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**Product-line variety and innovation along product life-cycle in car market: are
carmakers' policies really effective?**

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Abstract

This paper presents some preliminary results of a research concerning the evolution of product variety and product innovation policies of carmakers in the European market. Three market segments are taken into consideration for the period 1984-2004; data concerning model sales and product characteristics of some of the main carmakers are examined and the aspects taken into consideration refers to Product Life-Cycle (PLC), price positioning, rough measures of Product Line Width (PLW) and Product Line Innovation (PLI).

The aim of the research is to describe product replacement policies and timing pursued by carmakers within each segment to evaluate the effectiveness of carmakers PLC policies through inter-brand comparison mainly based upon: a) PLC extent for each model, b) PLW variation along the life-cycle, c) PLI effectiveness. Differences in brands policies, as well as evolutionary trends of persistence or of discontinuity within the same brand are investigated, as well as the relation between PLC trend and timing in new model introduction.

Introduction

In this article we present the preliminary results of a broader study concerning the evolution of product life-cycle strategies of carmakers in three of the most relevant European markets; expressly, the aims of the study are:

1. to analyze effectiveness of new-product introduction timing and Product Life-Cycle (PLC) policies;
2. to measure the existing relations between market performance and product innovation and/or product-line width;
3. to find out distinctive features among carmakers' price and product development policies;
4. to describe the evolution of price and product policies in car market.

The present paper focuses on topics 1 and 2, while topics 3 and 4 are still under analysis and will be presented in future works.

PLC theory is probably one of the most well known marketing theory¹ since early '60s (e.g.: Rogers 1962; Levitt, 1965; Bass, 1969; Day, 1981; etc.). According to such theory, the sales of a new product from the moment of its entry until its withdrawal from the market could be somehow predicted, at least as far their trend concerns. Sales of a new product are mainly depending on the adoption rate of the innovation by the consumers, so that the overall trend of sales could be described as a sequence of stages, each one showing its own peculiar rate of

¹ Several recent studies use the same terminology "PLC management" to indicate the organization and/or supervision of a product during its life-stages, from concept design to disposal/recycling. In this paper, however, we refer to the "traditional" notion of life-cycle commonly used in marketing, regarding the progression of sales of a product over time.

demand variation. In line with PLC theory, the firm that can predict the shift from one stage to another can manage sales tendency adopting proper marketing-mix policies, in order to deal with the changing situation and, possibly, gain the better advantages in terms of profits, sales, etc. (e.g.: Rogers 1962; Levitt, 1965; Bass, 1969; Day, 1981). In such sense, PLC theory is commonly alleged as useful (e.g.: Cox, 1967; Polli e Cook, 1969; Goldgehn, 1983), although some points and/or application of PLC are arguable (Dhalla e Yuspeh, 1976; Wood, 1990). Anyway, PLC occupies its own space in any marketing course and handbook; in someone's opinion, PLC is definitely "the most fundamental variable in determining an appropriate business strategy" (Hofer, 1975, 798). One point upon which everybody actually agreed since the advent of such theory is that "in recent years (...) products have been maturing more rapidly and life cycle getting shorter" (Clifford, 1965).

In fact, the most controversial question involves the frequent absence of regularities in PLC curves related to different products of same market and even between different products of the same firm over time. PLC trend is often assumed as a target rather than a descriptive and/or predictive model. For this reason, several authors focussed on identifying key-variables and related strategies relevant in each stage of PLC (e.g.: Levitt, 1966; Catry e Chevalier, 1974; Hofer, 1975; Anderson e Zeithaml, 1984; Parker e Neelamegham, 1997; Narayanan S. et al., 2005; Moon Y., 2005).

In a word, the use of PLC as a tool to define strategies and/or policies requires to identify the critical variables related to each stage and the characteristics of the demand, as well as to measure the potential performances of new products (Suomala, 2004). From this point of view sales data are insufficient, since other information like cross-elasticity between concurrent products, nature of demand (if first-purchase or replacement purchase), and so on, should be known (Midgley, 1981).

Due to the specific cost structure of automotive production processes, the attainment of break-even in general and specifically the effectiveness of PLC policy is a topic of great importance in this industry. In this paper we try to define a method capable - at least partially - to measure PLC policies effectiveness.

Data and Method

To assess different aspects of PLC policies we examined a 21 years historical data series (1984-2004) concerning car sales² in three European markets (Italy, France and Germany), car production in European plants and main product features in segment "B" (compact cars), "C" (medium), "D" (upper medium) and "E" (large). Collected data are related to car model and/or car version of a sample of European top-seller brands (Alfa Romeo, Audi, BMW, Citroën, Fiat, Ford, Lancia, Opel Peugeot, Renault, Volkswagen). These brands account for a large part of segment demand share within own segments, although such share has been decreasing in recent years, mainly as a result of "new entry" brands (Toyota, Nissan, Mazda, Suzuki, Chevrolet-Daewoo, Hyundai, etc.). Anyway, since our study focuses on evolution of product strategies and product life cycle we decided to consider only product offers characterized by a persistent presence (at least 20 years long) in each segment. Therefore, considerations developed from now on will be referred to the sample constituted by the mentioned brand. Anyway, at the moment the analysis of some data concerning segment "D" and the whole analysis of segment "E" have not been completed yet.

Table 1 shows an example of data series collected for Fiat product offer in segment B: same kind of data gathering has involved the mentioned brands and segments. Table 2 illustrates brands and model of the sample included in each segment.

² Data have been collected from publications made by ANFIA, VDA and CCFA.

Table 1: example of data series used in the analysis (brand Fiat, Segment “B”)

Brand Fiat - Segment "B" (Uno, Punto)										
	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
Sales Italy	331.019	332.080	433.694	457.254	374.853	382.203	372.700	340.970	336.262	237.270
Sales Germany	36.719	37.076	47.949	53.049	48.857	37.927	48.448	42.767	39.172	25.489
Sales France	27.290	31.234	44.235	60.199	66.862	62.896	60.053	48.185	44.861	29.311
Tot. I+D+F	395.028	400.390	525.878	570.502	490.572	483.026	481.201	431.922	420.295	292.070
Production Europe	482.012	585.572	661.635	682.260	580.261	556.244	594.195	524.458	530.357	412.900
entry price	4.580	4.229	4.737	4.932	5.112	5.023	4.851	5.494	5.783	6.787
top version price	6.040	5.801	7.925	8.159	8.570	10.053	10.649	10.439	11.372	12.124
engine options	3	3	5	5	5	7	7	7	5	8
# of versions	9	12	14	19	20	28	33	30	32	18

Brand Fiat - Segment "B" (Uno, Punto)											
	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Sales Italy	347.981	328.414	283.293	374.926	288.477	220.958	272.634	287.006	209.185	187.785	176.823
Sales Germany	44.948	60.197	60.111	40.562	55.491	42.312	49.862	46.554	36.873	30.015	23.564
Sales France	61.177	63.128	68.451	46.945	59.120	44.895	56.744	48.725	36.389	29.126	15.883
Tot. I+D+F	454.106	451.739	411.855	462.433	403.088	308.165	379.240	382.285	282.447	246.926	192.706
Production Europe	703.328	738.569	607.521	669.915	568.745	540.893	594.496	521.886	439.170	406.789	320.761
entry price	7.928	8.547	8.883	9.270	7.205	9.060	9.395	9.929	10.341	9.503	10.631
top version price	14.254	15.571	15.959	17.043	16.940	15.231	16.316	17.371	19.733	16.510	18.601
engine options	8	5	4	4	4	3	3	3	3	3	4
# of versions	29	31	31	29	29	21	25	25	35	36	39

Table 2: model segmentation

Segment "B"	Alfa Romeo	Audi	BMW	Citroen	Fiat	Ford	Lancia	Opel	Peugeot	Renault	Volkswagen
				Visa AX Saxo C3	Uno Punto	Fiesta	A112* Y Ypsilon	Corsa	205 106 206	R5 Clio	Polo
Segment "C"	Arna 33 145 146 147				Ritmo Tipo Bravo/a Stilo	Escort Orion Focus	Delta	Kadett Astra	305 306/7 309	R9 R11 R19 Megane	Golf
Segment "D"	Giulietta 75 155 156	80 A4	S3		Regata Tempra Marea	Sierra Mondeo	Prisma Deadra Lybra	Ascona Vectra	305 405 406 407	R18 R21 Laguna	Passat
Segment "E"	6 90 164 166	100 A6	S5		Argenta Croma	Skorpio	Thema K Thesis	Rekord Omega	505 605 607	R25 Safrane Vel Satis	

Segments have been identified taking into account some main product features; characteristics that identify segments are car dimension (length, internal space, price, engine displacement and/or horsepower, body). Actually, segments should be referred to demand preferences instead that product features, but it is a common practice in car market to base segments definition on product characteristics; for instance, in this study the “B” segment groups car with the following features:

1. wheelbase between 230 and 269 cm.;
2. entry-level price below 13.000 euros (2004);
3. displacement between 900 and 1500 cc for petrol engines, less than 1700 cc for diesel engines;
4. sedan or hatchback.

Segments boundaries have been delineated at car model level, although very often in a model are included one or more versions featuring attributes overtaking those specified for that segment (e.g. Renault Mégane Sport Power – 225 CV; Peugeot 206 RC – 180 CV). Where possible, data regarding special versions have been removed.

In order to highlight possible effects of product policies on sales performance, we defined two measures. The first one is a measure of Product-Line Width (PLW), related to each model and each year, based upon number of version, price range, number of engine options:

$$PLW = PR \cdot 10 + (V \cdot M) - 1;$$

- PR (Price Range) = $(P_{max} - P_{min}) / P_{min}$; P_{min} is the entry-level price of a specific model in that year and P_{max} the maximum price for the same model in the same year; index refers to list prices at their current values (not deflated);
- V is the number of versions offered for that model;
- M is the number of engine options (motorizations).

PLW is built so that it is equal to 0 if only one version of a model is offered, then it increases of 0,01 for each additional version sold at the same price with the same engine. Each additional 10% spread in price range make it raise of 0,01, while an additional engine option cause PLW to increase of 0,02. The overall PLW of each segment has been calculated applying the same formula at the whole segment; therefore, since it is related to the total number of version, of engine options and to a wider price range, PLW referred to a segment is obviously much bigger than the PLW of each brand.

The second measure is related to product line innovation (PLI) and is based on product renewal and on the increasing in the number of product version:

$$PLI = \alpha + \beta;$$

1. α vary in each year for a specific product offer in relation to following events:
 - $\alpha = 0,5$ if new engine options are introduced,
 - $\alpha = 0,7$ if a significant style modifications are introduced (*restyling*),
 - $\alpha = 0,9$ if a new model is presented,
 - $\alpha = 0$ in all other cases.

Each α value has been assigned to the year in which the innovation arouses a noteworthy difference in commercial performance, therefore not necessarily in the same year of the new model (or engine, or style) presentation (e.g., if the launch has been made in September while the rising in car registrations take place starting from next January).

2. β depends on the variation of number of versions with respect to previous year:
 - $\beta = (V_t - V_{t-1}) / (V_{t-1}) \cdot 2$ if $V_t > V_{t-1}$;
 - $\beta = 0$ if the number of version is decreased with respect to previous year.

The PLI index actually do not measure how much innovative is a model or a version compared to the previous one, rather it shows how often that brand renew its model. Therefore, PLI is in fact a measure of product renewal.

The correlation between PLW and sales, as well as PLI and sales, has been measured through the Pearson's index. Anyway, such results are to be considered provisional due to some data still missing (for instance, French carmakers sales regarding France are still largely incomplete).

Product Variety

In the last 21 years the product variety in European car market has grown outstandingly (fig. 1 and table 3): in 1984 carmakers offered on a whole 180 models and a bit more than 800 versions (that is, an average of 4,4 version for each model). In 2004 269 models are present in

the market, with an assortment of about 3210 versions, that is an average of 11,8 versions for each model (table 3). On the other hand, the overall number of brands has decreased from 62 to 53; it means that the average number of models per brand shifts from 2,7 to 5,1, while the average number of versions per brand (13 in 1984) raises to 60,6 (table 3).

Such increasing in variety, of course, is justified by the fact that in the period under examination important transformations took place within the car industry, due to several reasons that can be summarized as follows (Volpato et al., 2004):

- the shift from a first-purchase demand towards a market mainly composed by replacement demand;
- the rising of multi-motorisation;
- the enlargement of potential demand to different segments of customers, both for social and economic reasons;
- the increased importance attributed by drivers to innovation.

Figure 1: evolution of number of car models and car versions (1984-2004)

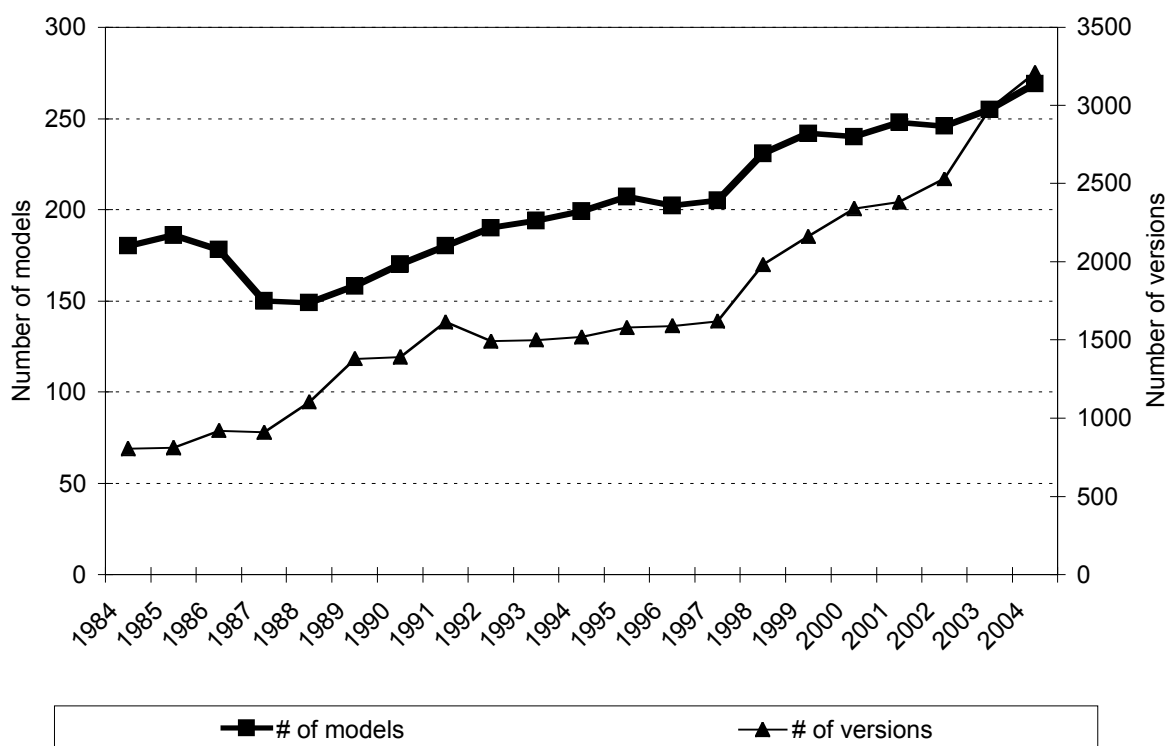


Table 3: 1984-2004: some key-data of European car market (all segments)

	1984	2004
Number of models	180	269
Number of versions	805	3210
Average version per model	4,4	11,8
Number of brands	62	53
Number of model per brand	2,7	5,1
Number of version per brand	13,0	60,6

All these factors increased the level of competition in car industry, pushing carmakers to produce with a higher degree of differentiation and boosting the elasticity of demand towards product newness, hence feeding a time-base competition (Blackburn, 1991). While in the 1970s a three-month lead time for a new car delivery would have been considered a very good performance, the current average 'ideal' delivery lead time is estimated at two weeks (Whiteman et al., 2001), in order to serve adequately a very volatile demand.

In our study we focus on three main segments, so-called "B" or compact car (e.g. Ford Fiesta, Renault Clio, Fiat Punto), segment "C", or medium car (e.g.: Ford Focus, Renault Scenic, Volkswagen Golf) and segment "D", or large car (e.g.: Ford Mondeo, Renault Laguna, Peugeot 407, BMW 3 series). According to our data, between 1984 and 2004 the line width of the three segments studied has considerably increased from the variety point of view (number of versions and PLW index), although the price range has remained more or less the same (fig. 2 and table 4). In this period the total number of car version sold in the three segments by the eleven brands of our sample increased from 278 in 1984 up to 810 in 2004. Consequently, in twenty-one year PLW increased about 3,5 time (from 30,47 to 107,85), although the price range in the last year of our data series is more or less the same than 1984 (1,22 in 1984, 1,43 in 2004).

Figure 2: Average price range and line width for segments "B", "C" and "D" (1984-2004)

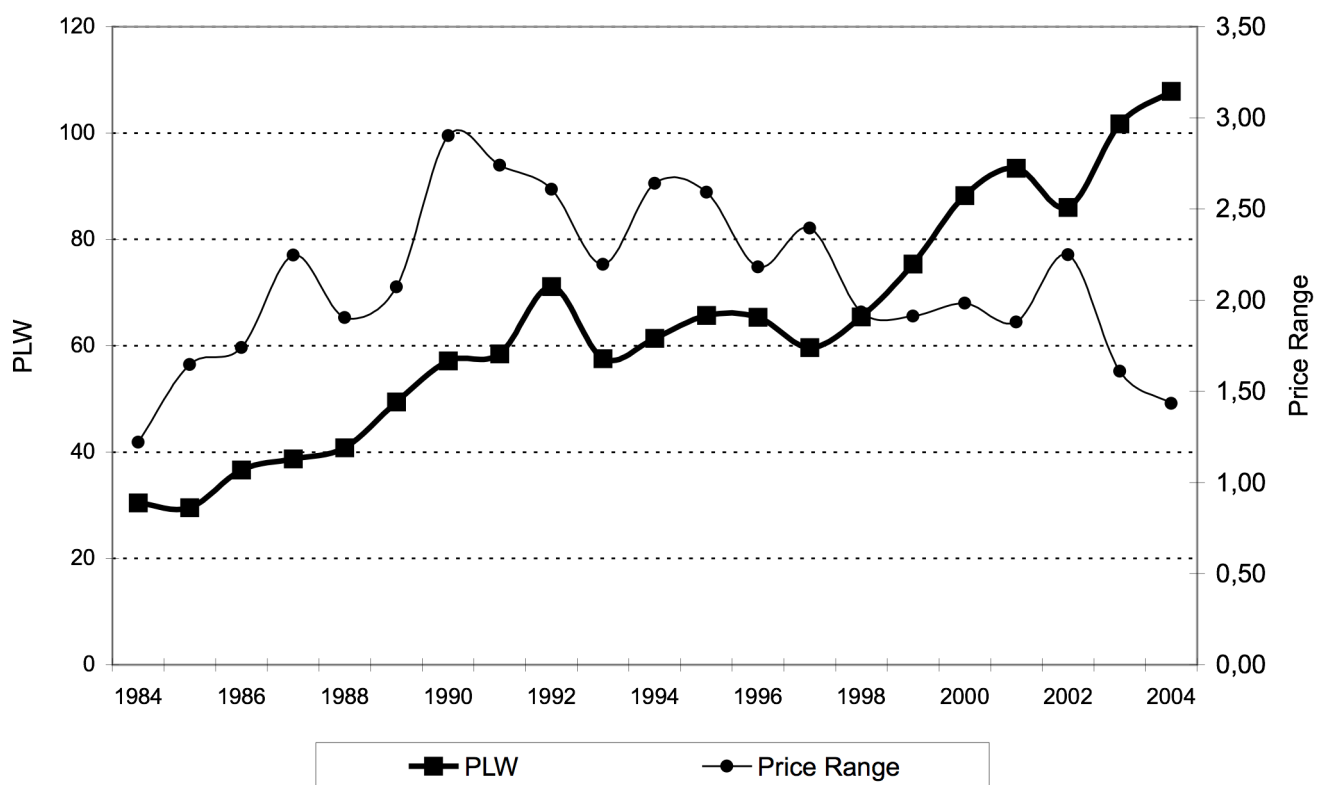


Table 4: Evolution of product line width and price range between 1984 and 2004 (Segments "B", "C", "D")

	'84	'85	'86	'87	'88	'89	'90	'91	'92	'93	'94	'95	'96	'97	'98	'99	'00	'01	'02	'03	'04
PLW (Average)	30,5	29,6	36,7	38,8	40,8	49,4	57,1	58,5	71,1	57,5	61,4	65,7	65,3	59,6	65,5	75,4	88,2	93,3	86,0	101,7	107,8
PR (Average)	1,2	1,6	1,7	2,2	1,9	2,1	2,9	2,7	2,6	2,2	2,6	2,6	2,2	2,4	1,9	1,9	2,0	1,9	2,2	1,6	1,4
Total # of versions	284	295	323	339	373	422	502	493	590	477	521	525	518	507	545	576	664	695	700	747	810

Main parameters for each segment are shown on table 5; it emerges that most important growth in product variety took place in segment “D” (table 5 and fig. 3), since the PLW indicator for this segment quadruplicate in 21 years (from 40,88 up to 168,53), with a noteworthy increase of average rate starting from 1997. Segment “C” overall PLW is evident as well (27,8 in 1984, 81,9 in 2004), especially starting from 1998 when the index was 53,7 and raised up to then 102,1 in 2004. The PLW of segment “B” increased 3,2 times (from 16,5 to 52,9), being the most significant growth actually concentrated in the last two years (fig. 3).

Table 5: Evolution of main parameters related to line width (1984-2004; segments “B”, “C”, “D”)

Segment "B"	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
engine options	27	19	20	23	24	24	25	25	24	23	23
# of versions	61	54	58	70	82	94	113	102	133	100	110
PLW	16,5	10,4	11,8	16,3	19,8	22,7	28,4	25,7	32,1	23,1	25,4
Price Range	0,85	1,09	1,75	1,73	1,33	1,84	1,80	2,00	1,52	1,35	1,31
Segment "C"	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
engine options	30	31	35	37	33	33	35	36	35	36	33
versions	113	131	137	138	134	159	184	180	198	187	207
PLW	34,0	40,8	48,0	51,2	44,3	52,6	64,6	64,9	69,5	67,5	68,5
Price Range	0,94	1,99	1,09	1,20	1,30	1,31	1,87	1,26	1,87	2,05	2,12
Segment "D"	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
engine options	37	34	39	37	37	43	38	40	43	43	44
versions	110	110	128	131	157	169	205	211	259	190	204
PLW	40,88	37,58	50,15	48,84	58,39	72,97	78,39	84,89	111,80	82,01	90,20
Price Range	1,87	1,86	2,39	3,81	3,07	3,07	5,03	4,96	4,43	3,18	4,49
Segment "B"	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	
engine options	22	25	26	24	24	24	21	17	34	35	
# of versions	116	118	128	142	118	139	127	126	146	151	
PLW	25,6	29,6	33,4	34,2	28,4	33,5	26,8	21,6	49,8	52,9	
Price Range	1,25	1,15	1,14	1,35	1,17	1,79	1,39	2,39	1,45	1,08	
Segment "C"	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	
engine options	35	37	33	31	32	36	39	31	34	31	
versions	211	201	198	173	176	227	307	298	303	329	
PLW	74,1	74,5	65,5	53,7	56,4	81,8	119,8	92,5	103,1	102,1	
Price Range	2,52	1,77	1,73	1,10	1,17	1,07	1,00	1,02	1,01	0,86	
Segment "D"	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	
engine options	49	46	44	47	50	50	51	52	51	51	
versions	198	199	181	230	282	298	261	276	298	330	
PLW	97,41	91,89	80,06	108,43	141,33	149,30	133,42	143,84	152,21	168,53	
Price Range	4,00	3,62	4,31	3,35	3,40	3,09	3,24	3,33	2,37	2,36	

Such generalized escalating of product variety comes almost exclusively from the proliferation of versions (fig. 4), since the evolution both of price range and of engine options is definitely smoother (fig. 5 and 6).

As one could expect, segment “D” is also the market with the widest offer in terms of price (figure 5); price range for upper-medium cars is higher than 2 from 1986 on; in the years between 1987 and 2002 it has been over 3 and in the 90’s even around 4 or 5 (that is: the price of the most expensive car in the segment is 5 or 6 time higher than the price of the cheapest one). At the same time, this segment is the one that has increased the overall number of engine options (fig. 6), shifting from 37 motorizations to 51 in 21 years (tab. 4). In contrast, the price range of segments “B” and “C” fluctuate between 1 and 2 with few exceptions (figure 4), while

engine the number of motorization remains more or less the same in both segments (fig. 5 and table 4).

Figure 3: Segments "B", "C" and "D" Line Width (1984-2004)

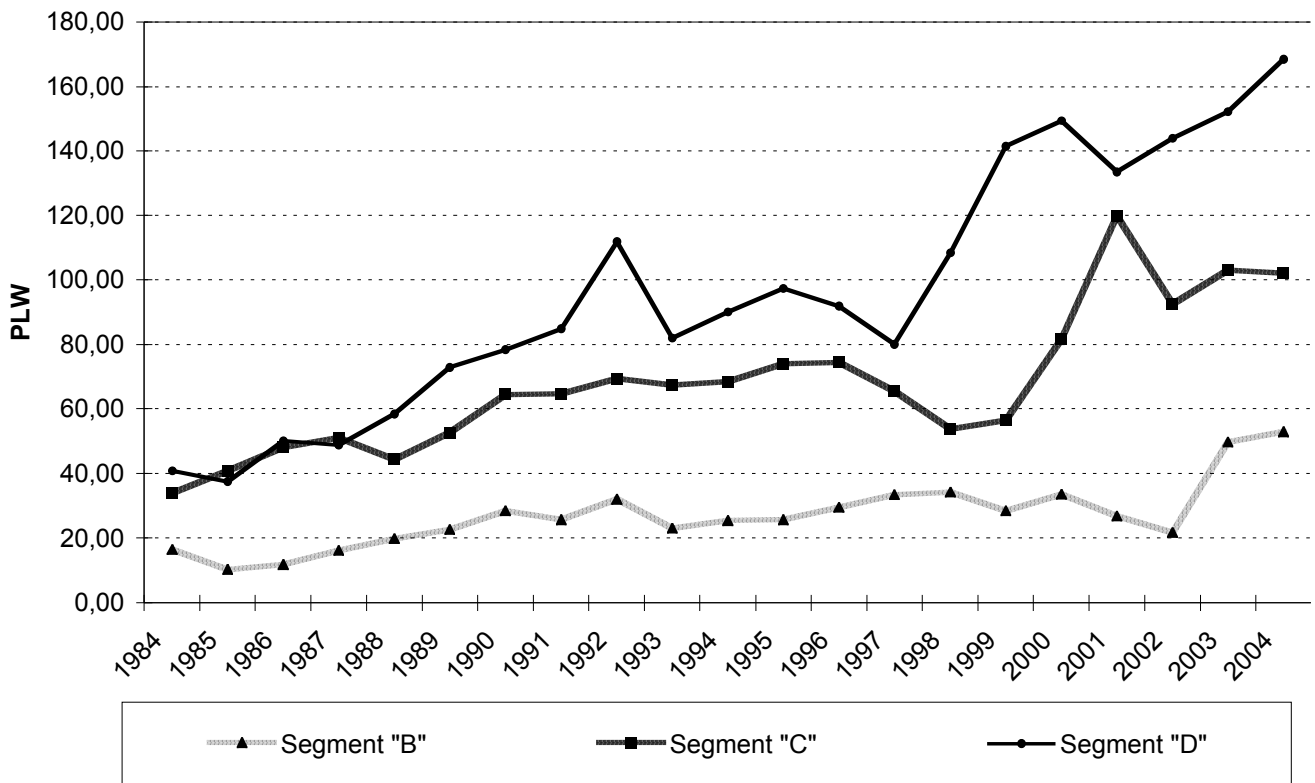


Figure 4: Segments "B", "C" and "D" total number of versions (1984-2004)

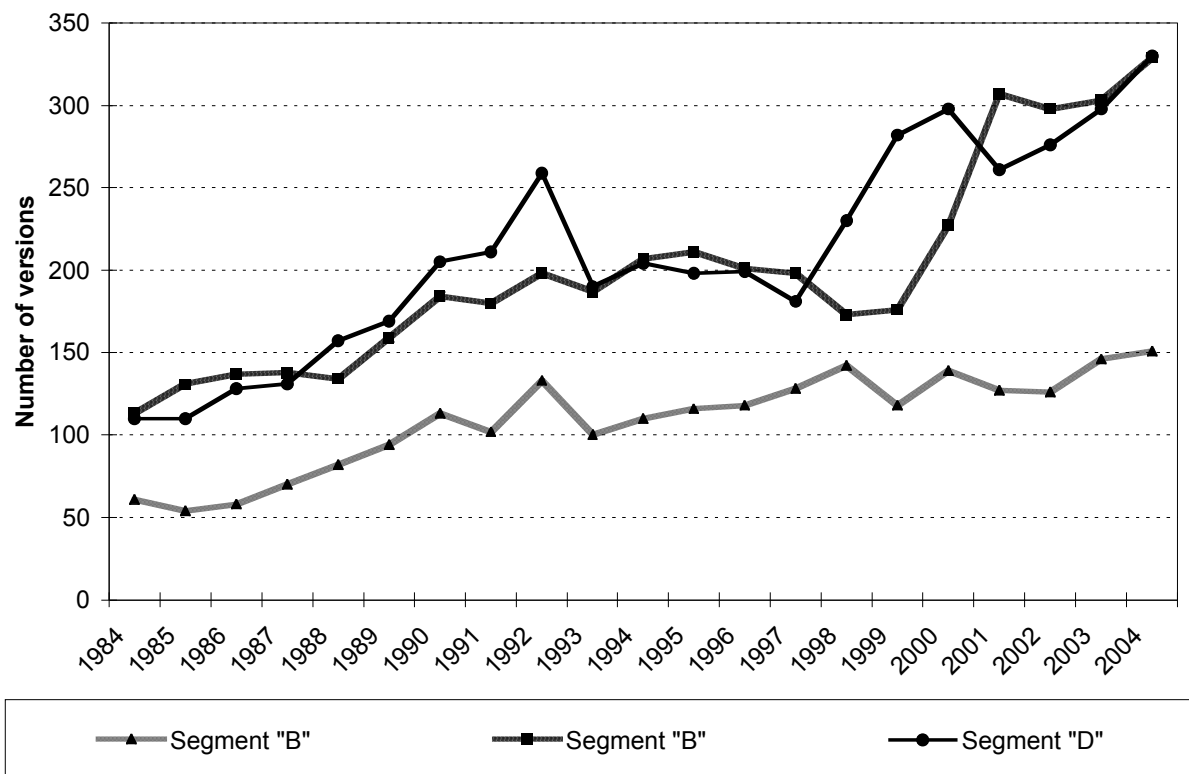


Figure 5: Segments "B", "C" and "D" Price Range (1984-2004)

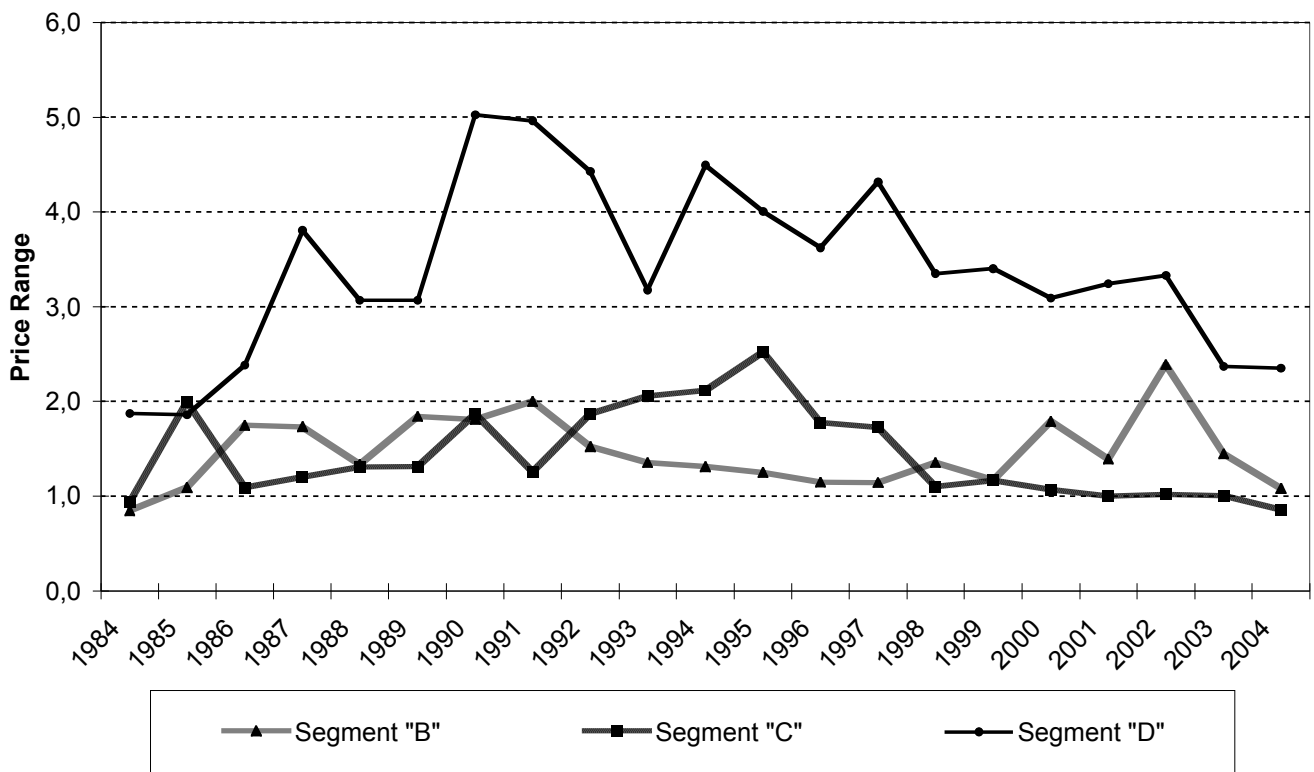
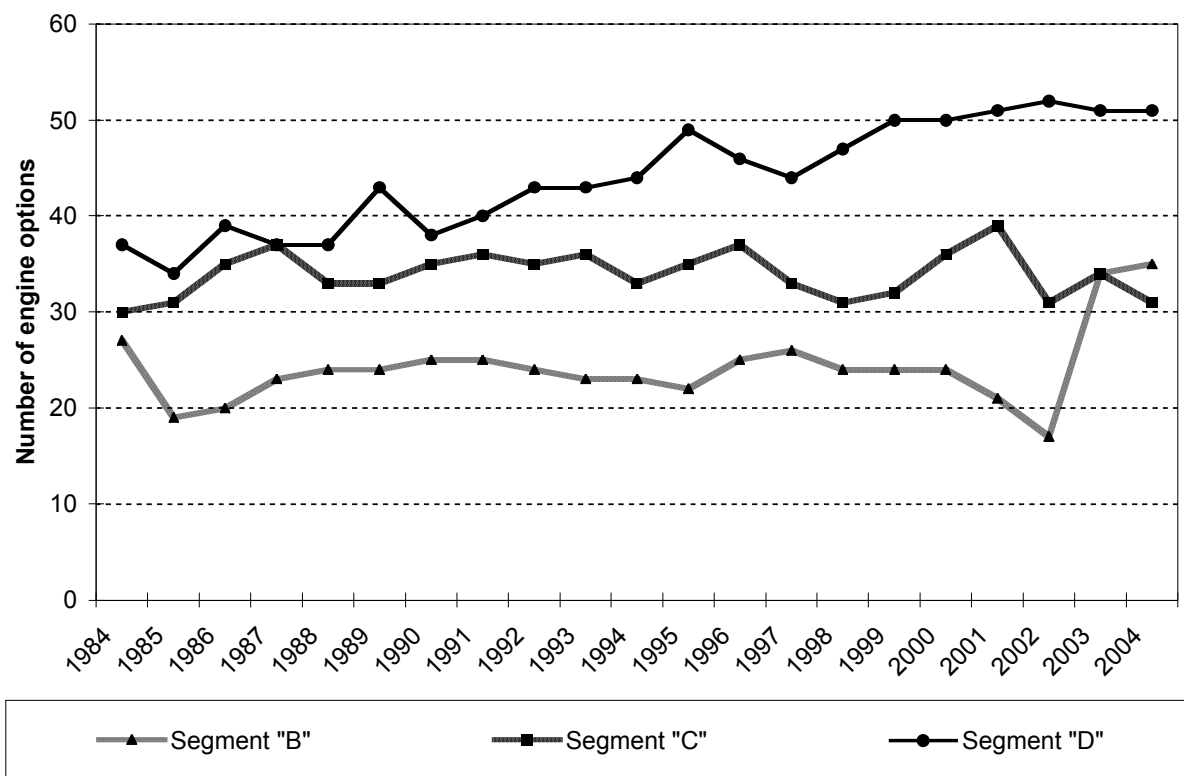
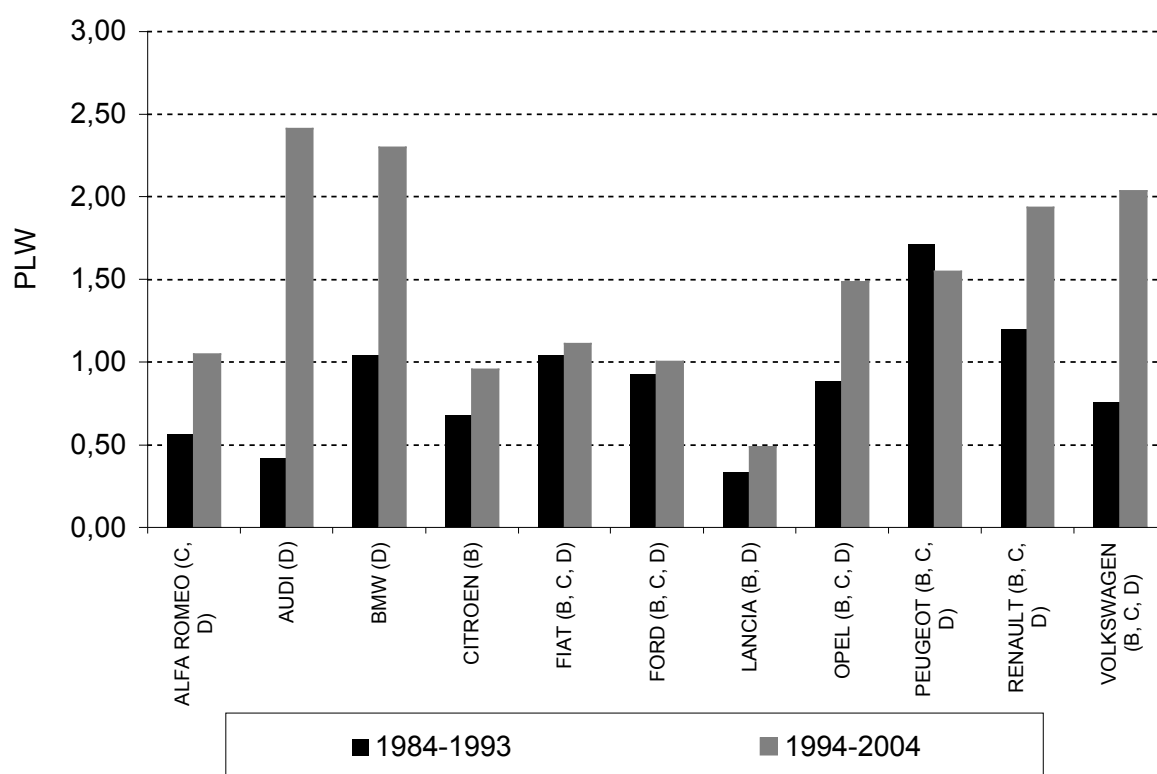


Figure 6: Segments "B", "C" and "D" overall number of engine options (1984-2004)



The general broadening of product lines in the studied period is not shared in the same way by all carmakers. We have split the period examined in two decades (1984-1993 and 1994-2004) and we have measured the value of PLW for each brand in the sample in the two decades, to evaluate the evolution of line width policies; results are shown in figure 7. The majority of carmaker have enlarged their lines in the second decade with respect to the previous one, except for Fiat, Ford and Peugeot, whose PLW index remains more or less the same. On the other hand, Audi, BMW, Volkswagen and Renault have strongly invested in variety in the last ten years. Anyway, how and if such policy can boost sales is controversial. Figure 8 shows the trend of PLW and sales (Italy and Germany) in segment “B” calculated upon data from eight brand of our sample. It seems to emerge an evident relation between the two parameters until 2002, when the sudden increase of variety is not followed by analogue escalation of sales. The situation in segment “C” is actually different, (figure 9), being the whole relation between sales and PLW not only feeble, but even counterintuitive, especially starting from 1996.

Figure 7: evolution of PLW by brand: 1984-1983 / 1994-2004



As a partial confirmation of the doubtful relation between sales and offer variety, we also calculated the correlation (Pearson’s index) with regards to these two variables trend in segments “B” and “C”, finding no significant correlation (Pearson’s index respectively equal to $-0,11$ and $-0,32$; if a correlation exists between two variables, the Pearson’s index tends to 1, or -1 if the relation is inverse). Therefore, it seems difficult to assert the existence of some meaningful connection between variety and sales, at least at segment level. At brand level, instead, the association between these two parameters seems to diverge greatly depending on the considered brand. Table 6 shows the correlation by brand between PLW trend and sales in the period 1984-2004 (Renault, Peugeot and Citroën excluded, since the historical series concerning French carmakers sales are not complete). Apart from the Ford case (index equal to $0,517$), for all the other brands no significant relation emerge between line width and sales.

Table 6: correlation (Pearson's index) between PLW and sales by brand

	ALFA ROMEO	AUDI	BMW	FIAT	FORD	LANCIA	OPEL	VW
correlation PLW-sales	-0,195	-0,276	0,248	-0,044	0,517	-0,345	0,158	0,059
average PLW (1984-2004)	0,82	1,47	1,70	1,08	0,97	0,42	1,20	1,43

Figure 8: sales and PLW in segment "B"

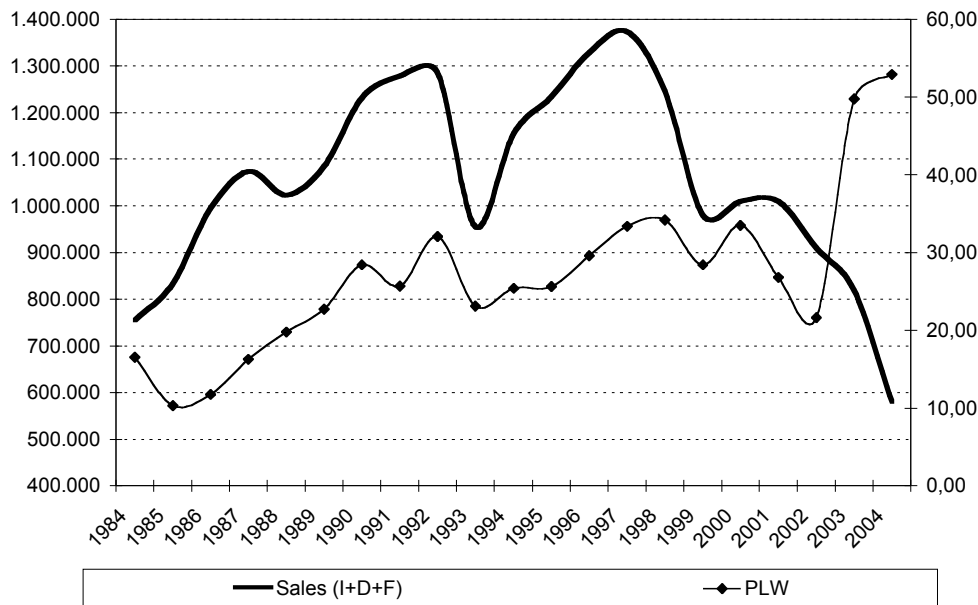
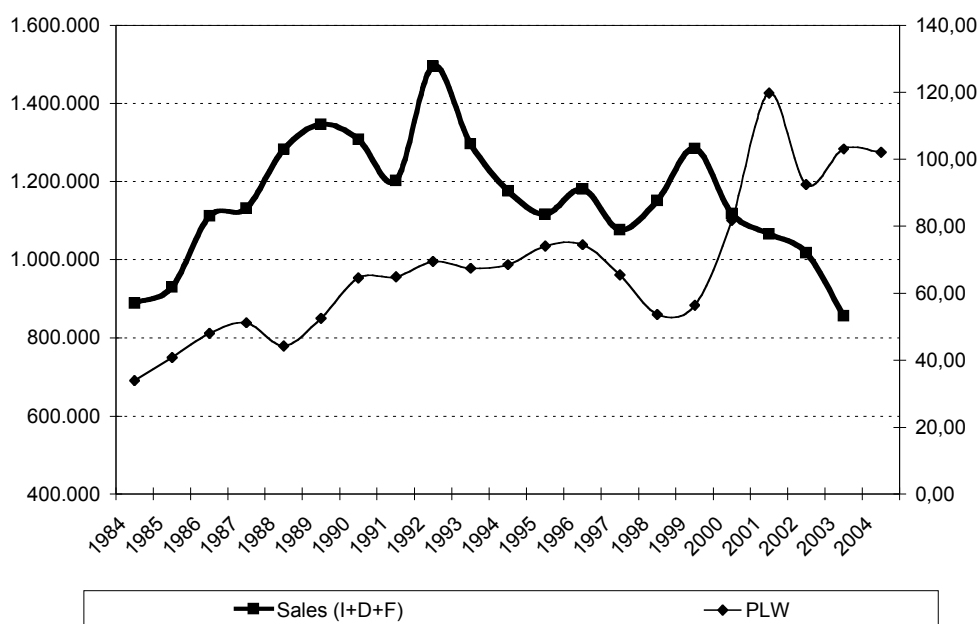


Figure 9: sales and PLW in segment "C"



We also measured the correlation between the variation of PLW and variation of sales, but we found no results worth mentioning. Same kind of counterintuitive situation emerge from the analysis of PLW and sales trend for each brand. For instance, figure 9 and 10 illustrate

respectively Fiat and Ford situation, that are the two brands having respectively the “lower” (near to 0) and the higher correlation index as far as relation between PLW and sales concerns. From such graphics, at a glance, only temporary and weak link seems to emerge.

Figure 9: Fiat sales and PLW (segments “B”, “C”, “D”; Italy, France & Germany)

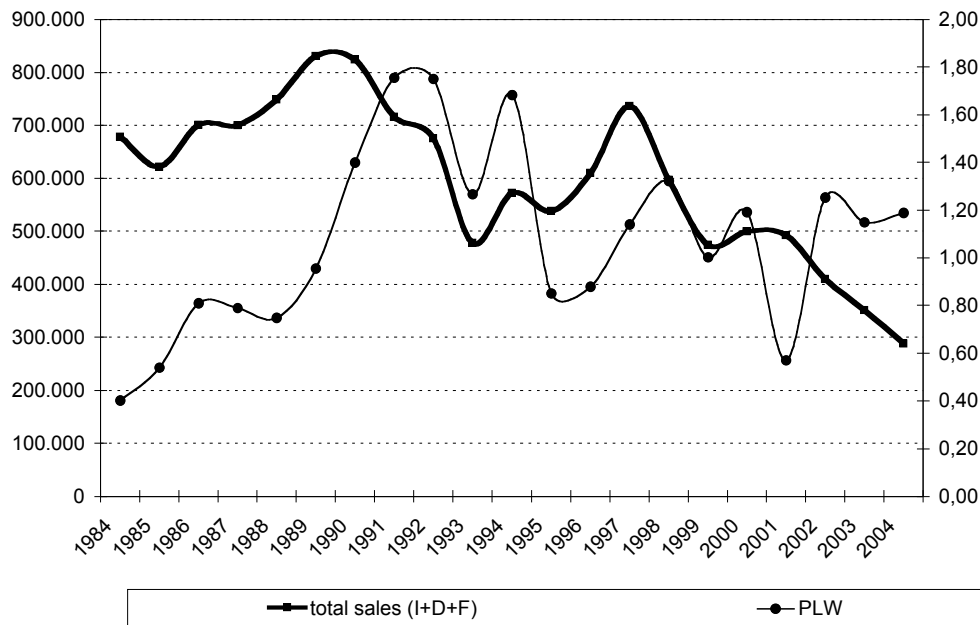
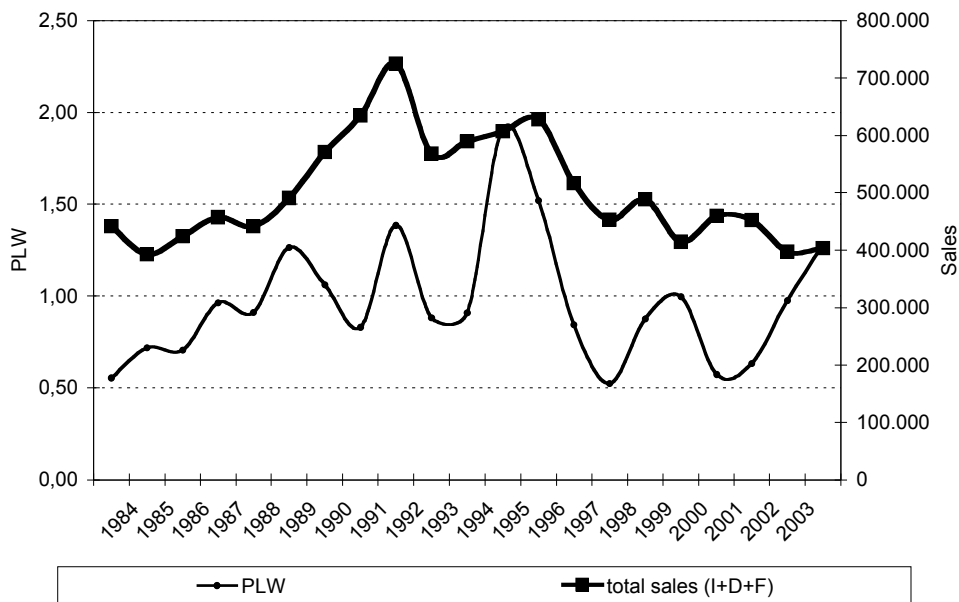


Figure 10: Ford sales and PLW (segments “B”, “C”, “D”; Italy, France & Germany)



A reasonable hypothesis could be the following: carmakers that have predominantly invested in product variety could have opted for a policy of “price skimming”, benefiting from a perceived segmentation to increase product profitability. Unfortunately such hypothesis cannot be evaluated since actual sale prices are not known; it is, in fact, possible to know only list prices that are just the starting point of the negotiation between dealer and customer. Anyway, it is well known that for some carmakers, like for instance BMW and Audi, price cuts are, on average, lower than those of other carmakers. These two brands in last decade have had a high degree of product variety as well as high earnings, and this is coherent with the

hypothesis suggested. On the other hand, if we look at price positioning some arguable data emerge: figure 11 and 12 compares the price positioning of entry-level version and of top-price versions in 1984 and 2004 for the selected brand, respectively in segment “C” and “D”; specifically, the graphs show the percentage difference of each brand price from the lowest price of the segment.

Figure 11: segment “C” price positioning of entry-level version and top-version (% difference from lowest price): 1984 and 2004

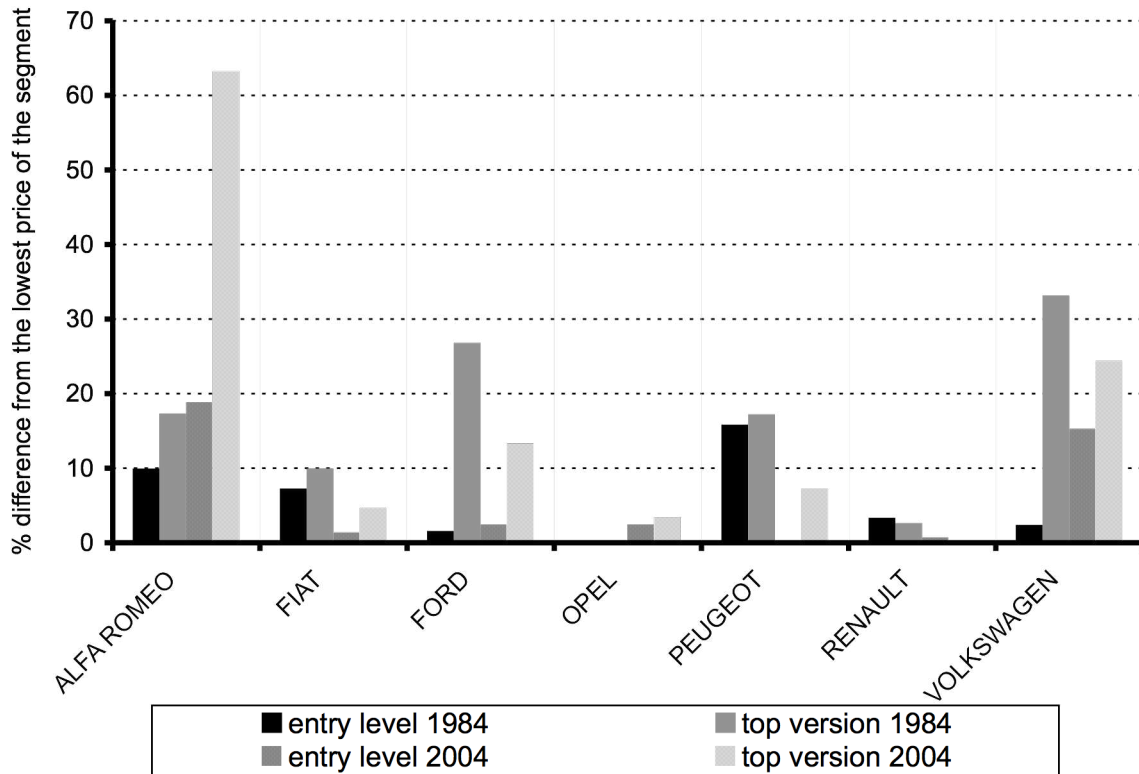
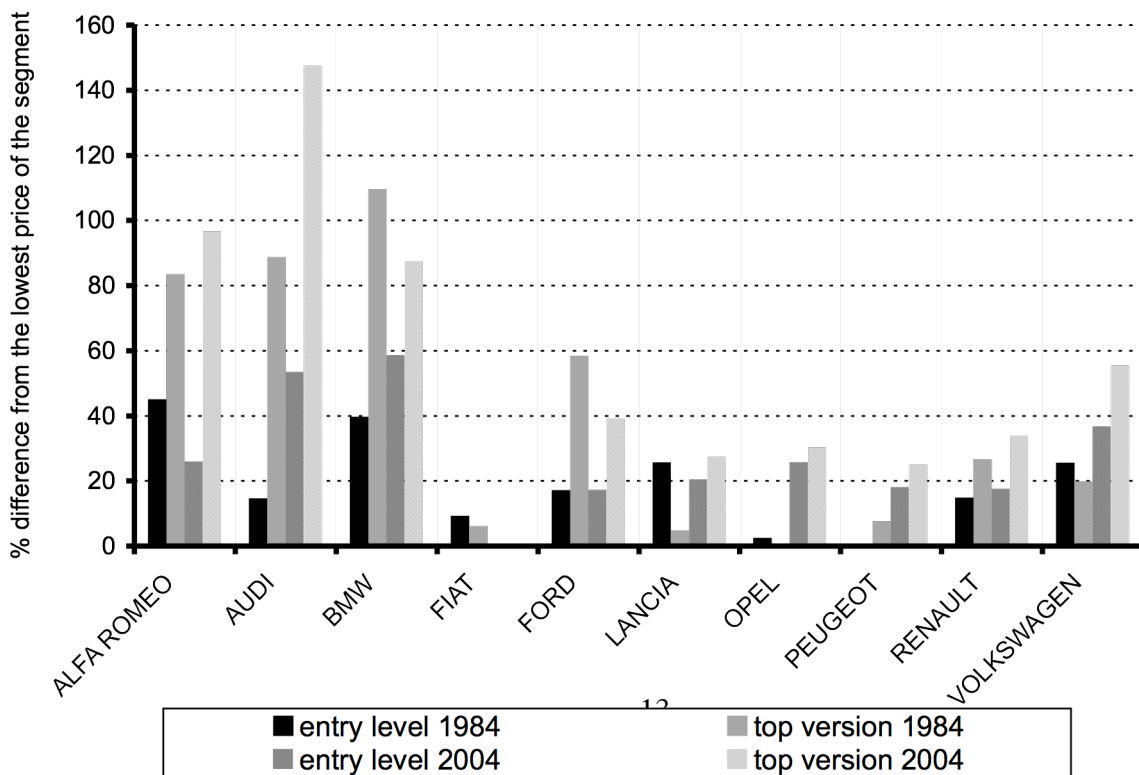


Figure 12: segment “D” price positioning of entry-level version and top-version (% difference from lowest price): 1984 and 2004



According to list prices, in segment “C” and “D” Alfa Romeo is positioned at a high-price level, although its PLW is below the average; in segment “D” Audi and BMW have the highest price positioning and they also have the higher PLW index (figure 11 and 12). It seems reasonable that brands that can rely on a peculiar image will apply higher prices to a lower number of version,

Product Innovation

To evaluate carmakers’ policies towards product line innovation we have measured an index (PLI, see “data and method”) that take into account major model improvements (new model, restyle, new engines) and minor innovation (new versions).

The average duration of model life-cycle has decreased, in general as well as in each segment: in the three segments we have studied, a model that could be bought from 1984 on and that have been introduced in the market before 1993 had an average life-cycle of 7,4 years (table 7); such average interval between a model and its newer substitute decrease to 6,0 years for model introduced after 1993 and to 5,3 years for car models introduced after 1998. Differences between segments are fairly small: segment “B” models experienced a life-cycle reduction of 2,5 years (from 7,5 to 5,0), while in segments “C” and “D” the gap between two new models decreased respectively of 1,7 (from 7,7 to 6,0 years) and 1,9 years (from 7,1 to 5,2 years) (table 7).

Table 7: average model life-cycle duration

	Before 1993	After 1993	After 1998
Segments "B", "C", "D"	7,4	6,0	5,3
Segment "B"	7,5	5,4	5,0
Segment "C"	7,7	6,3	6,0
Segment "D"	7,1	6,5	5,2

Carmakers’ policies in such sense are much more different in the last ten years compared to the previous ten. Between 1984 and 1993 all the examined brands presented an index of product line innovation contained between 0,65 (Lancia) and 1,2 (Renault) that is to say that the difference between the higher value of PLI and the lower one was about 70%. In the last decade such difference has increased significantly, since the lower PLI value remains around 0,60 (Peugeot), while the highest PLI shifts at 2,30 (BMW). The difference between the extreme values is about 380% (fig. 11). Under such circumstances, BMW, Opel, Renault and Volkswagen have significantly increased the frequency of product line renewal, while for all the other carmakers the PLI index shows no relevant modification.

On the other hand, as we said, the PLI measure both major innovations and minor improvements. Such index combine a parameter “ α ” that changes according to model renewal, restyling or according to the introduction of new engines, and a parameter “ β ” that varies according to the introduction of new versions of the same model. If we look at the evolution of the parameter “ α ” by brand then we can see that in the last ten years all carmakers, except Citroën, Ford and Peugeot, has increased (more or less) the frequency of major product innovation (fig. 12). This results let us think that some carmakers have chosen to hunt product innovation introducing more frequently “radical” innovation (e.g. Alfa Romeo, Fiat, Lancia, Renault and Volkswagen) than introducing new versions.

Figure 11: evolution of PLI by brand: 1984-1983 / 1994-2004

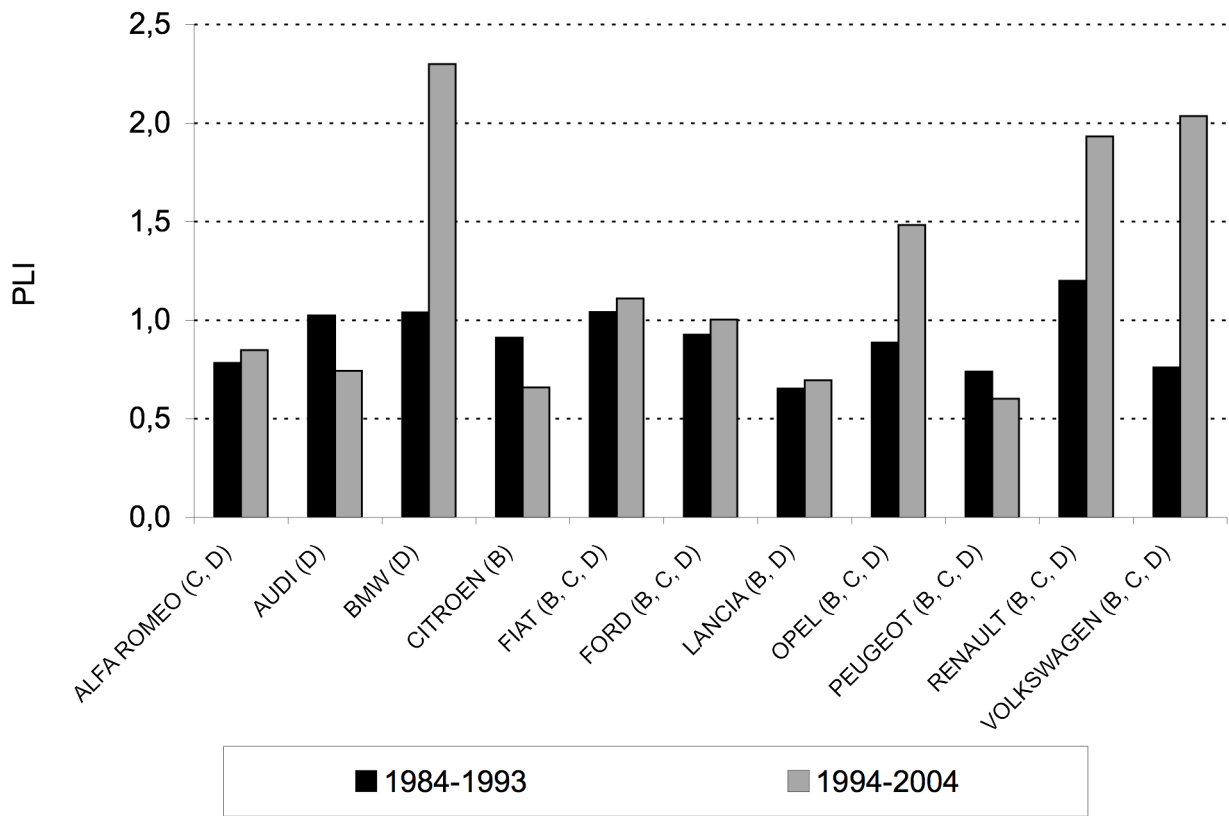
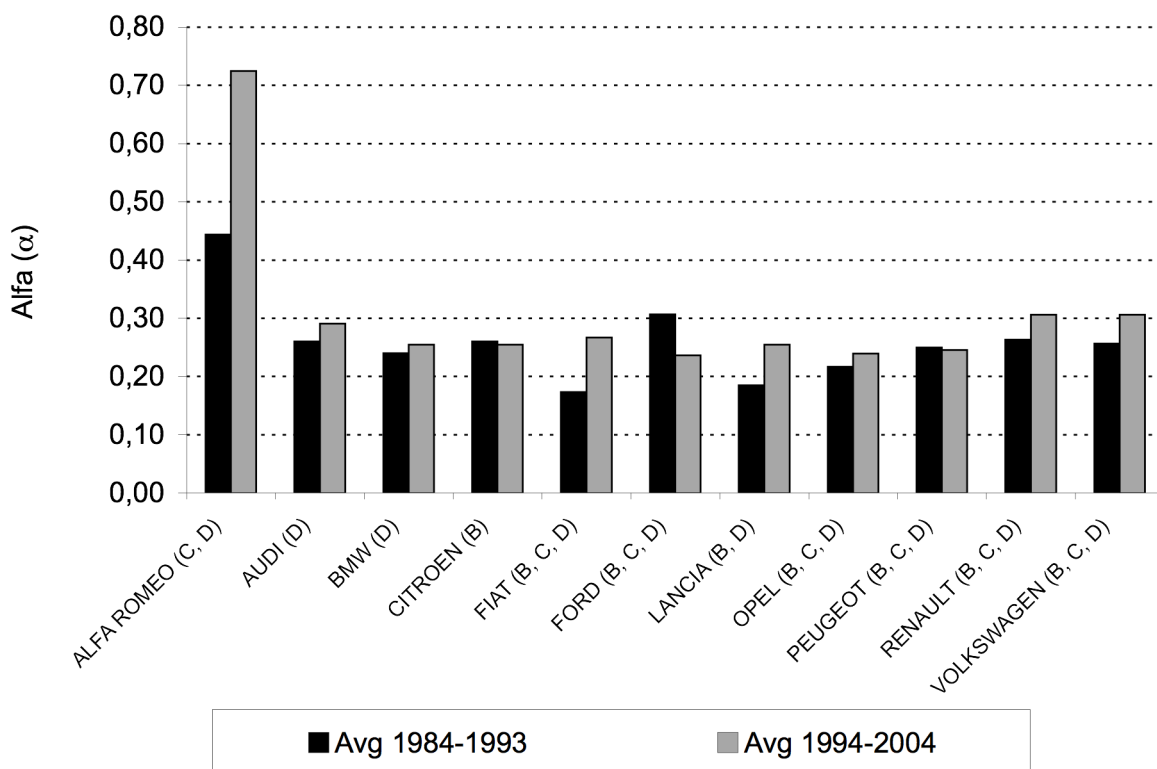


Figure 12: evolution of the parameter “ α ” by brand: 1984-1983 / 1994-2004



As we said, one of the aims of this (ongoing) study was to assess the effectiveness of product policies, especially in relation with product variety and product innovation. No significant relation has been found between line variety (PLW) and sales; on the other hand, there are some reasons that make us believe that the relation between product innovation and sales is much stronger than the previous one. Table 8 show the value of Pearson's index (correlation) between the yearly variation of the "α" parameter and the percentage variation of sales. On average, such values aren't high enough to confirm a strong relation between product "radical" innovation and sales increasing; but, in contrast, these values are from 2 to 4 times higher than the average correlation between PLW and sales (table 8).

Table 8: correlation (Pearson's index) between the variation of "a" and the percentage variation of sales by brand

	ALFA ROMEO	AUDI	BMW	FIAT	FORD	LANCIA	OPEL	VOLKSWAGEN
Seg. "B"				0,499	0,253	-0,231	0,405	0,238
Seg. "C"	0,406			0,567	0,455		0,362	0,293
Seg. "D"		0,483	0,211	0,618	0,421	0,290	0,443	0,412

Although the idea that innovation has an impact of car sales might seem a trivial conclusion, the point is that, according to our data, it has more sense to invest in product innovation rather than in product line enlargement. Another way to claim the same principle is the following: enlarging product line give no additional chance to a model in decline. To give a better idea of what we mean, figure 13 reports the life-cycles of three different model of Volkswagen "Golf" (1985, 1992 and 1998), in terms of sales with respect to previous model (last year sales of previous model = 100). Golf 1985 gets the better performance, although it has been sold in an average of "only" 30,7 versions per year. The other two Golf has been offered respectively in 38,1 and 45,5 versions (yearly average), but their life-cycle show poorer performances. Such situation is more or less widespread to the majority of carmakers and model. See, for instance, fig. 14 about two models of Fiat Punto: the version "2000" obtains much lower performance even though offered in wider line. The increased competition is probably one of the most realistic cause of such behaviour, since the policy of versions proliferation is intended: a) as an easy way to support decline, b) a necessity induced by equivalent policy from competitors. There's no evidence, anyway, that it is also an effective policy, and, very likely, it is less effective than product innovation.

Conclusion

PLC theory is a commonly acknowledged concept in management; however, firms' effectiveness in managing PLC is difficult to assess because of underlying problems related to the fact that sales data should be integrated with other information actually not available (e.g., cross-elasticity, advertising expenses, product profitability, etc.).

In our study we try to outline line-width and line-innovation policies of different carmakers from twenty-one year historical series. First suggestion can be summoned as follow:

- carmakers' policies are significantly different as far as product line width and innovation timing is concerned. Stable trajectories in single carmakers product policies emerge as well;
- innovation policies are shifting from intermittent "radical" innovation (new models, restyle, new engines) towards more frequent & "marginal" innovations new versions);
- although almost all carmakers try to support PLC increasing product-line width, such policy seems rather ineffective. Substantial product renewal, specifically model innovation, is more effective in enhancing sales.

Figure 13: new models lyfe-cycle: Volkswagen Golf

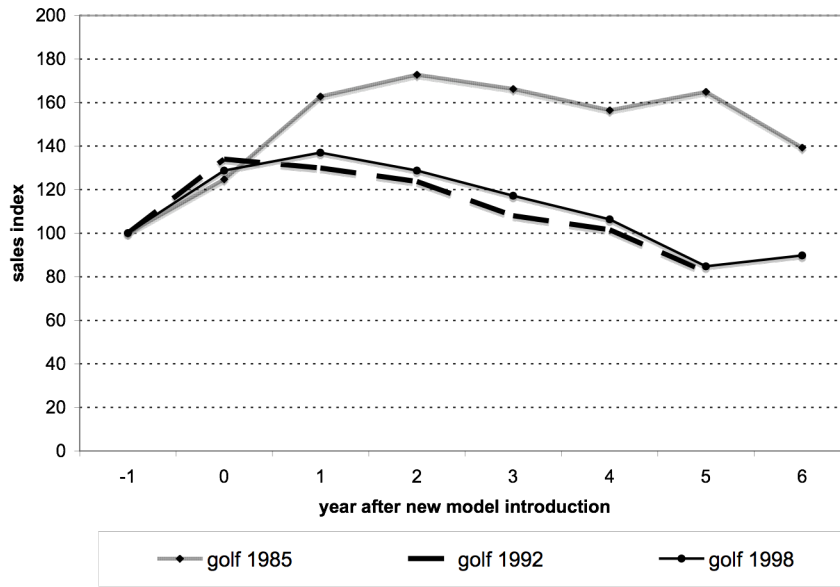
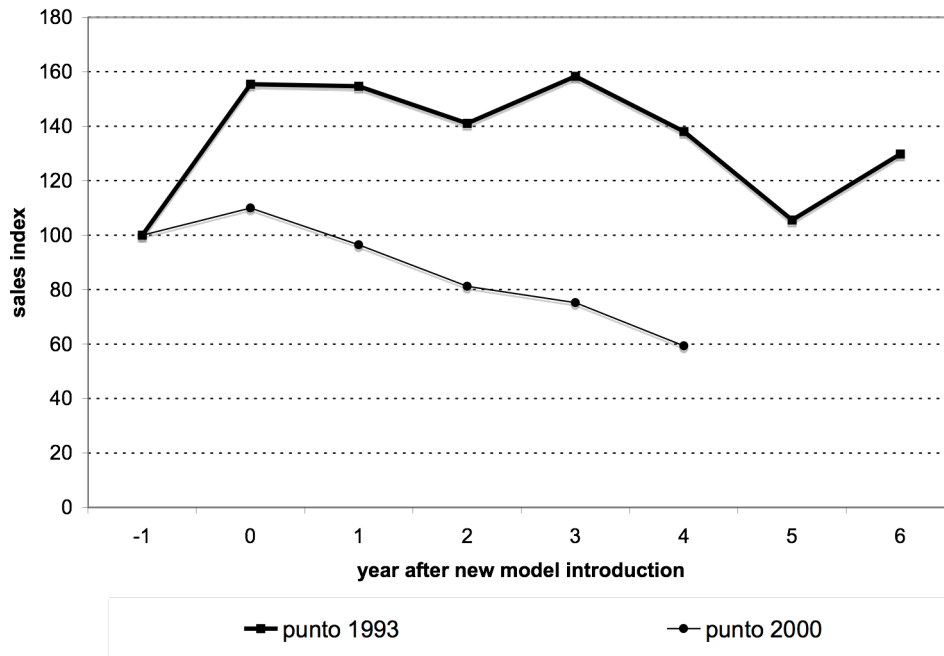


Figure 14: new models lyfe-cycle: Fiat Punto



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