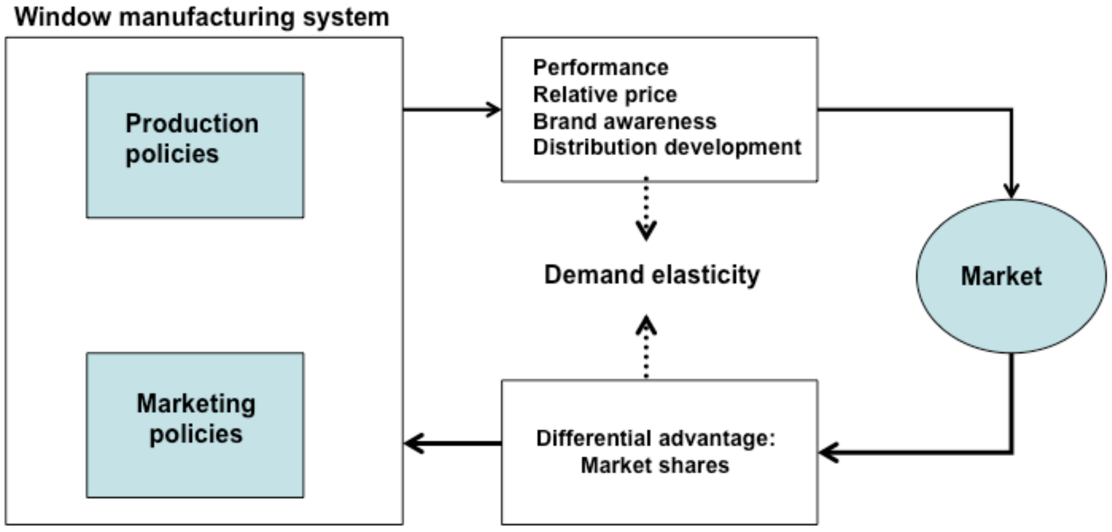

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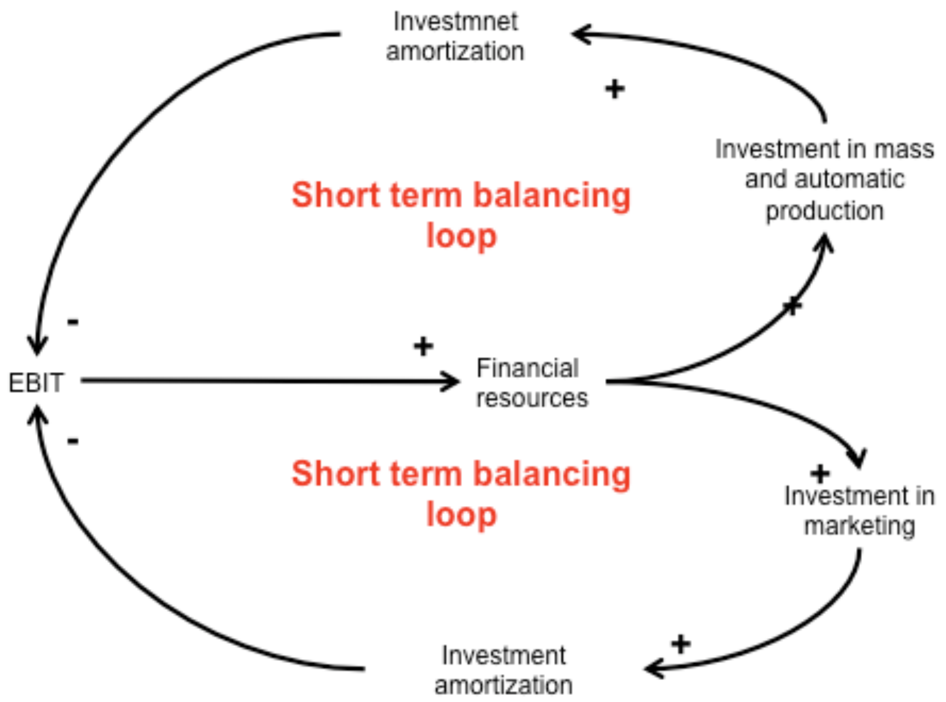

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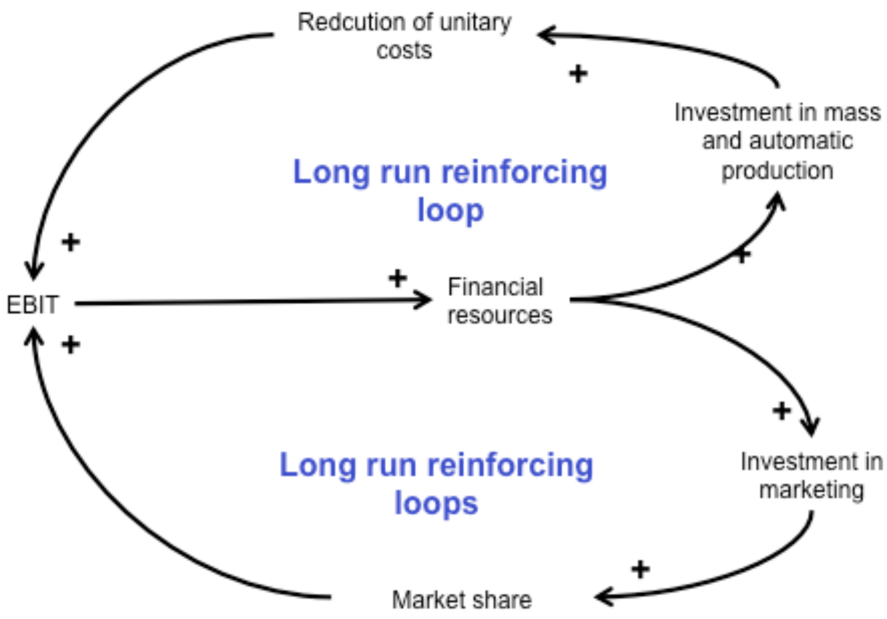


Figure 8

	BASE SCENARIO 1	INDUSTRIALIZATION SCENARIO
Average product lifetime	10 years	10 years
Termal insulation requirements	1.6 Uw	1.6 Uw
Investment in production scale	8'386 (windows/yer)	30'000 (windows/yer)
Investment of alu window manufacturers in production process automation	0	Benchmark reached between the 1st and 2nd year
Investment of system manufacturers in industrialization of the system	0	1. Benchmark reached between the 1st and 2nd year 2. Benchmark reached between the 2nd and 3rd year

Figure 9

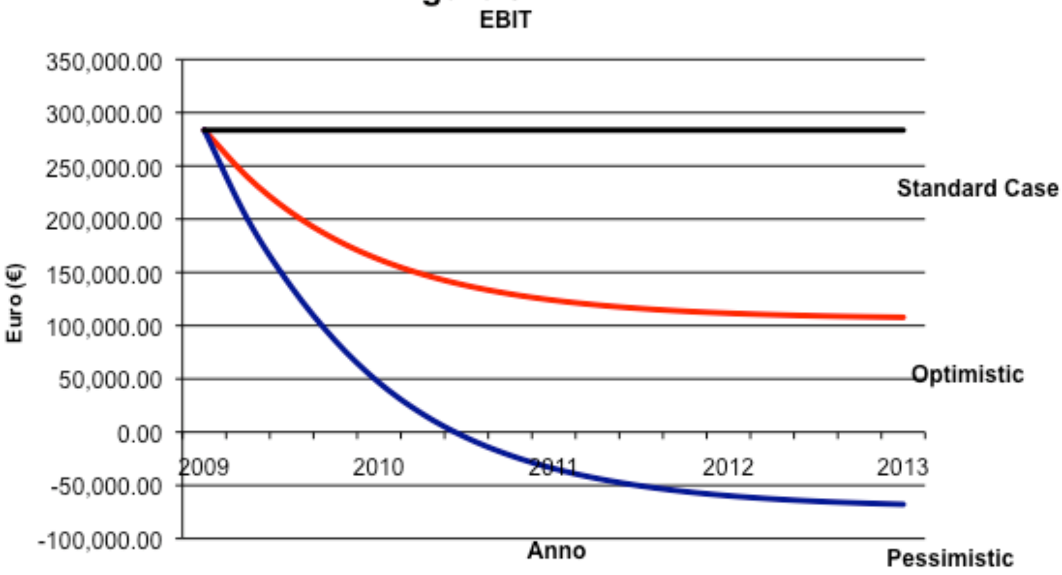
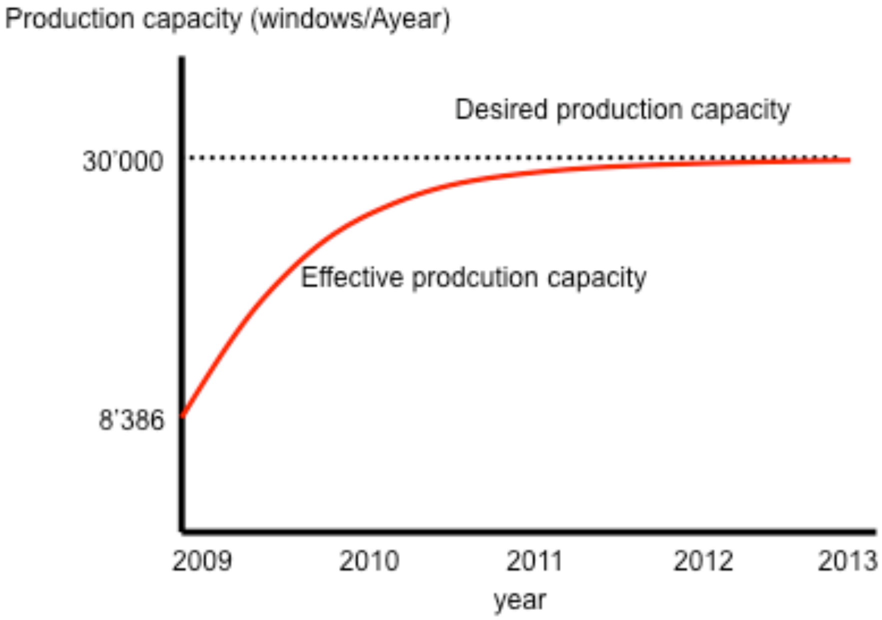


Figure 10



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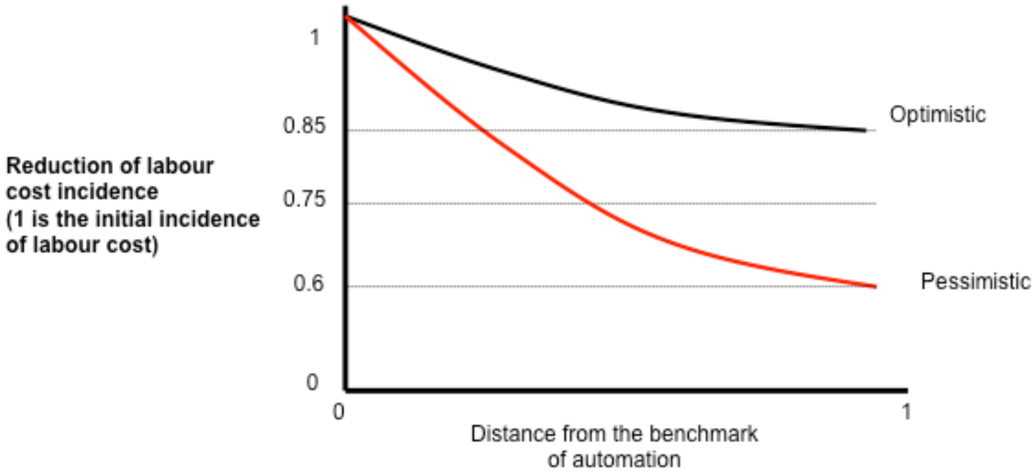

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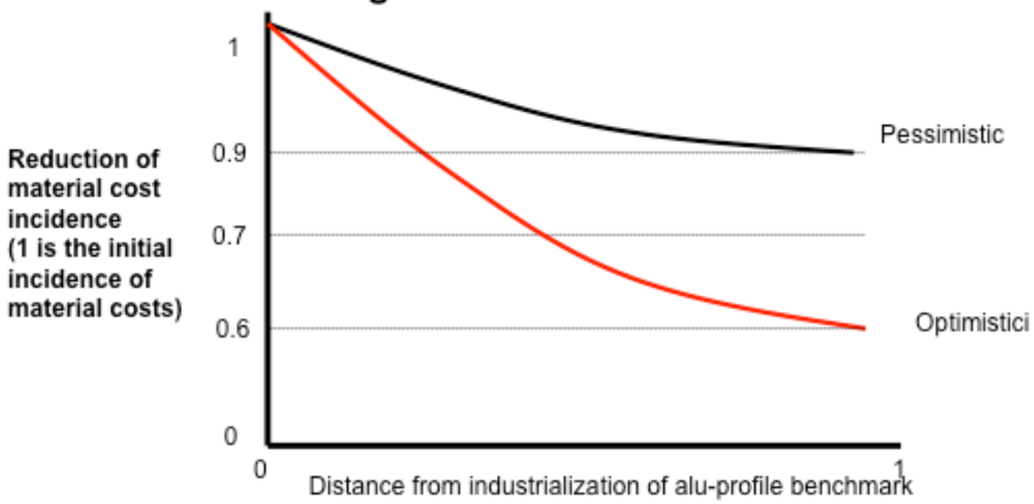

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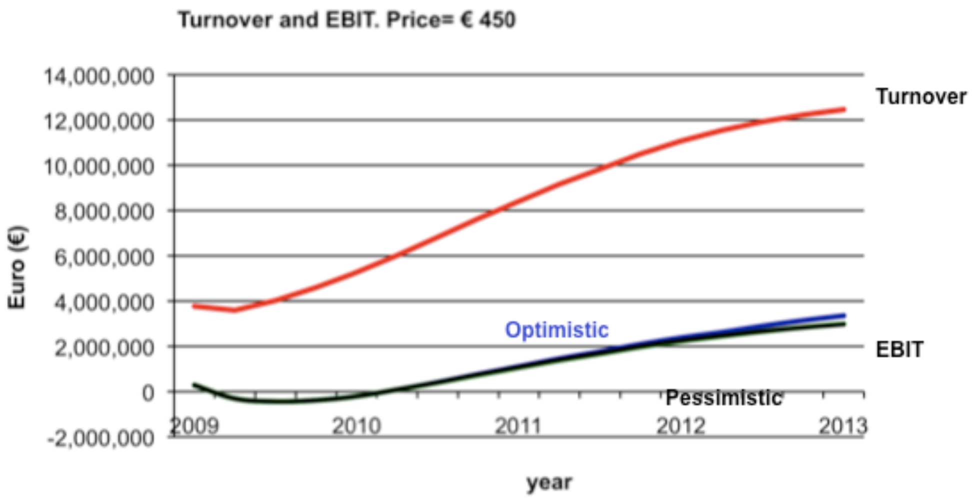


Figure 14

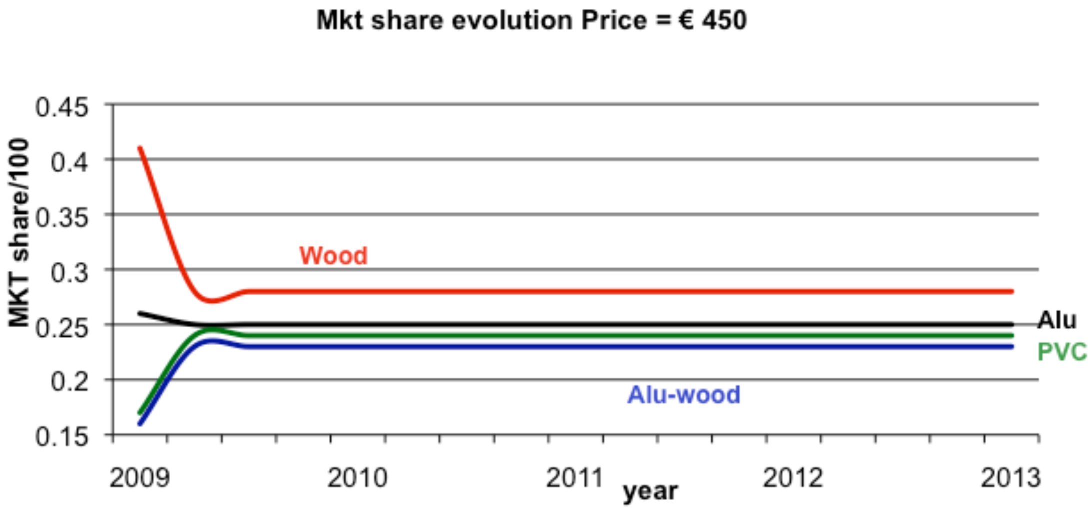


Figure 15

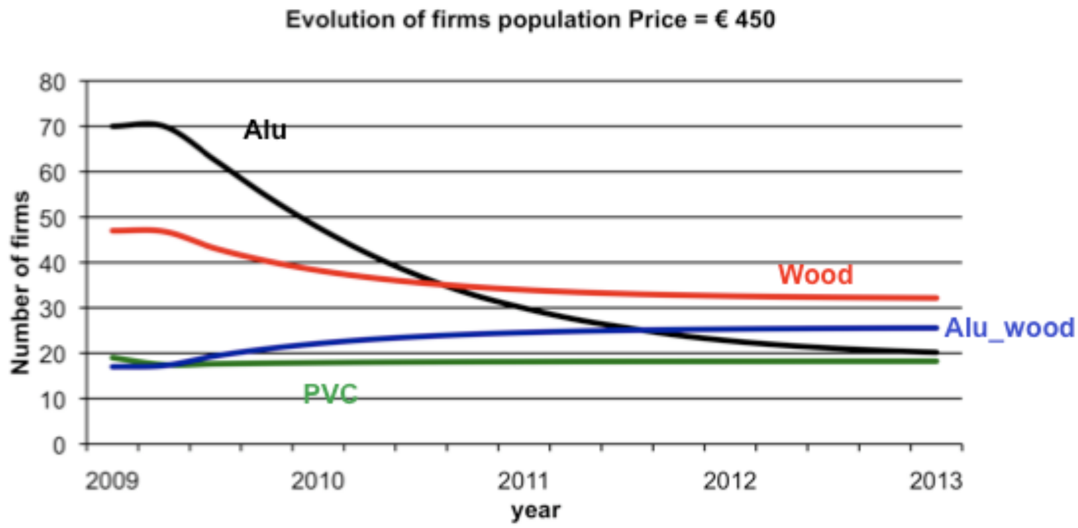


Figure 16

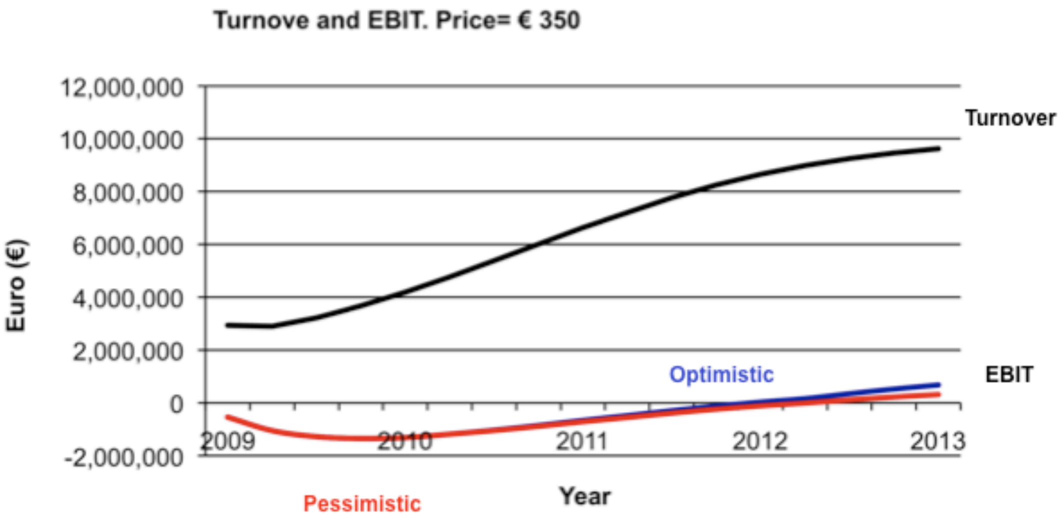
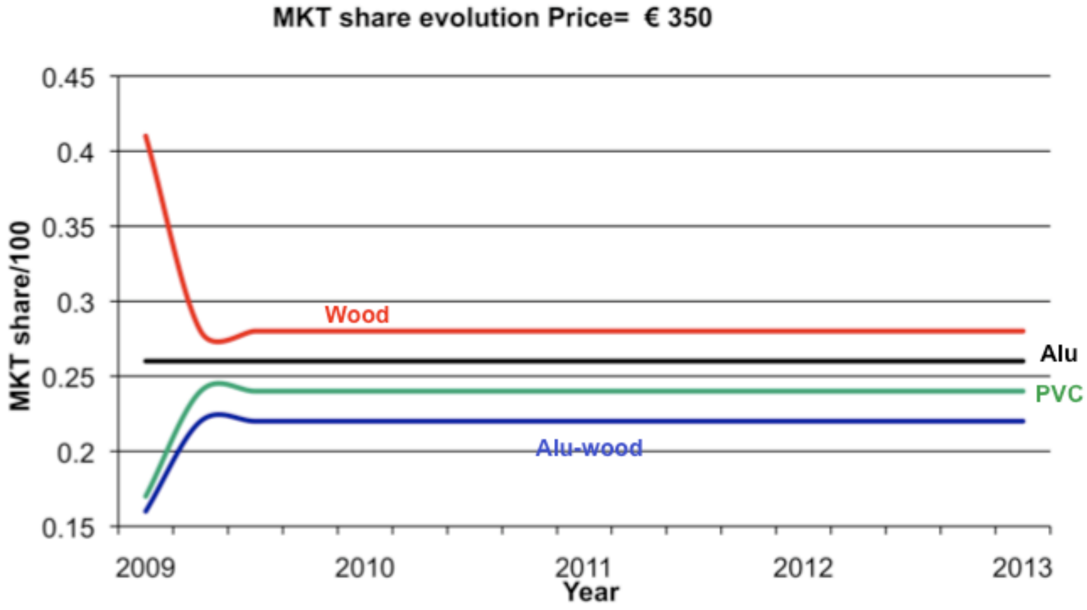


Figure 17



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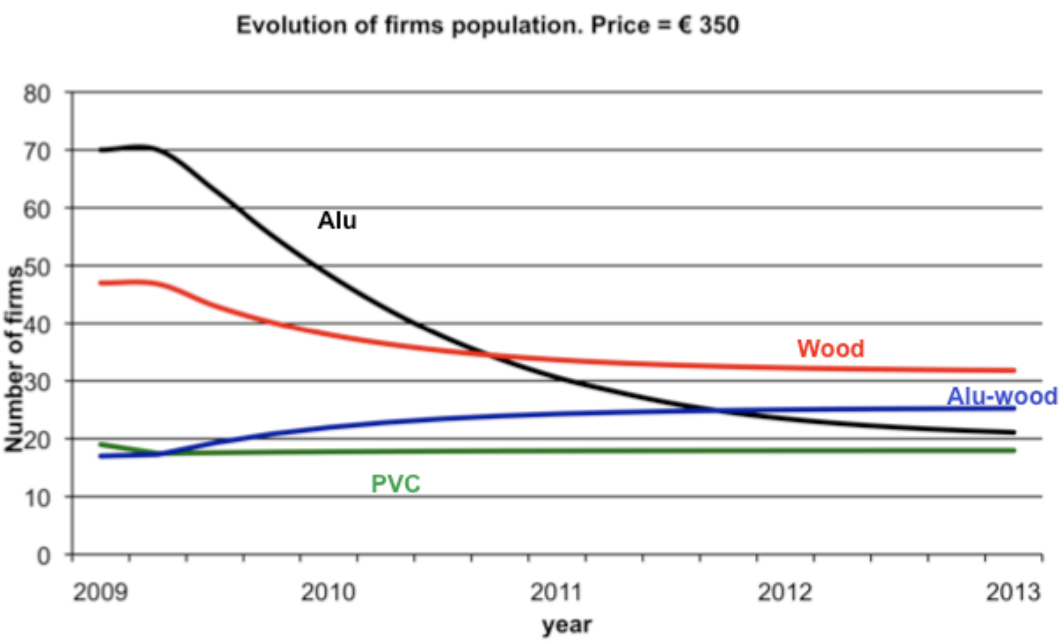

Figure 19

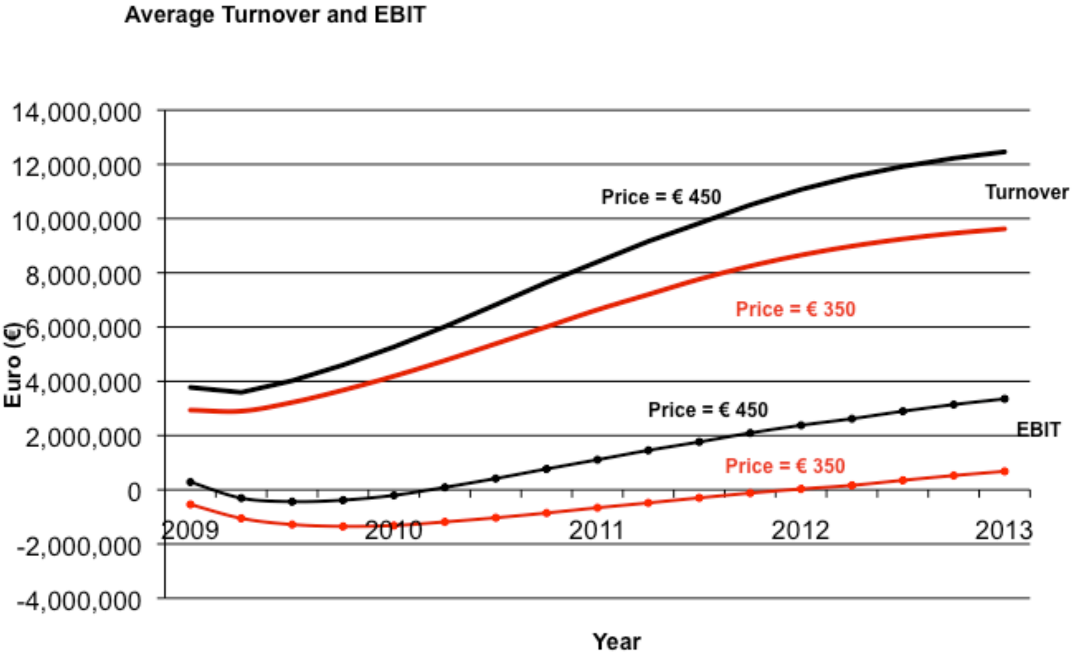

Figure 20