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Notes

The Empirical Exponential Relationship between the Cost of Manufacture and the Retailers' Gross Margin*

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I Introduction

The objectives of the paper are as follows: in the supermarket channel, (1) to examine whether the sum of wholesalers' gross margin and the manufacturer's own distribution cost is similarly distributed between the U.K. and Japan; (2) to state the cost of manufacture can be estimated by the retailers' gross margin based on a company based survey of Japanese manufacturers; (3) to find conditions under which the relationship between the above two possesses an exponential distribution in the sense of statistics.

II Survey And Results

The author conducted a postal survey of 540 British consumer goods manufacturers from February to May, 1986. He also conducted a survey of personal interviews of 39 Japanese consumer goods manufacturers from September to December, 1986. He was able to use 87 replies and 39 replies for analysis respectively. The reader can refer to Seto [1] in more detail about the survey. However, the author was given data of domestic

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electric washing machine and colour TV by the Japanese largest two manufacturers between October, 1987 and March, 1988.

We had three results from the above surveys.

(1) The average percentages of final sales with the standard deviations in he larger outlet channel (L-channel) of the U.K. were 65.6±24.3 for processed food, 74.6±24.8 for clothes and 49.1 ± 33.8 for other consumer goods such as domestic electric appliances, consumer electronics, footwear, crockery, pharmaceuticals, cosmetics, toilet preparations and domestic detergent. The same sorts of figures in Japan were 57.3 ± 16.53, 65.0 ± 6.43 and 35.9 ± 14.7 respectively. As the reader will notice, the two countries had the same tendency.

(2) We cannot state there was a difference between the retailers' gross margin (RGM) expressed as a percentage of the realised retail selling price in the L-channel of the two countries as Figure 1 and Table 1 show although Figure 1 does not include the clothing industries. When y is the British RGM and x is the Japanese RGM,

$$y = \underset{(0.43)}{1.61816} + \underset{(5.53)}{0.88055}\, x \qquad (1)$$

$$r = 0.87 \qquad \bar{R}^2 = 0.73 \qquad s = 4.11$$

The values in the brackets are t-values.

The t-value of the constant term is too small to discriminate it from zero. This is the reason why the diagonal line is drawn in Figure 1. The figures are of butter, sauce (soy-sauce of Japan), margarine, edible oils, mayonnaise, pet food, domestic detergent, confectionery, hams & bacons, domestic electric washing machines, colour televisions, pharmaceuticals and cosmetics. They are market leaders, the second or third largest manufacturers in each country.

Figure 1. Scatter Diagram between RGM in the L-channel of the U.K. (y) and Japan (x), Processed Food and Consumer Goods excluding Clothes

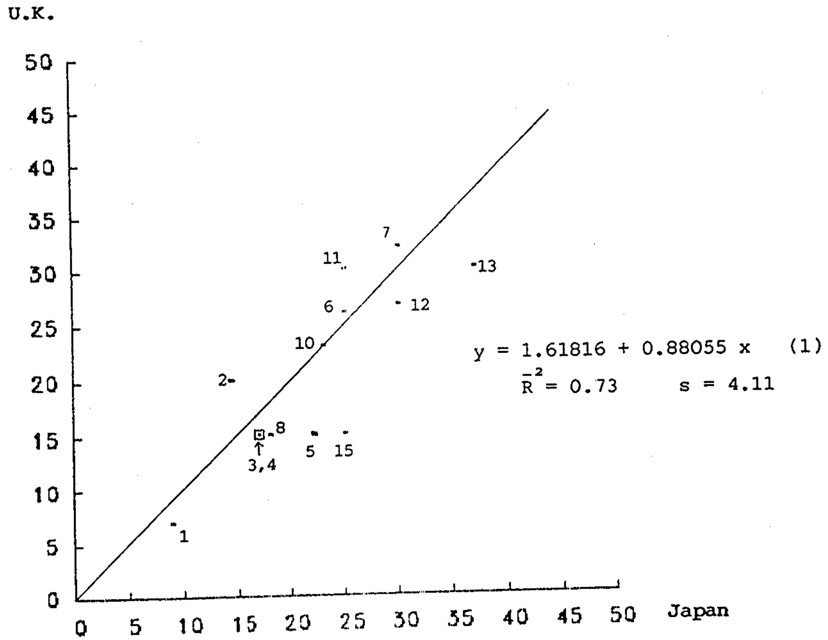


Table 1 Interval Values of RGM in the L-channel of the U.K. and Japan, 1986

	U.K.	Japan	U.K.—Japan
Butter	b	b	−a
Margarine	c	d	−a
Edible oils	c	d	−a
Sauce	d	c	b
Mayonnaise	c	e	−b
Hams & bacons	g	g	a
Confectionery	f	e	a
Pet food	c	f	−b
Domestic detergent	c	d	−a
Domestic electric washing Machine	e	e	±a
Colour TV	f	e	b
Pharmaceuticals	f	f	−a
Cosmetics	f	h	−b
Domestic paint	*	i	
Cameras	*	e	
Children's and men's underwear	*	i	
Lingerie	*	m	
Ladies' sweater	*	l	
Men's outerwear	*	i	

Notes:

a: under 5	e: 20-25	i: 40-45	m: 60-65
b: 5-10	f: 25-30	j: 45-50	*: unknown
c: 10-15	g: 30-35	k: 50-55	
d: 15-20	h: 35-40	l: 55-60	

(3) The British RGM in the L-channel of the clothing industry was less than the Japanese although the author could not compare them with each other on a commodity basis such as lingerie, hosiery and so on. As the reader will notice in the next section, various concepts like the RGM and the cost of manufacture in the L-channel, which means particularly the supermarket channel, cannot be compared with those in the traditional small retailer channel (S-channel) in money terms. Table 2 shows that the realised retail selling prices of eight out of thirteen in the L-channel are lower than those in the S-channel [1] in Japan. The author can indicate

edible oils, margarine and domestic detergent, which are higher in the L-channel in price, are loss leaders. The author's data are of weighted average of ordinary prices and reduced prices.

Table 2 Price Indices of Japanese Commodities, 1987

		S-channel	Chained supermarket	Other supermarket
Hams of quality		100.0	96.9	97.2
Hams		100.0	94.1	95.8
Edible oils	brand A	100.0	109.7	109.6
Margarine		100.0	108.5	108.3
Soy sauce		100.0	94.7	96.2
Mayonnaise		100.0	97.5	98.7
Confectionery	brand A	100.0	95.5	96.1
	brand B	100.0	94.6	95.5
Domestic electric refrigerator	brand A	100.0	92.4	99.8
Domestic electric washing machine, not automatic				
	brand A	100.0	95.6	89.6
	brand B	100.0	90.7	96.4
Domestic detergent	brand A	100.0	105.7	107.1
	brand B	100.0	106.3	107.0
Vitamin	brand A	100.0	102.6	90.6
Colour TV of 21 inches	brand A	100.0	94.5	93.4
	brand B	100.0	98.2	90.0
Camera	brand A	100.0	96.0	94.1
Pet food	brand A	100.0	101.1	101.6

Source: Bureau of Statistics [2]

Remark

Although lingerie, hosiery, sweater, men's and children's underwear and men's outerwear are also tabulated in [2], these in the L-channel are different from those in the S-channel in quality. As a result, we cannot compare these with those.

III Discussion

The author starts the discussion by estimating the relationship of the sum of the British wholesalers' gross margin (WGM) and manufacturer's own distribution cost (ODC) using the Japanese ones. The ODC is defined as the total of the labour cost in the sales department in the manufacturer, the advertising cost and the cost of sales promotion or support given to products. If there is a linear regression relationship between the two countries', we will be able to state that the two countries have the similar scatter diagram between the totals of the RGM and the above sum because we cannot say there is a difference between the RGM of the two countries as described in the last section. We have the regression line (2) if we take the British as y and the Japanese as x in Figure 2. Point numbered 15 was not used for computation because the point will disturb the computation.

$$\underset{}{y} = \underset{(-2.25)}{-9.08566} + \underset{(5.57)}{0.78884\,x} \qquad (2)$$

$$r = 0.88 \qquad \bar{R}^2 = 0.75 \qquad s = 3.70$$

Regression lines (1) and (2) means the two countries have the similar distribution in the sense that the slippage test would be accepted of the cost of distribution (CD) which can be defined as the total of RGM, WGM and ODC. This formula replace the words "the British CD is 17 lower than the Japanese in the L-channel" in Seto [1]. This is the first finding. Although the CD is similarly distributed in the sense of the slippage test, we cannot state the British cost of manufacture (CM) which can be defined as the total of the labour cost, the cost of materials and expenses for manufacture in the factory can be estimated by the RGM. We should be satisfied with the Japanese case. As the reader will probably suppose, it is easier for us to estimate the CM using the CD. However, we have no easy access to the CD. People will much easily be able to use the RGM.

Figure 3 shows that the Japanese CM of consumer goods industries were in the exponential regression relationship on the Japanese RGM in 1986 if points numbered 7 and 19 are eliminated, although the reader should note that the CM and RGM are, strictly speaking, not in the regression relationship, but in the correlation relationship. If we suppose there is a relationship of $y = be^{-cx}$ between y and x, it is convenient for us to take logarithms, to the base e, of both sides to obtain

$$\log y = \log b - cx.$$

Next, letting $u = \log y$ and $a = \log b$, this relationship reduces to the linear relationship

$$u = a - cx.$$

The problem has now been reduced to the problem of fitting a straight line to a set of points in the x, u plane (Hoel [3]). If we eliminate points 7 and 19 from the computation, we obtain

$$\log y = \underset{(54.19)}{4.26937} - \underset{(-10.53)}{0.01314}\, z$$

$$r = -0.94 \qquad \bar{R}^2 = 0.87$$

$$s = 0.14309366 \qquad z = 2x$$

Consequently,

$$y = 1/0.01399\, e^{-0.01314z} \tag{3}$$

This is the second finding.

Formula (3) can be transformed into Formula (4),

$$Y = y/\beta^2 = \frac{1}{\beta} e^{-z/\beta} \tag{4}$$

Figure 2. Scatter Diagram of the Sum of WGM and ODC between the U.K. (Y) and Japan (x) in the L-channel, 1986

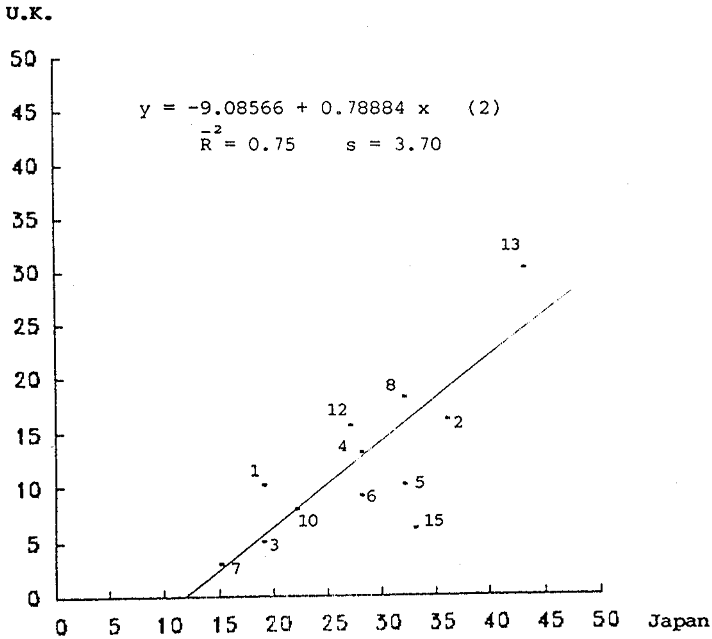
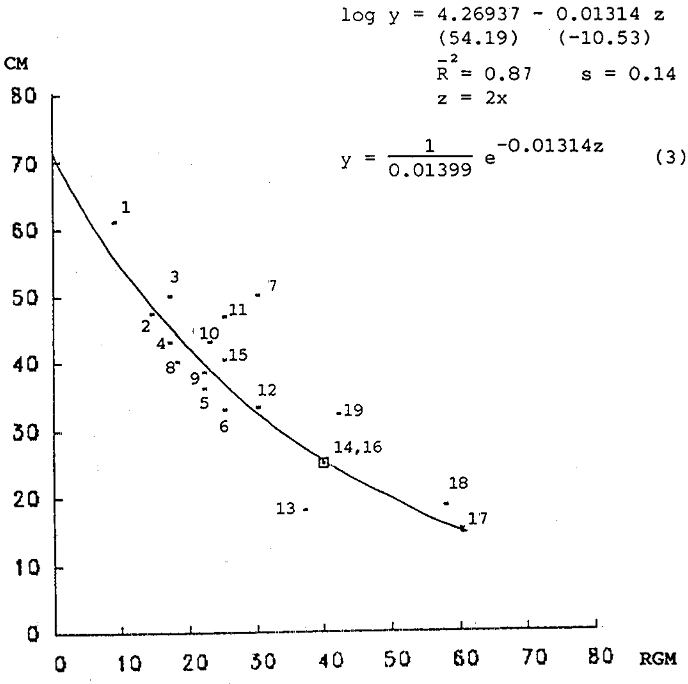


Figure 3. Scatter Diagram between CM (Y) and RGM (x) in the L-channel of the Japanese Consumer Goods Industries, 1986



where $z = 2x$ and β is assumed as 1/0.01399. Formula (4) does not express the exponential distribution of the RGM because the formula is based on the regression relationship between the CD (y) and the RGM (x). Although the author cannot, however, explain the reason, Formula (4), and consequently Formula (3), could explain the relationship between the realised observation and the 'theoretical' observation as follows. We calculate the theoretical and realised frequencies in the following manner. We consider a censored sample of size n from $F(z)$. Let us take twenty as n. The smallest ordered observations are seventeen.

x = RGM	$z = 2x$	realised observations	theoretical observations
0 – 15	30	2	6.86
0 – 30	60	11	11.36
0 – 45	90	14	14.32
0 – 60	120	17	16.27

If we assume that our seventeen observations are the smallest ordered observations out of twenty, the realised observations are closely fitted to the theoretical observations, which means probability, except for the value of less than or equal to 15 where the number of the realised observations are much smaller than the theoretical. The number of the realised observations between 16 – 30 are much greater than the theoretical in turn. This suggests we should consider that several points which are between 16 and 30 would have originally fallen into between 0 – 15 if any kind of business practice had not affected. This is, of course, based on the assumption that the exponential distribution are applicable for any sort of reason, which could not be found in the paper. This is the final finding.

As far as the degree of stability of the exponential relationship is concerned, we have the following values using eleven points from 1 to 12 excluding 7.

$$\log y = \underset{(45.97)}{4.31476} - \underset{(-6.37)}{0.01426}\,z$$

$$\bar{R}^2 = 0.80 \qquad s = 0.08284185$$

$$z = 2x$$

$$y = 1/0.01334\,e^{-0.01426z}$$

As the reader will notice, the value of the RGM, WGM, ODC or CM is restricted to the fact that they are expressed as a percentage of the realised retail selling price respectively. As a result, the sum of the WGM and the ODC can be expressed as follows: $c_2 = (100 - c_1) - x - a\,e^{-2x/a}$, where c_1 means the manufacturer's gross margin excluding ODC (MGM), x means the RGM and $a = 1/0.01399$. If we take 12 as c_1, c_2 is a curve as in Figure 4.

For further investigation

We might have found out an interesting fact in relation to the second finding. If we draw a regression line, which is based on thirteen points from 1 to 15 excluding points numbered 3 and 7, of the CM (y) on the RGM (x) in the S-channel, the line lies very closely to the exponential function around (19.6, 42). The difference is less than the absolute value of 1. Figure 5 shows this situation. Figure 6 shows that we have two regression lines between the CM (y) and the RGM (x_1) in the S-channel if we eliminate point 7 from the computation. The upper line consists of points numbered 16, 17 and 18, which belong to the clothing industry. The reader should notice that the RGM or the CM in the L-channel are expressed as a percentage of the realised retail selling price, which is mostly less than or equal to that in the S-channel. As a result it is restricted to

Figure 4. Exponential Distribution and Curve of the Sum of WGM and ODC in the Japanese L-channel, 1986

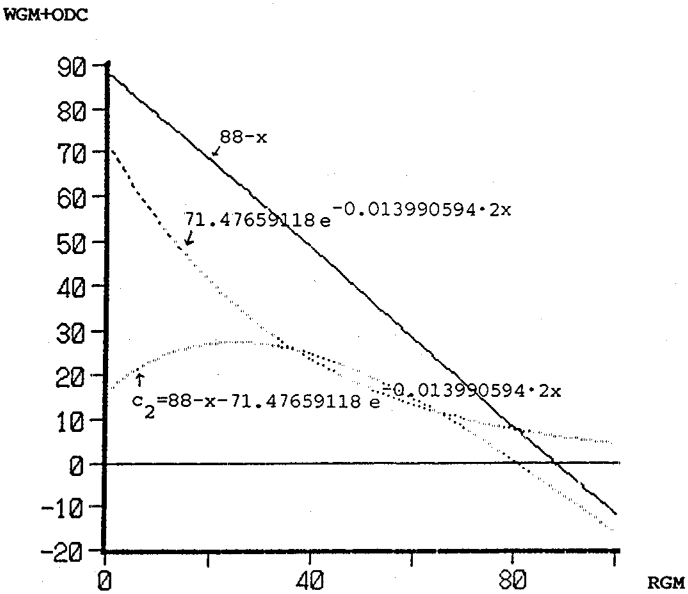


Figure 6. Scatter Diagram between CM (Y) and RGM (x_1) of Japanese Consumer Goods Industries in the S-channel, 1986

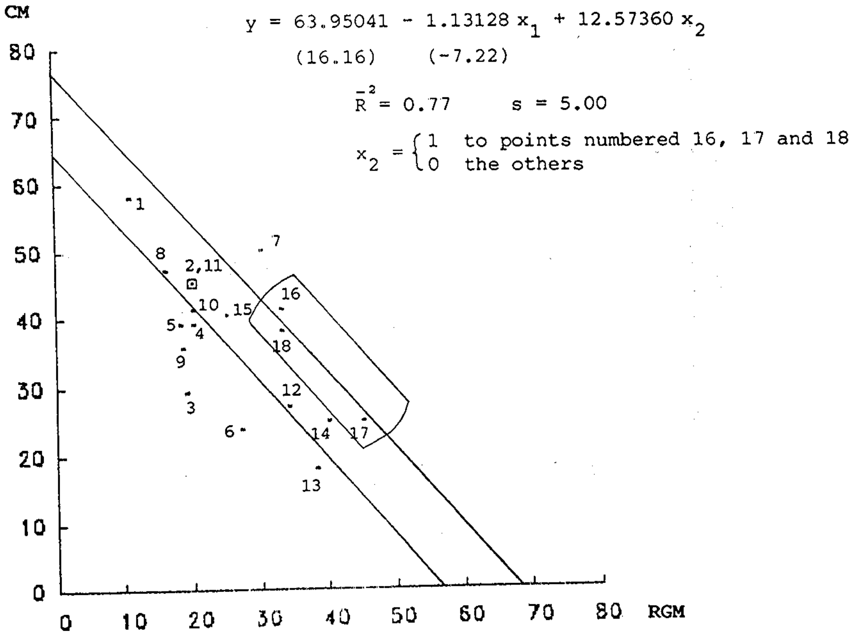
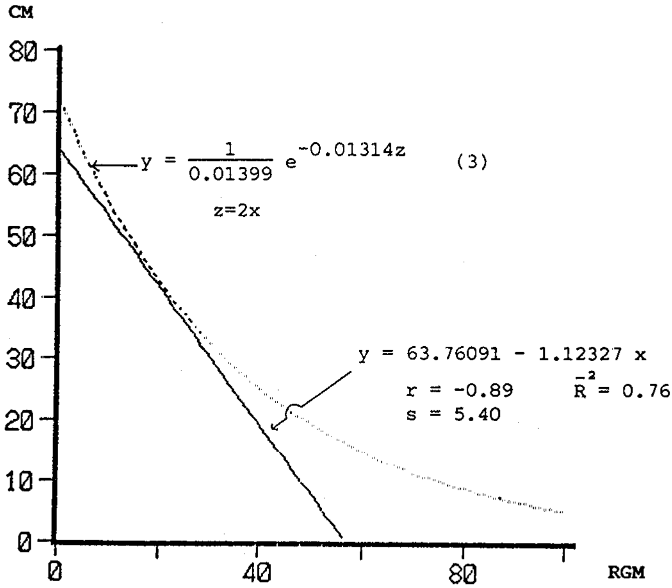


Figure 5. Exponential Regression of the L-channel and Linear Regression of the S-channel, Japan, 1986



the percentage term when we state the CM in the L-channel lies very closely located at the point (19.6, 42). The author has to leave any sort of discussion about its usefulness for the future.

With respect to manufacturer — dealer relationship like passenger cars and lorries, regression line (3) could be helpful to estimate the gross margin for retailing out of the dealers' gross margin, which should consist of the retailers' gross margin and wholesalers' gross margin. If the CM of a sort of passenger car is 56.7, the RGM is 8.81 in the L-channel. The wholesalers' gross margin is 21.19 when the dealers' gross margin is thirty. We might have got a useful estimation procedure for the manufacturer — dealer relationship from the point of view of the gross margin. If the S-channel is more suitable for the manufacturer — dealer relationship, we can use the regression line in Figure 6 in the following manner. When the CM (y) is 56.7, the RGM (x_1) is 6.41. Therefore, the WGM is 23.59 which is 6.41 less than thirty. We will be able to use the regression line (2) in Seto [1] to have 9.60 as the RGM using the value of 23.59 as the WGM. As a result, we have got two sorts of RGM, 6.41 and 9.60 in the S-channel.

III References

[1] Seto, H., "The Cost of Distribution in Britain and Japan", *The International Journal of Physical Distribution & Materials Management*, Vol.18 No.4, 1988, pp.22-31.

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