ALLOCATION GAME IN A SINGLE PERIOD SUPPLY CHAIN MODEL

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ABSTRACT
This paper considers a simple supply chain in which a single supplier sells to several downstream retailers and he may distinguish various retailers' demand by giving more importance to satisfying some categories of demand than others. The supplier has limited capacity. If the retailer orders exceed available capacity, the supplier allocates capacity using publicly known mechanism. After allocation if the supplier is left with inventory he can reallocate the demand. An algorithm has been developed for reallocation of demand using different allocation mechanism. It has been shown numerically, how reallocation mechanism can benefit the retailers as well as supplier causing higher supply chain profits. Further, we have tried to evaluate whether a retailer should use truth-inducing mechanism or he should use manipulable mechanism to increase his profit.

KEYWORDS: Supply chain, Bullwhip effect, Allocation mechanism

MSC 90B05

RESUMEN
Este trabajo considera una cadena simple de abastecimiento en la que un simple suministrador vende a varios intermediarios y puede distinguir varias de sus demandas dándole más importancia satisfaciendo algunas categorías de demanda que otras. El suministrador posee limitada capacidad.. Si las ordenes del intermediario exceden la capacidad disponible, el suministrador sitúa capacidades usando un mecanismo públicamente conocido. Después del suministro si el suministrador tiene sobrantes el re ubica la demanda. Un algoritmo ha sido desarrollado para reubicar de demanda usando diferentes mecanismos de reubicación. SE prueba numéricamente, como el mecanismo de reubicación puede beneficiar al intermediario incrementando sus ganancias.. Además, nosotros tratamos de evaluar si el intermediario debe usar un mecanismo que induzca lo verdadero o uno manipulable para incrementar sus ganancias.

1. INTRODUCTION

A supply chain is a network of facilities and distribution options that performs the functions of procurement of materials, transformation of these materials into intermediate and finished products, and the distribution of these finished products to customers. Recent interest in supply chain management centers on coordination among various members of supply chain i.e. manufacturers, suppliers, wholesalers, and retailers. One important mechanism for coordination in a supply chain is the information flows among members of the supply chain. These information flows have the direct impact on production scheduling, inventory control and delivery plans of individual members in supply chain. If this information is distorted as it passed along the supply chain in the form of orders, there will be larger variability between the orders at the supplier side and the demand at the retailer side. This phenomenon of variance amplification is known as bullwhip effect. This paper considers rationing which is one of the main causes of bullwhip effect and evaluates a rationing game in view of supplier as well as retailer. Rationing refers to strategic ordering behavior of retailer when supply shortage is anticipated. Consider one supplier and multiple retailers. When retailer orders exceed supplier capacity, he has to put the retailers on "allocation" i.e. rationing capacity through quantity limits. An allocation is used commonly in industries in which capacity expansion is costly and time consuming (e.g. steel and paper). It also occurs with popular new products such as initial public offerings of stocks, toys and sweets at festive time.

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In practice, various allocation schemes are used. Many car companies use a "turn and earn" scheme, rationing hot models on the basis of past sales. In some instances, explicit preferences are granted contractually; Frito-Lay, for example, has exclusive access to Procter and Gamble's new fat substitute [6]. Alternatively powerful customers may demand priority. The chosen allocation mechanism matters when retailers anticipate different levels of demand. Those expecting high demand would optimally set a high stocking level while the less optimistic would choose lower levels. Ideally, when the sum of needs exceeds available capacity, stock would be allocated among the retailers to maximize their total profits. Although collectively rational, such an arrangement requires that each retailer necessarily receive less than his optimal amount. Despite grumbling from individual retailers, the supplier could allocate stock to maximize total profits if he knew each retailer's ideal stocking level. Instead a supplier can only use his past experiences regarding retailer needs and submitted orders to construct an allocation scheme. Even if his beliefs are accurate in expectation, retailers may game the system, distorting their orders to receive larger allotments.

In such a case, the question arises that which allocation mechanism should a supplier use when the retailer uses manipulable mechanism? How does the chosen allocation mechanism influence? How much capacity the supplier should build? How does it affect the profit incurred at supplier as well as retailer side? There can be two types of ordering decision-one in which each retailer gives his actual demand to supplier which is called truth inducing mechanism and second in which each retailer inflates or suppress his order to get maximum share of the allocation which is called manipulable mechanism. If retailers order exactly their needs, the supplier could allocate more to those with the larger market. On the other hand, if the retailer would use manipulable mechanism, the supplier may not determine who truly needs the stock. Some with high-expected demand may receive too little and others with low expected demand may receive too much. In the end the system serves all retailers poorly. A supplier may distinguish between the demands he receives for an item, attaching greater importance to satisfying some categories of demand than others. The distinction may be based on customer characteristics, on the need for item, and so on. Such a supplier, with limited stock, must make a decision about allocating. Cachon and Lariviere [1,3] investigate the properties of capacity allocation mechanisms for the market where a single supplier supplies multiple numbers of retailers who enjoys local monopoly. Lee et al [7,8] demonstrate that allocating capacity in proportion to orders induces strategic behavior. Kaplan [4] discusses the use of reserve levels i.e. the stock levels at which a supplier should stop issuing in response to lower priority demand filling the higher priority demand. Nahmias[5] considers an inventory system in which stock is maintained to meet both high and low priority demands. When the stock level reaches some specified point all low priority demands are backordered while high priority demands are continued to be filled. The present paper is different from the above papers in the sense that it tries to compare different allocation mechanisms, which takes into account both the priorities as well as satisfaction of all the retailers. This paper reflects a case in which capacity is a constraint for the supplier, due to which he uses different allocation to fulfill the orders of the retailers partially or fully. The orders received by the supplier are relatively insensitive to the capacity decision, when capacity is high, but as capacity is reduced to a critical level, retailers raise their orders to get a better allocation. If the supplier is left with some inventory and the retailers demand is not satisfied he can reallocate the demand. We have proposed an algorithm for reallocation of demand through which not only the supplier is benefited, by avoiding lost sales, but the retailers too have got the optimum share of the order. It is shown numerically that after reallocation the supply chain profit has been increased.

The rest of the paper is organized as follows. Section 2 gives the notations and assumptions, which are used to develop the model. In section 3, we have developed the model for a single supplier and N retailers by considering different allocation mechanisms. We have tried to develop a procedure for reallocation of the demands that can increase the supply chain profit. A numerical analysis is presented in section 4 that shows the increase in profit at the retailer as well as the supplier's side. A comparative study between the two allocation mechanisms is done. The conclusions regarding the model are given in section 5.

2. NOTATIONS AND ASSUMPTIONS

The following notations are used in the paper:

z_i order quantity of retailer i.

h_1	holding cost as the percent of unit selling price for supplier
h_2	holding cost as the percent of unit selling price for retailer
s_1	shortage cost per unit for supplier
s_2	shortage cost per unit for retailer
c_1	Cost per unit at the retailer side which is also the selling price of the supplier
c_2	Cost per unit of the supplier
c_3	Selling price of the retailer
P_s	Profit for the supplier
P_i	Profit for the retailer i

The following assumptions are made to develop the model:

1. The capacity of the supplier (K) is finite and constant during the period under review.
2. The supplier has announced publicly the allocation mechanism he will use if total retailer orders exceed available capacity.
3. Retailers submit their orders independently and orders are the only communication between the retailers and the supplier.
4. No retailer can share his private information with the other retailer.
5. The supplier can't deliver to a retailer more than he has ordered.

3. MODEL DEVELOPMENT

Consider a simple supply chain in which a single supplier sells to N downstream retailers. The supplier has limited capacity and retailers are privately informed of their optimal stocking levels. If retailer orders exceed available capacity, the supplier allocates the capacity using different allocation mechanism. When the sum of needs exceeds available capacity, stock would be allocated among the retailers to maximize the profits of supplier as well as retailer.

The supplier can allocate the capacity using two mechanisms –linear allocation and uniform allocation. A Linear allocation deducts common number of units from each retailer's order. More specifically, index the retailers in decreasing order of their orders and allocate the retailer i according to linear allocation as

$$Q_i^l(z,n) = \begin{cases} z_i - \frac{1}{n}\max\left(0, \sum_{j=1}^{n} z_j - K\right) & i \le n \\ 0 & i > n \end{cases} \tag{1}$$

where n is the greatest integer less than or equal to N such that $Q_i^l(z,n) \ge 0$.

In Uniform allocation also, index the retailer in decreasing order of their orders and allocate the retailer i as

$$Q_i^u(z,n) = \begin{cases} \frac{1}{n}\left(K - \sum_{j=n+1}^{N} z_j\right) & i \le n \\ z_i & i > n \end{cases} \tag{2}$$

where n is the greatest integer less than or equal to N such that $Q_i^u(z,n) \le z_n$.

We consider both the mechanism to calculate retailer's profit as well as supplier's profit.

3.1. Retailer's profit

The retailer's ordering decision problem is to decide the proper order quantity, which he will order to supplier to get the maximum profit. Since the supplier has limited stock he would allocate the order according to different allocation, which will directly affect the retailer's profit.

If the supplier follows linear allocation then the retailer profit is given by

$$P_i^l = (c_3 - c_1)Q_i^l(z,n) - h_2 Q_i^l(z,n) - s_2(z_i - Q_i^l(z,n)) \quad (3)$$

Similarly the retailer's profit according to uniform allocation is

$$P_i^u = (c_3 - c_1)Q_i^u(z,n) - h_2 Q_i^u(z,n) - s_2(z_i - Q_i^u(z,n)) \quad (4)$$

3.2. Supplier's profit

The supplier's profit according to linear allocation and uniform allocation is given by

$$P_s^l = c_1 \sum_{i=1}^{n} Q_i^l(z,n) - c_2 K - h_1(K - \sum_{i=1}^{n} Q_i^l(z,n)) - s_1(\sum_{i=1}^{N} z_i - K) \quad (5)$$

$$P_s^u = c_1 \sum_{i=1}^{n} Q_i^u(z,n) - c_2 K - h_1(K - \sum_{i=1}^{n} Q_i^u(z,n)) - s_1(\sum_{i=1}^{N} z_i - K) \quad (6)$$

The supplier is having shortages due to limited capacity moreover; he is left with some inventory after fulfilling the orders of retailers using the allocation (linear/uniform). In this scenario, the supplier can reallocate the remaining inventory to avoid inventory-carrying cost. The reallocation of inventory can be done according to the allocation mechanism chosen by the supplier. We have developed an algorithm for reallocation for two allocation mechanisms under consideration, using which the supplier can reallocate his entire inventory and get away with inventory carrying cost. At the same time, he will be able to fulfill the demand of those retailers, which otherwise were getting no allocation.

3.3. Algorithm for reallocation using linear allocation

Step 1. Allocate orders to the retailers according to linear allocation.

Step 2. If $\sum_{i=1}^{n} z_i < K$, allocate the remaining units i.e. $K - \sum_{i=1}^{n} z_i$ to the retailer 1.

Step 3. If $\sum_{i=1}^{n} z_i < K$ and $Q_1^l = z_1$, allocate $K - \sum_{i=1}^{n} z_i$ to the retailer 2.

Step 4. Continue the allocation to succeeding retailer until $\sum_{i=1}^{n} z_i = K$ and all the preceding orders are fully satisfied.

3.4. Algorithm for reallocation using uniform allocation

Step 1. Allocate orders to the retailers according to uniform allocation.

Step 2. If $\sum_{i=1}^{N} z_i < K$, allocate the remaining units i.e. $K - \sum_{i=1}^{N} z_i$ to the retailer n.

Step 3. If $\sum_{i=1}^{N} z_i < K$ and $Q_n^u = z_n$, allocate $K - \sum_{i=1}^{N} z_i$ to the retailer $n-1$.

Step 4. Continue the allocation to preceding retailer until $\sum_{i=1}^{N} z_i = K$ and all the succeeding orders are fully satisfied.

4. NUMERICAL STUDY

To gain more insights, a numerical study is presented to compare the two allocation mechanisms. An analysis of the allocation mechanism in terms of the profit at supplier as well as retailer's side has been provided. Then the reallocation is done due to which an increase in supply chain profit can be seen. Consider the demand (z_i) for 10 retailers in Table1 and c_1 =\$50, c_2 =\$30, c_3 =\$90, h_1 =\$6, h_2 =\$7, s_1 =\$8 , s_2 =\$10, K =150.

4.1. Retailer's side

Results of the linear allocation given by the supplier (using equation (1)) to different retailer and reallocation after applying the proposed algorithm (section 3.3) has been summarized in Table1, whereas Table 2 exhibits the profit of the retailers before and after applying the reallocation algorithm.

Table 1 : Demand Allocation- Linear Allocation

		Before reallocation							*After reallocation*						
S.no.	z_i	n =4	n =5	n =6	n =7	n =8	n =9	n =10	n =4	n =5	n =6	n =7	n =8	n =9	n =10
1	34	34	34	34	33	32	31	31	34	34	34	**34**	**34**	**34**	**34**
2	26	26	26	26	25	24	23	23	26	26	26	**26**	**26**	**26**	**25**
3	25	25	25	25	24	23	22	22	25	25	25	**25**	**24**	**24**	22
4	21	21	21	21	20	19	18	18	21	21	21	**21**	19	18	18
5	18	0	18	18	17	16	15	15	**18**	18	18	**18**	16	15	15
6	15	0	0	15	14	13	12	12	**15**	15	15	**15**	13	12	12
7	12	0	0	0	11	10	9	9	**11**	11	**11**	11	10	9	9
8	10	0	0	0	0	8	7	7	0	0	0	0	8	7	7
9	8	0	0	0	0	0	5	5	0	0	0	0	0	5	5
10	6	0	0	0	0	0	0	3	0	0	0	0	0	0	3
$\sum z_i$	175	106	124	139	144	145	142	145	150	150	150	150	150	150	150

Table 2: Profit for retailers (Linear Allocation)

	Before reallocation							*After reallocation*						
S.no.	n =4	n =5	n =6	n =7	n =8	n =9	n =10	n =4	n =5	n =6	n =7	n =8	n =9	n =10
1	1122	1122	1122	1079	1036	993	993	1122	1122	1122	**1122**	**1122**	**1122**	**1122**
2	858	858	858	815	772	729	729	858	858	858	**858**	**858**	**858**	**815**
3	825	825	825	782	739	696	696	825	825	825	**825**	**782**	**782**	696
4	693	693	693	650	607	564	564	693	693	693	**693**	607	564	564
5	-180	594	594	551	508	465	465	**594**	594	594	**594**	508	465	465
6	-150	-150	495	452	409	366	366	**495**	**495**	495	**495**	409	366	366
7	-120	-120	-120	353	310	267	267	**353**	**353**	**353**	353	310	267	267
8	-100	-100	-100	-100	244	201	201	-100	-100	-100	-100	244	201	201
9	-80	-80	-80	-80	-80	135	135	-80	-80	-80	-80	-80	135	135
10	-60	-60	-60	-60	-60	-60	69	-60	-60	-60	-60	-60	-60	69

Table 3: Demand Allocation - Uniform Allocation

		Before reallocation							*After reallocation*						
S.no.	z_i	n =4	n =5	n =6	n =7	n =8	n =9	n =10	n =4	n =5	n =6	n =7	n =8	n =9	n =10
1	34	20	19	19	18	17	16	15	20	19	19	18	17	16	15
2	26	20	19	19	18	17	16	15	20	19	19	18	**18**	**19**	**20**
3	25	20	19	19	18	17	16	15	20	**22**	**22**	**24**	**25**	**25**	**25**
4	21	20	19	19	18	17	16	15	**21**	**21**	**21**	**21**	**21**	**21**	**21**
5	18	18	18	18	18	17	16	15	18	18	18	18	**18**	**18**	**18**
6	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
7	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
8	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
9	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
10	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
$\sum z_i$	175	149	145	145	141	136	131	126	150	150	150	150	150	150	150

Moreover, Table3 represents how the retailers are allocated through uniform allocation (using equation (2)) and the reallocation after applying the proposed algorithm in (section 3.4). Further, Table 5 and 6 represents percentage change in retailer's profit using linear and uniform allocation respectively.

4.2. Supplier's side

Now we consider the profit at the supplier side due to linear allocation and uniform allocation. Supplier's profit through linear and uniform allocation (using equation 5and 6) and after applying the proposed reallocation algorithm (in section 3.3 and 3.4 respectively) has been presented in Table 7 and 8 respectively, whereas percentage change in profit has been shown in table 9 and 10 respectively .A comparative graph in respect to the change in profit after reallocation has been shown in Figure1.

Table 4: Profit for retailers (Uniform Allocation)

	Before reallocation							*After reallocation*						
S.No.	n =4	n =5	n =6	n =7	n =8	n =9	n =10	n =4	n =5	n =6	n =7	n =8	n =9	n =10
1	520	477	477	434	391	348	305	520	477	477	434	391	348	305
2	600	557	557	514	471	428	385	600	557	557	514	**514**	**557**	**600**
3	610	567	567	524	481	438	395	610	**696**	**696**	**782**	**825**	**825**	**825**
4	650	607	607	564	521	478	435	**693**	**693**	**693**	**693**	**693**	**693**	**693**
5	594	594	594	594	551	508	465	594	594	594	594	**594**	**594**	**594**
6	495	495	495	495	495	495	495	495	495	495	495	495	495	495
7	396	396	396	396	396	396	396	396	396	396	396	396	396	396
8	330	330	330	330	330	330	330	330	330	330	330	330	330	330
9	264	264	264	264	264	264	264	264	264	264	264	264	264	264
10	198	198	198	198	198	198	198	198	198	198	198	198	198	198

4.3. Comparative study between linear allocation and Uniform allocation

We observe from Table1, that using linear allocation, for n = 4, 5, 6, the total allocation to retailers i.e.

$\sum z_i$ is less than the total capacity of the supplier i.e. K, means supplier is left with surplus inventory whereas some of the retailers have zero allocation, which causes shortage cost to these retailer and a high inventory carrying cost to the supplier as well. But after reallocation some of the retailers who otherwise, were having zero allocation get maximum allocation, sometimes up to their demand. Because of this, there is significant increase in the profit of these retailer, which has been exhibited in Table 2.Further for n =7,8,9,10, the reallocation is done first to high demand retailers, if any, that increases the profit of these retailers and thereafter if capacity is available, the low demand retailers are allocated. Moreover, while using uniform allocation, the low order retailers are allocated first and some amount of demand of high order retailers are deducted, due to which high order retailers incurs stock outs, Table 3. Reallocation, of the left out inventory helps the high order retailers to enhance their share, which ultimately increases their profit (Table 4). Further, it can be seen from the Table 4, that the highest order retailer will always be at a loss, since they never gets their full allocation, even after reallocation.

Table 5: Percentage change in Profit (in Linear Allocation)

S.no.	n =4	n =5	n =6	n =7	n =8	n =9	n =10
1	*0*	*0*	*0*	*3.99*	*8.3*	*13*	*13*
2	*0*	*0*	*0*	*5.28*	*11.1*	*17.7*	*11.8*
3	*0*	*0*	*0*	*5.5*	*5.82*	*12.4*	*0*
4	*0*	*0*	*0*	*6.62*	*0*	*0*	*0*
5	*430*	*0*	*0*	*7.8*	*0*	*0*	*0*
6	*430*	*430*	*0*	*9.51*	*0*	*0*	*0*
7	*394*	*394*	*394*	*0*	*0*	*0*	*0*
8	*0*	*0*	*0*	*0*	*0*	*0*	*0*
9	*0*	*0*	*0*	*0*	*0*	*0*	*0*
10	*0*	*0*	*0*	*0*	*0*	*0*	*0*

Table 6: Percentage change in Profit (in Uniform Allocation)

S.no.	n =4	n =5	n =6	n =7	n =8	n =9	n =10
1	*0*	*0*	*0*	*0*	*0*	*0*	*0*
2	*0*	*0*	*0*	*0*	*9.13*	*30.1*	*55.8*
3	*0*	*22.8*	*22.8*	*49.2*	*71.5*	*88.4*	*109*
4	*6.62*	*14.2*	*14.2*	*22.9*	*33*	*45*	*59.3*
5	*0*	*0*	*0*	*0*	*7.8*	*16.9*	*27.7*
6	*0*	*0*	*0*	*0*	*0*	*0*	*0*
7	*0*	*0*	*0*	*0*	*0*	*0*	*0*
8	*0*	*0*	*0*	*0*	*0*	*0*	*0*
9	*0*	*0*	*0*	*0*	*0*	*0*	*0*
10	*0*	*0*	*0*	*0*	*0*	*0*	*0*

By using any allocation the supplier is left with some inventory, which incurs inventory-carrying cost. Since capacity is a constraint, shortages will occur which reduces his profit. But after reallocation he is able to allocate up to his capacity to the retailers, and reducing his inventories to zero. As a result his profit also increases. It is observed from Table 9 and 10, that in linear allocation there is significant increase in profit for small values of n whereas in uniform allocation there is substantial increase in profit for large values of n. Moreover, supplier's profit remains the same in both the cases, but change in profit varies from retailer to retailer.

Table 7: Supplier's profit with Linear Allocation

n	*Before reallocation*		*After reallocation*	
	Inventory	*Profit (in $)*	*Inventory*	*Profit (in $)*
4	*44*	*336*	*0*	*2800*
5	*26*	*1344*	*0*	*2800*
6	*11*	*2184*	*0*	*2800*
7	*6*	*2464*	*0*	*2800*
8	*5*	*2520*	*0*	*2800*
9	*8*	*2352*	*0*	*2800*
10	*5*	*2576*	*0*	*2800*

Linear allocation gives priority to high demand retailer; therefore some of the low demand retailer might get zero allocation which causes high shortages at their end. Also since supplier is not been able to satisfy all the retailers, though he is having inventory with him, the small retailer will lose interest in ordering him again. There can be the possibility that the retailer will inflate their orders to get maximum share, which can create an artificial market. After reallocation the supplier is able to satisfy some retailer partially or fully by filling their orders, but still some retailers are left with shortages.

Table 8: Supplier's profit with Uniform Allocation

n	*Before reallocation*		*After reallocation*	
	Inventory	*Profit (in $)*	*Inventory*	*Profit (in $)*
4	*1*	*2744*	*0*	*2800*
5	*5*	*2520*	*0*	*2800*
6	*5*	*2520*	*0*	*2800*
7	*9*	*2296*	*0*	*2800*
8	*14*	*2016*	*0*	*2800*
9	*19*	*1736*	*0*	*2800*
10	*24*	*1456*	*0*	*2800*

Table 9: Percentage change in profit in Linear Allocation

n	*Before reallocation Profit (in $)*	*After reallocation Profit (in $)*	*percentage change in profit*
4	*336*	*2800*	*733.33*
5	*1344*	*2800*	*108.33*
6	*2184*	*2800*	*28.20*
7	*2464*	*2800*	*13.63*
8	*2520*	*2800*	*11.11*
9	*2352*	*2800*	*19.04*
10	*2576*	*2800*	*8.69*

On the other hand Uniform allocation favors small retailers. Also for any value of n, all the high ordered retailers are allocated uniformly with equal allocation. After reallocation the high ordered retailers get an increase in their allocation since all the low ordered retailers are fully satisfied. In any case each retailer is getting some part of his order; therefore there is no case of zero allocation. Uniform allocation achieves high supply chain profit when capacity is relatively low.

Table 10: Percentage change in profit in Uniform Allocation

n	Before reallocation Profit (in $)	After reallocation Profit (in $)	Percentage change in profit
4	2744	2800	2.04
5	2520	2800	11.11
6	2520	2800	11.11
7	2296	2800	21.95
8	2016	2800	38.88
9	1736	2800	61.29
10	1456	2800	92.30

Truth inducing mechanism increases profit at the retailer end but it fails to maximize the same at the supplier side. It is due to the fact that if a supplier invests in producing the capacity, which is more than the actual demand, he will remain with the inventory even after satisfying the demand. The supplier's profit will be maximum only when whole capacity is utilized. When capacity is relatively low truth-inducing mechanism is favorable. Therefore, if the retailers increase or decrease their order under manipulable mechanism then definitely the supplier's profit will be maximized, though the retailer won't get the same profit. The supplier will always gain by implementing a manipulable mechanism because he faces a lower risk of keeping idle capacity. Reducing idle capacity is more important than a perfect allocation of capacity among retailers.

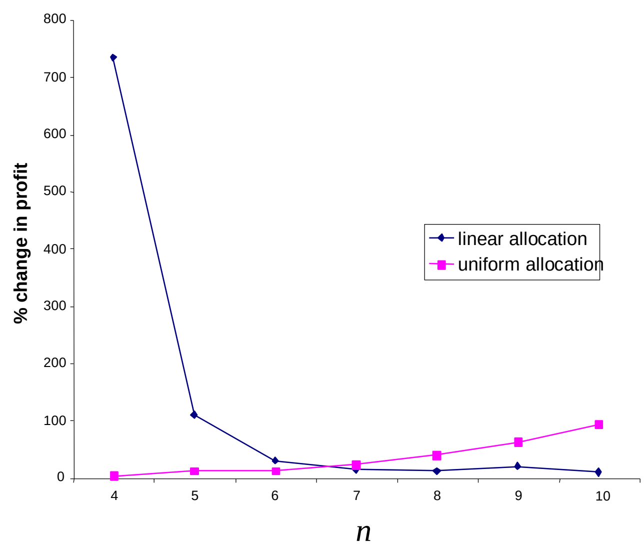

Figure1. Comparison between linear and uniform allocation

5. CONCLUSION

This paper investigates a model with single supplier and multiple retailers. The retailers have monopoly in the consumer market but compete through their orders for scarce supplier's capacity. We have shown that the allocation mechanisms induce the retailers to place their optimal order by inflating or deflating the orders in an effort to gain a better allotment of stock. Inflating order may be beneficial in the case of linear allocation, where the high demand retailer is given priority. On the other hand suppressing the order is beneficial in uniform allocation, where the low demand retailers are given priority. In any case the supplier is left with some inventory, now in order to utilize the leftover inventory reallocation procedure has been introduced through which supplier not only get rid of his left over inventory by satisfying the demand of those retailers which has got zero allocation previously but also increases the supply chain profit .The supplier can use any allocation depending on the situation that whether he is concerned to satisfy all the retailers or he want to earn profit keeping lost sales with him. In a monopolistic environment the supplier will act as a leader by announcing the allocation mechanism publicly. Though after reallocation the change in profit is high (in case of linear allocation) as shown in table 9, but their may be a case that the retailers may have inflate their orders to get the maximum share. Therefore if the supplier will go for linear allocation, the retailer will always use manipulable mechanism that will create an artificial market. In this environment the supplier may think of capacity expansion to get the optimal profit at minimum cost of expansion. From the retailer point of view reallocation due to uniform allocation is preferable because all the retailers are getting some share of the demand and there is no case of zero allocation. Also the supplier will be able to fulfill partially or fully all his retailers to some extent and there is no case of lost sales. Supply chain profits can increase when a truth inducing mechanism will be replaced by manipulable mechanism.

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