Socio-Economic Effects as a Result of the Enactment of Tire Efficiency Rating (Labeling) System in South Korea

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EXECUTIVE SUMMARY

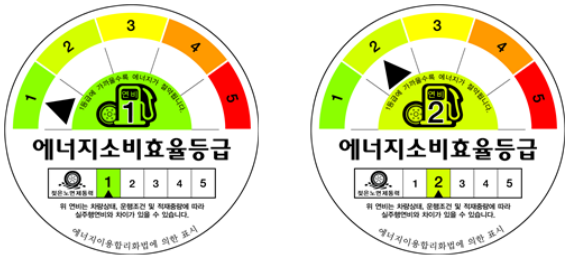
1. Introduction

The tire industry is a market derived from the automobile industry, and is influenced by the changes in the automobile industry. The most important among such changes is that the price of oil and raw materials is rising and there is much uncertainty in the prices for same, and that the regulations on energy and environement are being gradually strengthened. The tire industry is endeavoring to strengthen the capabilities in material, design and environmental aspects in order to respond to such changes in the automobile industry. Such tendency also influences the rubber industry, the consumption of which is expected to decrease in the future. Therefore, there will be greater demand for high value-added products, and one such product are those that are eco-friendly products and thus there is a heightened interest and effort required for green rubber.

2. Current Status of Tire Efficiency Rating System

One of such eco-friendly efforts is the tire efficiency rating system. The overview of the tire efficiency rating system in Korea is as follows:

<Table 1> Overview of tire efficiency rating system: Korea

<Overview of tire efficiency rating system>	
Classification	**Description**
Applied to	▪ Automobile tires sold in Korea
Items to be measured	▪ Rolling Resistance coefficient (friction) ▪ Wet grip (traction)
Method for displaying grades (example)	
Displayed on	▪ Tire tread (the surface that contacts the ground)
Enforcement Date	▪ Voluntary labeling for Passenger Car (“PC”) tires as of November 1, 2011. ▪ Implementation of compulsory labeling for PC tires as of November 1, 2012. ▪ Implementation of compulsory reporting for small truck (“ST”) tires as of November 1, 2013.
Implementation Date of Min. Energy Efficiency Standards	▪ November 1, 2013 for PC tires. ▪ November 1, 2014 for small truck tires.

The standards for tire efficiency rating system in Korea are as follows:

<Table 2> Tire energy consumption efficiency rating standards: Korea

<Tire Energy Consumption Efficiency Rating Standards >				
Grade	Rolling Resistance Coefficient (RRC) (Unit: N/kN)		Wet Grip (G)	
	PC	ST (including light truck ("LT"))	PC	ST (including LT)
1	RRC ≤ 6.5	RRC ≤ 5.5	1.55 ≤ G	1.40 ≤ G
2	6.6 ≤ RRC ≤ 7.7	5.6 ≤ RRC ≤ 6.7	1.40 ≤ G ≤ 1.54	1.25 ≤ G ≤ 1.39
3	7.8 ≤ RRC ≤ 9.0	6.8 ≤ RRC ≤ 8.0	1.25 ≤ G ≤ 1.39	1.10 ≤ G ≤ 1.24
4	9.1 ≤ RRC ≤ 10.5	8.1 ≤ RRC ≤ 9.2	1.10 ≤ G ≤ 1.24	0.95 ≤ G ≤ 1.09
5	10.6 ≤ RRC	9.3 ≤ RRC	G ≤ 1.09	G ≤ 0.95
Minimum	12.0 or less	10.5 or less	1.10 or higher	0.95 or higher

The tire efficiency rating system is being introduced by the government in order to respond to the changes domestically and abroad, and is expected to accelerate the eco-friendly movement for tires, and to contribute to the changing the rubber industry to a more eco-friendly one. The current tire efficiency rating system targets only PCs because they are currently the largest in number, however, as the STs, vans and large trucks ("LT") are expected to grow in the future, it would be necessary to fully expand the current system.

3. Analysis of Consumer Effect on Tire Efficiency Rating System

We have conducted a survey on the level of consumers' awareness and practice of environmental issues, and hereby provide the summary as follows: their level of practice was lower than their awareness of environmental issues; small and semi-medium PC owners were more interested in the expense and cost; medium PC owners showed high concern for the environment; however, large PC owners were relatively not interested in environmental issues. It is noteworthy that the import car owners were especially concerned in the environment. Those in the Northern Seoul area showed a low level of awareness for environmental issues, but demonstrated a high demand for the need for regulations. In addition, the awareness for fuel efficiency was very low, and thus a need to implement a policy tool for increasing the awareness of fuel efficiency is appropriate. Adequate information should be provided to the consumers by developing a "tool for calculating fuel efficiency and fuel reduction" to calculate the level of fuel reduction, and by providing the same through various channels (online, off-line, smart phones, etc.)

<Table 3> Consumer's awareness and practice of environmental issues: Summary

Classification		Content
Comprehensive		**The level of practice is lower when compared with the level of awareness of environmental issues.**
Displacement of vehicles owned	Less than 1,000 cc	Low awareness of environment Energy consumption an important consideration when purchasing electronic goods High demand for eco-friendly information. Considers the government's eco-friendly efforts not sufficient Intends to choose vehicles with low displacement because of fuel consumption and carbon dioxide emission.
	1,000 cc or more ~ less than 2,000 cc	Considers price more important than environmental effect. High level of efforts for fuel reduction.
	2,000 cc or more ~ less than 3,000 cc	High demand for eco-friendly information. Demand for higher level of environmental regulations. Considers the government's eco-friendly efforts sufficient.
	3,000 cc or more	Energy consumption not an important consideration when purchasing electronic goods. Prefers application of eco-friendly technology rather than changing to eco-friendly living habits.
Origin	Domestic	Nothing significant to report.
	Imported	High environmental awareness. Demand for higher level of environmental regulations.
Residential area	Northern Seoul	Nothing significant to report.
	Southern Seoul	Low environmental awareness. Demand for higher level of environmental regulations.

In general, they were highly aware of the energy efficiency rating system, and considered it an important factor when purchasing products; however, they responded that while the system is very important, it is not helpful on a practical level despite the importance. They also responded that it is highly necessary to expand the energy efficiency ratings. In other words, the efficiency rating system should be strengthened as well as imporved in the future.

<Table 4> Energy efficiency rating system: summary

Classification		Content
Comprehensive		**In general, highly aware of energy efficiency rating system.** **In general, energy efficiency rating system considered an important factor when purchasing products (higher than the importance of energy consumption).** **Therefore, energy efficiency rating system is highly important.** **However, they responded it is not actually so helpful despite the importance.** **Therefore, it is really necessary to expand the energy efficiency rating.**
Displacement of vehicles owned	Less than 1,000 cc	It is highly necessary to expand the energy efficiency rating.
	1,000 cc or more~ less than 2,000 cc	Energy efficiency rating system not helpful in practical terms.
	2,000 cc or more~ Less than 3,000 cc	Nothing significant to report.
	3,000 cc or more	Nothing significant to report.
Origin	Domestic	Nothing significant to report.
	Imported	Highly aware of energy efficiency rating system. It is really necessary to expand the energy efficiency rating.
Residential area	Northern Seoul	Nothing significant to report.
	Southern Seoul	Nothing significant to report.

The price elasticity of tire demand could be calculated by surveying the willingness to pay, and we came up with 1.42. That is, if the price increased by 1%, there would be 1.42% reduction in demand, showing that the demand is sensitive to price.

<Table 5> Degree of extension in the period of use following increase in tire price

Q17-1. (If you intend to use the tires longer) How much longer would you use them? <1> Period of Use									
Classification		Case Nos. (No. of people)	6 months or less	7 months~ 12 months	13 months~ 18 months	19 months or more	Total (%)	Average (months)	Standard Deviation (months)
Entire Consumer		302	**22.2**	**28.1**	**30.5**	**19.2**	100	**16.1**	13.6
Entire Dealers		10						**15.6**	7.6
Displacement of Vehicles Owned	Less than 1,000 cc	48	14.6	29.2	33.3	22.9	100	16.8	11.8
	1,000 cc or more~ less than 2,000 cc	137	21.2	27.0	32.8	19.0	100	16.6	15.2
	2,000 cc or more~ Less than 3,000 cc	65	20.0	26.2	30.8	23.1	100	17.4	14.1
	3,000 cc or more	52	34.6	32.7	21.2	11.5	100	12.7	9.1
Origin	Domestic	245	20.8	28.2	31.0	20.0	100	16.5	14.1
	Imported	57	28.1	28.1	28.1	15.8	100	14.6	11.1
Residential Area	Northern Seoul	148	20.3	29.1	29.7	20.9	100	17.0	15.3
	Southern Seoul	154	24.0	27.3	31.2	17.5	100	15.3	11.7

<Table 6> Degree of extension in the distance of use following increase in tire price

Q17-1. (If you intend to use the tires longer) How much longer would you use them? <2> Distance of use								
Classification		Case Nos. (No. of people)	5,000 km or less	5,000 km~ 10,000 km	More than 10,000 km	Total	Average (km)	Standard Deviation (km)
Entire consumer		302	**32.8**	**38.1**	**29.1**	100	**13,796.7**	14,898.5
Entire dealers		14					**7821.4**	4444.6
Displacement of Vehicles Owned	Less than 1,000 cc	48	35.4	33.3	31.3	100	13,645.8	14,674.5
	1,000 cc or more~ less than 2,000 cc	137	32.1	39.4	28.5	100	13,567.9	1,5043.9
	2,000 cc or more~ Less than 3,000 cc	65	30.8	35.4	33.8	100	16,212.3	17,709.1
	3,000 cc or more	52	34.6	42.3	23.1	100	11,519.2	10,081.0
Origin	Domestic	245	32.7	38.0	29.4	100	13,463.7	14,076.7
	Imported	57	33.3	38.6	28.1	100	15,228.1	18,086.1
Residential Area	Northern Seoul	148	27.7	41.2	31.1	100	14,195.9	14,768.4
	Southern Seoul	154	37.7	35.1	27.3	100	13,413.0	15,060.7

When asked to select three (3) important criteria in selecting a new vehicle, the consumers chose in the order of safety, price, fuel efficiency, design, performance, durability, comfort, convenience, driving dynamics, and eco-friendly features. When asked to indicate on a scale of 1 to 5, the order was safety, fuel efficiency, price = durability, design, comfort, convenience, performance, driving dynamics, and eco-friendly features. When the answers to these two questions are compared, it may be viewed that the most important criteria are safety, price and fuel efficiency, whereas driving dynamics and eco-friendly features were not as important. The other five (5) criteria including design, performance, durability, comfort and convenience rendered different results depending on the method of survey, especially performance.

<Table 7> New vehicle selection criteria: comprehensive

New Vehicle Selection Criteria	Average Score (0 = 5)	Ranking
Safety	4.5	1
Durability (life)	4.33	3
Price	4.33	3
Fuel efficiency	4.39	2
Performance (including speed)	4.08	8
Comfort	4.16	6
Driving Dynamics	3.85	9
Eco-friendly Features	3.76	10
Design	4.19	5
Convenience	4.12	7

<Table 8> New vehicle selection criteria: simple comprehensive for ranks 1-3

Q5. Please choose, in the order of importance, the three most important among the factors listed above that you considered when purchasing your vehicle. <4> Simple comprehensive for ranks 1-3											
Classification		Safety	Price	Fuel Efficiency	Design	Perfor-mance	Dura-bility	Comfort	Conve-nience	Driving Dynamics	Eco-friendly Features
Comprehensive		**58.7**	**53.6**	**47.7**	**29.9**	**28.3**	**26.4**	**23.7**	**16.6**	**11.3**	**3.9**
Displacement of Vehicles Owned	Less than 1,000 cc	30.0	89.0	81.0	20.0	7.0	17.0	4.0	40.0	3.0	9.0
	1,000 cc or more~ less than 2,000 cc	57.1	63.6	54.3	26.1	27.5	25.4	16.8	15.7	9.6	3.9
	2,000 cc or more~ Less than 3,000 cc	61.3	40.0	38.1	38.1	33.8	35.6	26.3	10.0	13.1	3.8
	3,000 cc or more	76.9	27.5	25.0	34.4	37.5	25.0	45.6	10.0	17.5	0.6
Origin	Domestic	57.4	59.8	50.0	26.5	25.2	25.9	24.3	19.8	7.0	4.1
	Imported	63.1	32.5	40.0	41.3	38.8	28.1	21.9	5.6	25.6	3.1
Residential Area	Northern Seoul	57.1	53.1	44.9	32.3	29.1	28.9	22.9	16.3	11.1	4.3
	Southern Seoul	60.3	54.0	50.6	27.4	27.4	24.0	24.6	16.9	11.4	3.4

Unlike the high level of environmental awareness, the level of awareness of tire-related information were generally on the whole low, especially with respect to Rolling Resistance. It demonstrates that the information on Rolling Resistance needs to be disseminated in advance to ensure successful implementation of the tire efficiency rating system. It was also revealed that the owners of large PCs with low fuel efficiency were highly interested because while the awareness level was lower than the average especially with small PC owners, it was above average with respect to large PC owners.

<Table 9> Awareness of tire-related information: comprehensive

Awareness of tire-related information	Average Score (0 - 5)
Rolling Resistance	2.94
Wet Grip	3.48
Various road conditions that affect fuel consumption	3.88
Effect of tire pressure on fuel consumption	3.87
Driving pattern affects fuel consumption	4.15
Rolling Resistance affects fuel consumption	3.14
Wet Grip affects safety while driving	3.73

The survey on various practices for improving fuel efficiency revealed that the efforts for improving fuel efficiency (average 3.22) were lower than the level of awareness of environmental issues (Q1.<1>, average 4.03). The most frequently carried out practice was

not making sudden start, speed-up or stop, which is interpreted to be the result of successful publicity. As for the purchase of eco-friendly tires, it is currently not being practiced on a frequent basis, but given the willingness to make the replacement, it is expected to contribute to improving fuel efficiency through various publicity programs and support in the future. The level of regular check-ups of tire pressure and timely replacement of tires are currently satisfactory, but not practiced sufficiently. It is notable that consumers are adverse to and not inclined to purchasing small cars. It leads to the supposition that it would be difficult to induce an awareness to increase fuel efficiency through the promotion of small car purchases in the future. The current level of purchases for eco-friendly cars is low, but the future willingness to purchase is not so low.

<Table 10> Ways to improve fuel efficiency: comprehensive

Ways to Improve Fuel Efficiency	Average Score (0 - 5)	Ranking
Do not make a sudden start, speed-up, or stop	3.88	1
Check tire pressure regularly	3.54	4
Turn off the engine or put the gear in neutral position when the car is stopped	3.54	4
Reduce use of air-conditioning	3.51	6
Use additives to improve fuel efficiency (or use premium fuel)	2.62	14
Keep the driving speed at 60~80km/h	3.43	7
Do not carry unnecessary cargo to reduce the vehicle weight	3.67	3
Regularly check and replace consumable parts relating to engine	3.72	2
Purchase a small car for fuel efficiency	2.43	15
Purchase an eco-friendly (high-efficiency) car for fuel efficiency	2.67	13
Purchase eco-friendly (high-efficiency) tires	2.70	12
Replace tires on time	3.24	10
Consider purchasing a small car in the future	2.72	11
Purchase an eco-friendly vehicle	3.40	8
Replace the tires with eco-friendly (high-efficient) ones	3.28	9
Average	**3.22**	

The most important factors in selecting tires was [price > life > noise arising from tires > Road Grip > Rolling Resistance > tire width > tires with specific functions or features > tread pattern > OE tire brand]. When the consumer survey results are compared with those for dealers, the dealers considered Road Grip, noise, price and life of tire more important, whereas the consumers considered other factors including Rolling Resistance more importantly than others. The relative importance of safety, economics, and durability is as follows. From the consumer survey result, safety, economics and durability marked 50.3%, 25.8% and 23.9%, respectively. It demonstrates that the consumers consider economics and durability equally important. It seems that the durability should also be considered when implementing the tire efficiency rating system. In other owrds, it seems necessary to review an integrated and comprehensive plan for tires (economics, safety and durability, etc.).

<Table 11> Tire selection criteria

Tire Selection Criteria	Average Score (0 - 5)	Remarks	Dealer Survey Result (0 - 5)
Road Grip	3.84	<	4.08
Rolling Resistance	3.65	>	3.08
Noise arising from tires	3.91	<	4.10
Price	4.08	<	4.58
OE tire brand	3.14	>	2.88
Tires with specific functions or features	3.53	>	3.50
Tire width	3.57	>	3.40
Tread pattern	3.37	>	2.93
Life	4.01	<	4.28

It seems that most of the information, when replacing tires, is obtained from dealers such as auto repair shops or tire shops. It further shows that the information is not generally shared through online media including portal sites or manufacturers' web sites. In order for detailed and comparable information to be shared online, it would be necessary to expand the tire efficiency labeling system, and to further introduce voluntary systems such as the report on tire-related information. When compared with the dealer survey results, the dealers seem to believe that the information is delivered more effectively than the consumers. They appear to believe that, in particular, the tire-related information is delivered adequatetly from themselves (the tire shops), which is considerably different from the consumers' perspective. The differences in the recognition of phenomenon by suppliers and consumers during the delivery and dissemination of information should be corrected.

The survey results on awareness of tire prices demonstrated that 51.6% do not know about tire prices. It is highly likely that the consumers would not participate in the tire efficiency rating system if they are not knowledgable about tire prices. The owners of import cars and large PCs relatively better informed about tire prices. It appears desirable to approach the high-end market first with eco-friendly tires because the price elasticity for these two groups is expected to be low. Although the tire efficiency rating system will be implemented in full scale, it seems recommendable to engage consecutively in selective and assymetric regulation, publicity and support for specific tire groups.

The responses that consumers would consider such information as Rolling Resistance and Road Grip, etc., if they were provided when selecting tires marked "4.00" which was the highest value when compared with the other responses. They also responsed that they would be more interested in selecting tires if they could easily receive or access informaiton about tires (3.89), and that they would select tires marked with relevant information (3.87). The also took the position that the disclosure of tire related information would provide more options for the consumers (3.85), and contribute to improving tire performance (3.83). In conclusion, consumers believe that it would assist them to select tires through utilizzation of such information if they could obtain tire information easily through the tire efficiency rating system, and tire performance would also be improved during such a process.

However, it is also evident that consumers were not fully aware that the government had introduced the tire efficiency rating system (2.82), that information regarding tires were not

readily available at current time (3.11), and that they did not expect to receive detailed and expansive information if tire suppliers were to provide it to them voluntarily (3.38). Despite the foregoing, they take the position that it is desirable for tire suppliers to provide information on a voluntarily basis prior to the government regulation (3.63); therefore, the tire suppliers should exercise increased efforts to deliver and disseminate tire-related information.

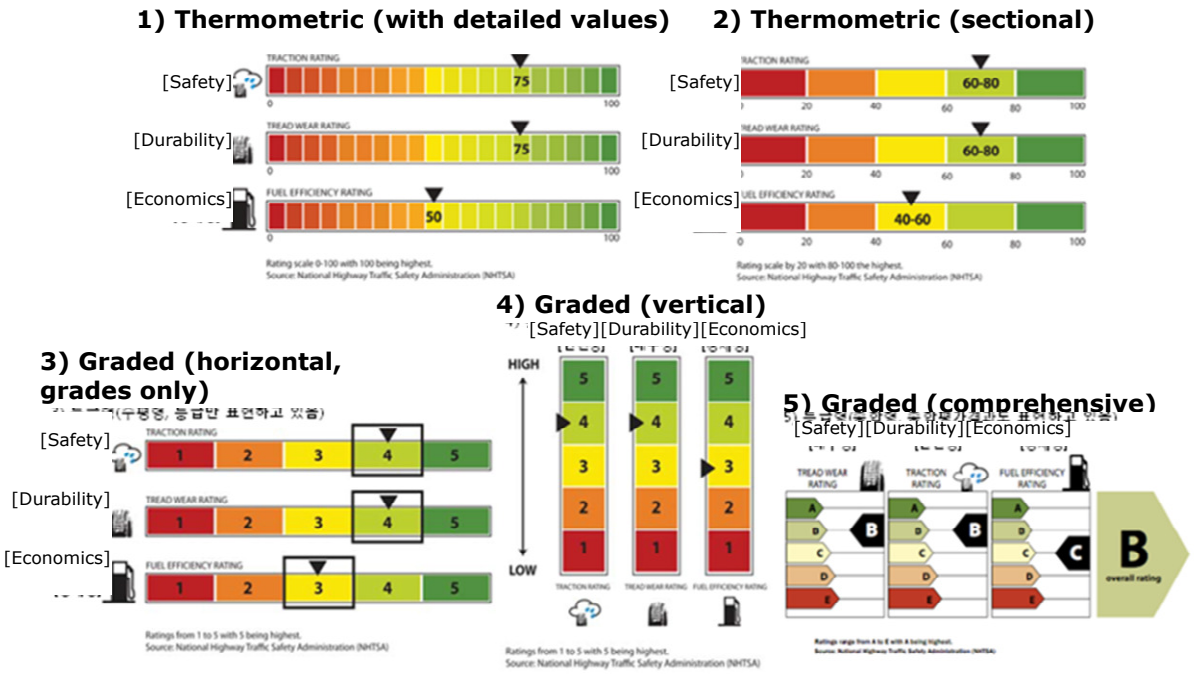
<Table 12> Awareness of tire information disclosure: comprehensive

Awareness of Tire Information Disclosure	Average Score (0 - 5)	Consumer ranking	Re-marks	Dealer Survey	Dealer Ranking
<1> I can easily obtain information on tires when it's time to replace them.	3.11	11	<	3.45	10
<2> If I could easily get information about tires, I would be more interested in selecting tires.	**3.89**	**2**	<	4.05	**1**
<3> If information about tires (Rolling Resistance, Road Grip, and life) become available to consumers, I would consider those factors when selecting tires.	**4.00**	**1**	>	3.73	8
<4> I would recommend tires more strongly to my friends and family if I have some information about the particular tire.	3.75	6	<	3.83	**2**
<5> I will not hesitate to purchase certain tires even if the price increases by 5% if I have some information about them.	3.50	9	>	3.13	11
<6> I will not hesitate to purchase certain tires even if the price increases by 15% if I have some information about them.	2.82	12	>	2.53	12
<7> I prefer tires with performance information, such as Road Grip, life, etc., to those without such information.	**3.87**	**3**	>	3.78	**4**
<8> I am aware that the tire efficiency rating system that requires disclosure of information such as Rolling Resistance, wet grip, etc. will be adopted and introduced by the government.	2.82	12	>	2.35 (2.80)	13
<9> I believe that the tire efficiency rating system requiring disclosure of tire performance information will be helpful in improving the actual performance.	**3.83**	**5**	>	(3.7)	9
<10> I believe that the tire efficiency rating system will assist consumers in getting their tire information effectively.	3.66	7	<	(3.75)	**5**
<11> I believe that the tire efficiency rating system will provide more options to consumers.	**3.85**	**4**	>	(3.75)	**5**
<12> I believe that tire manufacturers' voluntary disclosure of tire performance information is more desirable than the government's regulation.	3.63	8	<	(3.83)	**2**

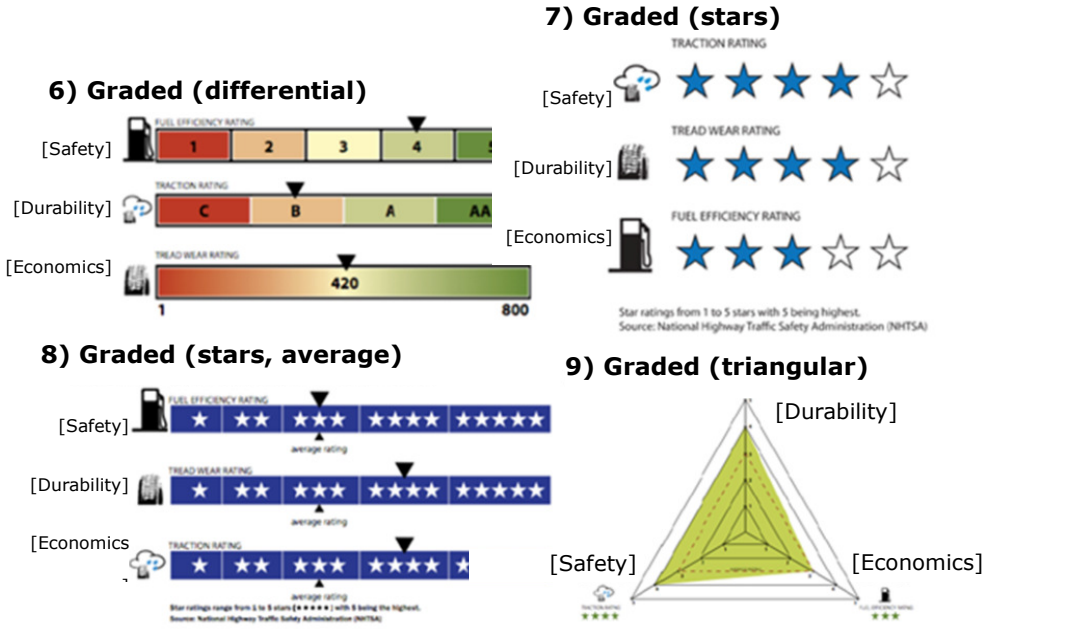
Awareness of Tire Information Disclosure	Average Score (0 - 5)	Consumer ranking	Re-marks	Dealer Survey	Dealer Ranking
<13> I believe that tire manufacturers' voluntary disclosure of tire performance information will offer more detailed information to consumers than the government's regulation.	3.38	10	<	(3.75)	5
Note 1: Those without parenthesis indicate awareness about the consumers, and those with parenthesis indicate dealer survey result. For example, in question <8>, 2.34 is the consumer awareness level conceived by the dealers, and 2.80 is the dealer awareness level.					

The efficiency grade labeling methods preferred by the consumers were those indicating the information on a horizontal basis (1) thermometric [with detailed values], (2) graded [horizontal], (3) thermometric [sectional]), and the most preferred was (4) the thermometric [with detailed values] method, which indicated detailed information. On the other hand, consumers found it difficult to understand if they took a different shape per item, if they were in a form other than horizontal bars, or if additional information (average, comprehensive scores, etc.) were indicated. In other words, they seem to prefer easily understandable and visually outstanding formats, rather than those that include excessive information or that are easy to compare (the comparison of information between products become easy if there are additional information such as the average or comprehensive scores, etc.). Therefore, the method of labeling tire efficiency grade should be reviewed additionally by taking such findings into consideration. The information provided could be indicated in detail directly on tires, or by changing the color of tires, etc. Further, it is also important that the information about tires is indicated in detail in the relevant documents such as receipts and repair quotations.

In addition, when the results between that of consumers and dealers are compared, there is no material difference in the reasons for selection although there is clear differences in the preference between the dealers and consumers, which show that there is considerable difference between information recognition method between tire suppliers and consumers.



<Diagram 1> Tire efficiency grade labeling method (1)



<Diagram 2> Tire efficiency grade labeling method (2)

<Table 13> Preference for tire efficiency grade labeling method: simple comprehensive

Q19-1. From the following <Examples of Display Methods> choose three that you think would be the best in the order of preference. <4> Simple comprehensive for ranks 1-3										
Classification		Thermo-Metric (detailed)	Graded (horizontal)	Thermo-Metric (sectional)	Graded (Stars)	Graded (Vertical)	Graded (Compre-hensive)	Graded (Stars + average)	Graded (Differen-tial)	Graded (Triangular)
Entire consumer (700)		**79.3**	**53.3**	**47.0**	31.3	31.1	18	13.7	13.4	12.9
Entire dealers (40)		22.5	**37.5**	32.5	**72.5**	30.0	30.0	30.0	**40.0**	5.0
Displace-ment of vehicles owned	Less than 1,000 cc	80.0	54.0	46.0	29.0	30.0	14.0	13.0	18.0	16.0
	1,000 cc or more~ less than 2,000 cc	78.9	56.4	48.2	30.0	27.5	17.9	12.5	15.0	13.6
	2,000 cc or more~ Less than 3,000 cc	82.5	50.0	50.6	28.8	37.5	15.6	13.8	10.6	10.6
	3,000 cc or more	76.3	50.6	41.9	37.5	31.9	23.1	16.3	10.6	11.9
Origin	Domestic	79.4	56.1	47.8	31.3	31.5	16.7	12.0	13.3	11.9
	Imported	78.8	43.8	44.4	31.3	30.0	22.5	19.4	13.8	16.3
Residential area	Northern Seoul	82.0	52.0	44.3	32.9	32.6	19.4	10.9	12.3	13.7
	Southern Seoul	76.6	54.6	49.7	29.7	29.7	16.6	16.6	14.6	12.0

As for the percentage of each grade in the tire efficiency rating system, the responses averaged 29.1% for grade 1, 22.5% for grade 2, 20.6% for grade 3, 15.0% for grade 4, and 12.8% for grade 5. It should be noted that such percentages could be applied to the tire efficiency rating system.

<Table 14> Percentage of each tire efficiency grade

Q20. What percentage do you think would be appropriate for each grade if they were to be classified into 5 grades on the basis of their efficiency, on a scale of 100?											
Classification		Grade 1		Grade 2		Grade 3		Grade 4		Grade 5	
		Average (%)	S.D.*	Average (%)	S.D.	Average (%)	S.D.	Average (%)	S.D.	Average (%)	S.D.
Comprehensive		**29.1**	20.5	**22.5**	9.8	**20.6**	10.1	**15.0**	8.3	**12.8**	11.3
Displacement of vehicles owned	Less than 1,000 cc	28.2	20.9	21.1	10.8	19.3	8.1	16.6	8.9	14.9	11.0
	1,000 cc or more~ less than 2,000 cc	28.5	19.6	23.0	10.9	21.1	10.7	14.9	7.9	12.6	10.6
	2,000 cc or more~ Less than 3,000 cc	30.5	19.9	23.0	8.1	19.5	8.7	14.1	8.0	12.8	13.5
	3,000 cc or more	29.0	22.2	22.1	8.6	21.9	11.4	15.1	8.9	11.9	10.0
Origin	Domestic	29.0	19.2	23.0	10.2	20.6	10.0	14.9	8.1	12.6	10.7
	Imported	29.4	24.2	20.9	8.4	20.7	10.4	15.4	9.1	13.6	13.1
Residential area	Northern Seoul	27.6	19.4	22.9	11.4	20.8	9.7	15.5	8.1	13.3	11.9
	Southern Seoul	30.5	21.4	22.1	7.9	20.5	10.5	14.5	8.5	12.3	10.6

* S.D.: Standard deviation

It is evident that the current system needs to be supplemented because the grade labeling method would affect consumer behavior. A dualistic system needs to be operated, comprising the rating system which provides brief information and is the basis for the minimum energy consumption efficiency standards, and of the detailed labeling system which provides detailed and expansive information. It is because detailed and specific information is not readily available at present time; and if improved, the consumers would be more apt to select eco-friendly tires.

Given the willingness to pay a premium for eco-friendly tires, it would be a more effective means of providing information to suggest the actual amount of savings, rather than fuel efficiency, because the consumers' awareness of information is distorted.

In conclusion, as for the willingness to pay more upon 20% improvement in safety, which was set up for comparison, the amount consumers were willing to pay was KRW 139,977 if counterbalanced by economics, and KRW 189,022 if not counterbalanced by economics. In case of dealers, the amount was KRW 45,527 if counterbalanced by economics, and KRW 322,973 if not counterbalanced by economics, showing a greater difference than the consumers. Moreover, there is wider difference in the willingness to pay in case of the dealers, as opposed to consumers, between products that are counterbalanced and those that are not counterbalanced. Such differences may be interpreted to arise from the irrationality of perception in the valuation of fuel efficiency or safety, or the non-linear characteristics in

structure. Additional studies may be conducted on the subject, which is expected to reveal more about the behavioristic characteristics of consumers, to ultimately contribute to substantial improvement in the performance of the tire efficiency rating system.

<Table 15> Consumer's willingness to pay upon improvement on fuel efficiency

Q21-1. Assuming that the current tire price is KRW 100,000, how much more would you pay for tires that can improve fuel efficiency from current 7km/l to 7.7km/l?							
Classification		Case nos. (No. of people)	Less than KRW 10,000	KRW 10,000 or more ~ less than KRW 20,000	KRW 20,000 or more	Total	Average (KRW)
Entire consumer		700	39.4	23.7	36.9	100	**15,322**
Entire dealers		40					**9,630**
Displacement of vehicles owned	Less than 1,000 cc	100	42.0	18.0	40.0	100	14,611
	1,000 cc or more~ less than 2,000 cc	280	36.4	27.9	35.7	100	15,032
	2,000 cc or more~ Less than 3,000 cc	160	40.6	18.8	40.6	100	16,698
	3,000 cc or more	160	41.9	25.0	33.1	100	14,897
Origin	Domestic	540	37.8	24.4	37.8	100	15,432
	Imported	160	45.0	21.3	33.8	100	14,951
Residential area	Northern Seoul	350	37.4	24.3	38.3	100	15,533
	Southern Seoul	350	41.4	23.1	35.4	100	15,110

<Table 16> Consumer's willingness to pay upon reduction in fuel cost

Q21-2. By replacing tires with ones that can save the fuel cost by 1%, consumers can save KRW 3,000 per month, KRW 36,000 per year, and KRW 108,000 for three years if the usual monthly fuel cost is KRW 300,000. How much more would you be willing to pay for these tires assuming the current tire price is KRW 100,000?							
Classification		Case Nos. (No. of people)	Less than KRW 10,000	KRW 10,000 or more ~ less than KRW 20,000	KRW 20,000 or more	Total	Average (KRW)
Entire consumer		700	39.4	24.3	36.3	100	**14,721**
Entire dealers		40					**8,463**
Displacement of Vehicles Owned	Less than 1,000 cc	100	41.0	23.0	36.0	100	12,920
	1,000 cc or more ~ less than 2,000 cc	280	37.9	26.8	35.4	100	14,590
	2,000 cc or more ~ less than 3,000 cc	160	37.5	23.1	39.4	100	15,946
	3,000 cc or more	160	43.1	21.9	35.0	100	14,853
Origin	Domestic	540	38.5	23.9	37.6	100	14,898
	Imported	160	42.5	25.6	31.9	100	14,127
Residential Area	Northern Seoul	350	39.4	23.4	37.1	100	14,433
	Southern Seoul	350	39.4	25.1	35.4	100	15,010

<Table 17> Consumer's willingness to pay upon counterbalance between safety and economics

Q22. What do you think is the reasonable price for tires with 20% improvement in fuel efficiency, but 20% reduction in safety? (Please answer assuming that the current tire price is KRW 100,000)							
Classification		Case nos. (No. of People)	Less than KRW 150,000	KRW 150,000 or more ~ less than KRW 200,000	KRW 200,000 or more	Average (KRW)	Additional Amount Average (KRW)
Entire consumer		700	20.6	35.3	44.1	178,633	**78,633**
Entire dealers		40				208,500	**108,500**
Displacement of vehicles owned	Less than 1,000 cc	100	20.0	30.0	50.0	177,971	77,971
	1,000 cc or more ~ less than 2,000 cc	280	17.9	38.6	43.6	180,232	80,232
	2,000 cc or more ~ less than 3,000 cc	160	22.5	33.8	43.8	178,844	78,844
	3,000 cc or more	160	23.8	34.4	41.9	176,038	76,038
Origin	Domestic	540	20.6	37.0	42.4	177,333	77,333
	Imported	160	20.6	29.4	50.0	183,022	83,022
Residential area	Northern Seoul	350	22.0	36.3	41.7	178,973	78,973
	Southern Seoul	350	19.1	34.3	46.6	178,293	78,293

<Table 18> Consumer's willingness to pay upon concurrent improvement in safety and economics

Q23. What do you think is the reasonable price for tires with 5% improvement both in safety and efficiency due to improved wet grip and fuel efficiency? (Please answer assuming that the current tire price is KRW 100,000)								
Classification		Less than KRW 200,000	KRW 200,000 ~ KRW 210,000	KRW 210,000 ~ KRW 220,000	KRW 220,000 ~ KRW 230,000	KRW 230,000 or more	Average (KRW)	Additional amount average (KRW)
Entire consumer (700)		20.0	13.9	18.4	23.1	24.6	201,908	**101,908**
Entire dealers (40)							219,250	**119,250**
Displacement of vehicles owned	Less than 1,000 cc	20.0	16.0	16.0	22.0	26.0	202,490	102,490
	1,000 cc or more ~ less than 2,000 cc	17.5	14.3	20.7	27.5	20.0	203,620	103,620
	2,000 cc or more ~ less than 3,000 cc	21.3	13.8	18.8	20.6	25.6	201,097	101,097
	3,000 cc or more	23.1	11.9	15.6	18.8	30.6	199,358	99,358
Origin	Domestic	21.3	13.5	20.2	22.8	22.2	199,763	99,763
	Imported	15.6	15.0	12.5	24.4	32.5	209,147	109,147
Residential area	Northern Seoul	20.9	14.3	18.9	22.6	23.4	200,617	100,617
	Southern Seoul	19.1	13.4	18.0	23.7	25.7	203,199	103,199

4. Analysis on the Economic/Environmental Effects of Tire Efficiency Rating System, and Policy Proposal

According to the study of relevant literature, and as a result of this survey, the economic and environmental effects of the tire efficiency rating system in Korea are expected to reduce fuel consumption by 231 million liters each year, which is equivalent to KRW 438 billion and 184,802 TOE, and also to reduce CO2 emissions by 490,774 tCO2. While Rolling Resistance (economics), durability (abrasivity), and wet grip (safety) were known to be mutually contradictory, it was confirmed that the contradiction could be overcome and all such characteristics could be improved through development of new materials and application of new technology, and that the improvement in economics does not necessarily result in the reduction in durabilty and safety. Such expansion of new materials and technology is expected to be applied to green tires, and to give them more significance in the future.

<Table 19> Economic/environmental effects of tire efficiency rating system in Korea

Classification	Values	Calculatiom Method	Remarks/Assumption
Total distance covered (A)	41,830 km	Survey result	- For one tire - Tire life assumed to be 3 years
Fuel efficiency (B)	11.2 km/L	Survey result	
Degree of improvement in fuel economics (C)	1%	Basic assumption	- Deemed to be fuel consumption reduction rate
Oil Price (D)	1896.2 KRW/L	Survey result	
Total amount of fuel reduction (E)	KRW 70,820	=A*C*D/B	
Total no. of nationwide vehicle registrations (F)	14,017,012 vehicles	Basic assumption	- Based on the Ministry of Land, Transport and Maritime Affairs' data of August 2011, additional increments not reflected; need to analyze the scenario in the future
Total amount of potential fuel reduction (G)	KRW 3,970,721,437,852	=4*E*F	- For a set of 4 tires; assuming that all vehicles use eco-friendly tires 100%
Total amount of potential annual fuel reduction (H)	KRW 1,323,573,812,617	=G/3	- Amount adjusted for a year
Total potential amount considering demand elasticity and production cost (I)	KRW 1,135,626,331,226	=H*(1-10%*1.42/100)	- Tire price assumed to be KRW 100,000 reflecting the survey result (Tire prices were investigated to be KRW 128,707 for local vehicles, and KRW 97,818 in case of dealers, but the dealers' price was reflected because the consumer survey result came only from those people who knew about tire prices) - The rate of price increase was set at 10% with reference to the study of literature, by reflecting

Classification	Values	Calculatiom Method	Remarks/Assumption
			to tire price the ceiling for the production cost of eco-friendly products, and based on the assumed increase of KRW 10,000 in addition. - The price elasticity for tire demand was applied at 1.42 based on the survey result.
Total amount of annual fuel reduction considering consumers' willingness to pay (J)	**KRW 438,027,299,187**	=I*(700-430)/700	- According to the survey result, the willingness to pay in excess of KRW 10,000 turned out to be 38.57%, which was used as the rate of purchasing eco-friendly tires.
Total quantity of fuel reduction (K)	**231,002,689 L**	=J/D	
Fuel reduction (based on TOE)(L)	**184,802 TOE**	=K*0.0008	- A liter of gasoline is 0.0008 TOE.
CO2 reduction amount (M)	**490,774 tCO2**	=L*0.783*44/12*0.74/0.8	- The TOE (net caloric value) for gasoline is assumed to be 0.740, and the carbon emission factor, 0.783

Further, it would be necessary to review how the tire effciency rating system could be connected with the automobile efficiency rating system. As the Fuel Economy and Environment Label of the U.S. provides detailed information about automobiles, Korea also needs to likewise have a system for providing detailed information, and to have it connected with tire-related information.

In case of the U.S., the Environmental Protection Agency announced in May 2011 its plan to revise the "Fuel Efficiency and Environment Label" for automobiles which would be revised from the existing Fuel Efficiency Label, and can be confirmed from the online and offline shops, and provides various information including the fuel efficiency, energy consumption, fue cost, and environmental effects, etc., of vehicles. They target automobiles and trucks scheduled to be released in 2013 and onwards, including the existing gasoline vehicles, hybrid and electric vehicles. The manufacturers can affix the label voluntarily on 2012 models. As the fuel efficiency for new models in 2012 through 2016 increases, the consumers will be able to save an average USD 3,000 and 1.8 barrels of fuel during the entire period of the vehicle life. The new label will enable consumers to compare the fuel use and expenses for electric and gasoline vehicles, and to obtain an estimation on fuel consumption and reduction for the next five (5) years for each vehicle. It would also enable to compare greenhouse gas and environment pollutants, to obtain an estimation of fuel or electricity needed to drive 100 miles, and to confirm information on the scope of driving and recharging time for electric cars. It is also possible to obtain relevant information through QR codes from smartphones (Business Service Center for Global Environmental Regulation, 2011).

Finally, Korea needs to design an integrated policy for the tire efficiency rating system. They may be divided into three areas: (1) establishing compulsory standards (fuel efficient tire standards, mandatory sales requirements); (2) introducing an incentive mechanism (rebates,

feebates, fees, other incentives and promotions); and (3) consumer education, support and publicity strategies (tire labeling, tire advertising, web site listings, fuel efficiency guide, public education), etc. The performance of the tire efficiency rating system will be affected by the organization and integration of specific plans and portfolio for each policy. In this regards, the Commission for Environmental Cooperation plansto apply different regulation standards on the additional expenses for reducing Rolling Resistance (2003).