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ANALYSIS OF THE EFFECT OF AGING POPULATION ON THE HOUSEHOLD CONSUMPTION EXPENDITURE WITH THE QUAIDS MODEL

Heekyung SON

Statistics Korea, Daejeon, Korea

ABSTRACT

These days, the aging speed in Korea has been going on much faster than ever before, which is causing Korean society to have significant riffle effects on the social and economic aspects and to add the burden of supporting the elderly to the economically active people. In this study, I empirically analyzed effects that changes in the structure of household consumption expenditure led by the aging population have on the total economy in Korea, using the QUAIDS model with the data "Household Income and Expenditure" compiled by Statistics Korea from 2006 to 2015. As a result, the income elasticities in the household with the elderly householder are bigger than those in the household without the elderly householder from all items except for the Food & soft drinks and Entertainment & culture, which means the consumption expenditure from the household with the elderly householder is significantly sensitive to volatility in the household income since the household with the elderly householder is not able to secure stable income sources. With the private consumption continuing to stagnate and the aging population going on fast, it is analyzed that the mounting elderly households with relatively lower level of income and consumption have high possibility to hinder fast-paced consumptions in Korean economy and have a negative impact on its economic growth in the future.

.**Keywords:** Aging Population, Structure of Consumption Expenditure, Engel Consumption Curve, Income Elasticity

INTRODUCTION

Low fertility and aging population is one of the first-priority projects confronting all countries around the world and there is no exception for Korea. Korea's population is aging at an alarmingly fast rate due to the continuing fall in the birth rate, increasing life expectancy, the rising aging baby boomers and so on. According to the OECD Population Statistics published in 2015, Korea is prospected to be involved in the super-aging society in 2050, which is expected to cause our society to have significant riffle effects on the social and economic aspects in Korea. In particular, It needs to be carefully scrutinized since changes in the household structure have direct impacts on the demand side of the economy such as the structure of consumption and expenditure of the household that is a subject of the private consumption. The purpose of this study is to figure out the effects that changes in the structure of household consumption

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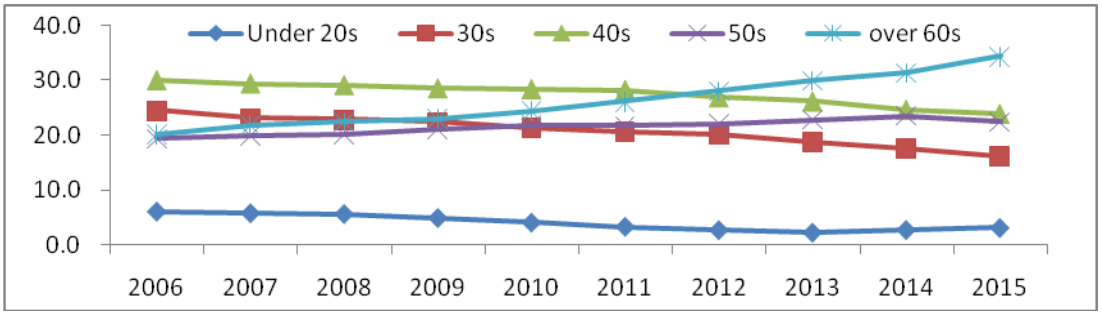
expenditure led by the aging population have on the total economy in Korea with the QUAIDS model and to come up with its policy implications responding preemtively to rapidly changing social structure.

2. Current situation of Structure of Household Income and Expenditure

To grasp the current situation of the structure of the household income and expenditure in Korea at first, I classified and checked out the micro-data of the Household Income and Expenditure by the age of a house head and income quintile of the household from 2006 to 2015. When it comes to the Korea's household structure, the portion of the 40s'households from total households stayed above 28.2% by 2011, which had the highest percentage of total households. But it kept decreasing dramatically since 2012. On the other hand, the portion of over 60s' households from total households in the Korea's household structure began at 20.1% in 2006 and went up 14.3% points to 34.4% in 2015. In particular, it stood at 28.1% and exceeded that of 40s'households from total households in 2012, which had the highest percentage of all of age levels. In addition, the portion of the household under 40s making up most of the economically active population has been continuouslydecreasing, which means Korea's aging population is going on rapidly.

〔Figure 1〕Household Distribution by age of householder (Unit : %)



As for the average monthly income distribution by a household, the income level of the household aged over 60 is 1,834,920 KRW a month on average among the lowest in total by age and the income level of the household in the 5 Quintile is 6,742,499 KRW a month on average among the highest in total. The thing you have to pay attention to in the table 1 is that the income level of the household aged over 60 in the 5 Quintile is higher than the average income level of the total household in the 5 Quintile while that the income level of the household aged over 60 in the 1 Quintile is the lowest in total, which typically shows there is the income inequality among the households aged over 60.

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〔Table 1〕 **Average Monthly Nominal Income from 2006 to 2015 (Unit : KRW)**

	1 Quintile	2 Quintile	3 Quintile	4 Quintile	5 Quintile	Total
under 20's	730,582	1,795,784	2,746,886	3,855,567	5,975,200	2,377,279
30's	785,620	1,908,812	2,891,967	4,015,613	6,376,634	3,593,774
40's	789,096	1,867,072	2,902,315	4,061,587	6,678,687	3,861,366
50's	766,416	1,858,345	2,920,356	4,111,535	7,120,361	3,748,196
Over 60's	694,293	1,815,328	2,927,708	4,093,161	6,858,561	1,834,920
Total	721,716	1,853,873	2,899,381	4,056,561	6,742,499	3,195,565

The average propensity to consume(APC) in total is 75.3% on average and shows much bigger difference in the level of the household's income rather than in the level of the household's age. The APC in the quintile of income has a trade-off relation to the level of income. In particular, The APC of the household in the 1st quintile of income stands at 134.4% on average and its consumption and expenditure goes over its disposable income, which means its marginal propensity to consume is very high since the disposable income of the household in the 1st quintile of income is so low that the household in the 1st quintile of income can't even make ends meet with their income in spite of its minimum spending. In addition, the householder aged over 60 accounts for 64.7% from the household in the 1st quintile of income so that it makes the whole average increased, which indicates that there are a lot of the elderly suffering from financial difficulties due to the lack of preparing for their old age. As for the age level of the householder, the 40s'APC is the highest and the over 60s'APC is the lowest from the total quintiles, which shows the household aged over 60 has little spending power from all aged levels.

〔Table 2〕 Average Propensity to Consume by age of householder from 2006 to 2015 (Unit : %)

	1 Quintile	2 Quintile	3 Quintile	4 Quintile	5 Quintile	Total
under 20s	135.1	84.9	74.0	66.0	59.7	70.9
30s	172.6	94.1	82.8	74.1	60.0	77.3
40s	169.6	98.7	86.6	80.1	67.7	82.8
50s	161.1	92.4	79.5	71.2	60.2	74.3
Over 60s	117.9	82.6	72.2	62.4	54.4	65.3
Total	134.4	91.1	81.2	74.2	62.5	75.3

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3. Analysis on Structure of Consumption and expenditure of the elderly household

3.1. Analysis Model

It is needed to estimate the demand function at first to analyze effects that the aging population has on the structure of the household consumption expenditure. Almost Ideal Demand System(AIDS) model from Deaton and Muellbauer(1980) set up an equation that consists of a dependent variable, the weight of the expenditure by an item and explanatory variables such as price, income and the variable of interest and then estimate the Engel curve. The power of the model is high since this model is flexible to expand not only basic explanatory variables including price and income but also interest variables including a demographic factor and so on, while there is a limit that the estimated Engel curve is linear. Making up for this kind of limitation is the model of the Quadratic Almost Ideal Demand System(QUAIDS), which assumes the form of a quadratic function considering the linear term of income and the squares of income as the explanatory variable. Therefore, I analyzed the structure of the consumption and expenditure of the elderly household by adding a demographic factor to the demand function, based on the model of the QUAIDS.

The QUAIDS model is derived from the expenditure function of the price-independent log(PIGLOG) and at first, the direct utility function is as below.

$$\ln V(p,m) = \left[\left\{ \frac{\ln m - \ln a(p)}{b(p)} \right\}^{-1} + \lambda(p) \right]^{-1} \quad (1)$$

$$\ln a(p) = \alpha_0 + \sum_k \alpha_k \ln p_k + \frac{1}{2} \sum_k \sum_i \gamma_{ki} \ln p_k \ln p_i$$

$$b(p) = \prod_{i=1}^{k} p_i^{\beta_i}, \quad \lambda(p) = \sum_{i=1}^{k} \lambda_i \ln p_i$$

To summarize it, $\ln c(u,p) = (1-u)\ln a(p) + u \ln b(p)$ and $\ln b(p) = \ln a(p) + \beta_0 \Pi_k p_k^{\beta_k}$. $u$means the utility, $p_i$is the price of an item i, $\alpha, \beta, \gamma$are coefficients estimated. Furthermore, $c(u,p)$is the function presenting the expenditure that would be required to get a certain level of utility, $u$in the given price p. After substituting $\ln a(p)$and $\ln b(p)$to the equation (1) and applying the Shepherd's lemma and then differentiating both sides by $\ln p_i$, the weight of an item $i$from the amount of the

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total consumption expenditure, w_i can be expressed as the function for the weight of the expenditure by an item like the equation (2). Applying Roy's identity to the equation (1), the function for the weight of the expenditure by an item i can be found as below.

$$w_i = \alpha_i + \sum_{i=1}^{k} \gamma_{ij}^{*} \ln p_j + \beta_i \ln\left\{\frac{m}{a(p)}\right\} + \frac{\lambda_i}{b(p)}\left[\ln\left\{\frac{m}{a(p)}\right\}\right]^2 \quad (2)$$

$$\gamma_{ij}^{*} = \frac{1}{2}(\gamma_{ij} + \gamma_{ji})$$

w_i is the weight of the expenditure by the item from the amount of the total expenditure, m is the income(or amount of the total expenditure), p is the price index of items that needs to be analyzed and the total price index of all items, P is derived from $\ln P = \sum_k w_k \ln p_k$.

Parameters should meet the constraints since the sum of the weight of the expenditure by the each item should be 1 in the AIDS model.

$$\sum_{i=1}^{n} \alpha_i = 1, \sum_{i=1}^{n} \beta_i = 0, \sum_{i=1}^{n} \gamma_i = 0 \quad (3)$$

To satisfy the condition of homogeneity and symmetry, the constraint as below should be given to all of the item i.

$$\sum_{i=1}^{n} \gamma_{ij} = 0 \text{ and } \gamma_{ij} = \gamma_{ji} \quad (4)$$

If the Vector of demographic factors assumes the z and the expenditure function which means the expenditure of reference household needed to get the utility, u in the price vector, p supposes $e^R(p,u)$, the expenditure function of each household can be shown like the equation(5).(Poi(2012))

$$e(p,z,u) = m_0(p,z,u) \times e^R(p,u) \quad (5)$$

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$$w_i = \alpha_i + \sum_{j=1}^{n} \gamma_{ij} \ln p_j + (\beta_i + \eta_i' z) \ln\left(\frac{m}{\overline{m_0}(z) a(p)}\right) + \frac{\lambda_i}{b(p)c(p,z)} \left[\ln\left\{\frac{m}{\overline{m_0}(z) a(p)}\right\}\right]^2 (6)$$

After estimating the Engel demand curve as mentioned above, It is required to obtain the income elasticity($\mu_i = 1 + \frac{1}{w_i}(\beta_i + \eta_i' z)$) reflecting changes in the expenditure in response to change in income.

3.2. Analysis Results

A. The estimated result of the function of consumption and expenditure

I checked out changes in the structure of the consumption and expenditure of a household with the elderly aged over 65 by analyzing 12 items from the micro-data of the Household Income and Expenditure from 2006 to 2015 being able to use information about households all over the countries including a single-person household.

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[Table 3] Estimated results of α_i, β_i, λ_i and $\eta_{i,k}$

Item	α_i	β_i	λ_i	$\eta_{i,k}$
Goods				
1.Food & soft drinks	0.0412*	0.0741***	-0.00384***	0.0109***
	-0.025	-0.00476	-0.000226	-0.000264
2.Alcoholic beverages & cigarette	0.133***	-0.0126***	0.000374***	-0.000164*
	-0.0076	-0.00139	-6.40E-05	-9.33E-05
3.Clothing & footwear	0.0701***	0.00109	0.000763***	-0.0116***
	-0.0134	-0.00243	-0.000111	-0.000204
4.Housing, water, electricity, gas & other fuels	0.758***	-0.0633***	0.00201***	0.00595***
	-0.023	-0.00427	-0.000199	-0.000225
5.Household equipment & housekeeping services	-0.00272	0.000723	0.000692***	-0.00500***
	-0.0116	-0.0021	-9.55E-05	-0.000274
Service				
6.Health	0.340***	-0.0355***	0.00128***	0.0244***
	-0.00485	-0.00103	-5.77E-05	-0.00034
7.Transportation	0.135***	0.00675***	-0.000212***	-0.00222***
	-0.00426	-0.000915	-5.11E-05	-0.000301
8.Communication	0.161***	0.0134***	-0.00150***	-0.0145***
	-0.00248	-0.000529	-2.96E-05	-0.000174
9.Entertainment & culture	0.150***	-0.0152***	0.000809***	8.90E-05
	-0.00262	-0.000557	-3.12E-05	-0.000183
10.Education	0.0392***	-0.0242***	0.00289***	0.00459***
	-0.00493	-0.00105	-5.89E-05	-0.000347
11.Restaurants & hotels	0.0256***	0.0484***	-0.00272***	-0.00812***
	-0.00414	-0.000881	-4.93E-05	-0.00029
12.Other miscellaneous goods & services	0.149***	0.00632***	-0.000552***	-0.00423***
	-0.00358	-0.000765	-4.28E-05	-0.000252

Standard errors in bramkets , *** p<0.01, ** p<0.05, * p<0.1

I exploited the Iterated Feasible Generalized Nonlinear Least Square(IFGNLS) method since the PS-AIDS model is a non-linear model.$\alpha_i$is the constant. the change in the real total consumption and expenditure, $\beta_i$means the sensitivity on the real income of the weight of a consumption and expenditure about an item i since $\beta_i$assumes that a household spends all income. That is to say, if$\beta_i$has a positive(+) value, an item i's weight from the total consumption and expenditure is of great importance and there is a tendency that an item $i$has a characteristic of the discretionary goods, while there is a tendency that an item $i$has a characteristic of the essential goods, if $\beta_i$shows a negative(-) value. $\gamma_{i,j}$means a response to the relative price of items between $i$and j. and $\eta_{i,k}$stands for changes in both an item and a demographic characteristic.

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As a result, α_i's coefficients of all items are statistically significant except for the item of Household equipment & housekeeping services and β_i's coefficients of all items are statistically significant at the level of 1% except for the item of Clothing & footwear and the Household equipment & housekeeping services. The item of Alcoholic beverages & cigarette and Housing, water, electricity, gas & other fuels from the expenditure of goods have negative(-) values and so do the item of Health, Entertainment & culture and Education from the expenditure of the service, which means those items have high possibility to become the essential goods since their weights from the total expenditure are able to be decreased when the income rises. In other words, there is a chance that some items in the household with the elderly householder are relatively much less sensitive than those in the household with the non-elderly householder.

$\lambda_i$reflects the effect of expenditure weight of aggregate prices from each item and all of λ_i's coefficients are statistically significant at the level of 1%. the coefficients of the Housing, water, electricity, gas & other fuels, Household equipment & housekeeping services, Transportation, Entertainment & culture and Education have positive(+) values, while the rest of items show negative(-) values.

$\eta_i$indicates how much demographic factors(z) have the effect on each item's expenditure portion from the amount of the real expenditure(income). That is, if $\eta_{i,k}$has the significantly positive(+) value, it shifts its average effect on each item's expenditure portion from the amount of the real expenditure(income) to the positive(+) direction and vice versa. Thus, $\eta_{i,k}$'s coefficients of the item of Food & soft drinks, Housing, water, electricity, gas & other fuels, Health and Education have positve(+) values in the household with the elderly householder, which describes that the elderly household increase weights of those items from the amount of the real expenditure.

B. Estimated results of Income elasticity

Checking out the income elasticity based on the Engel consumption curve drawn by estimates of the model mentioned above, all of the income elasticities from 12 expenditure items have positive(+) values, which means all items analyzed are normal goods. As for the income elasticity of the elderly householder aged over 65, the income elasticity of Education is the biggest with 1.6170 among all items. To put it concretely, the income elasticities of the item of Household equipment & housekeeping services and Clothing & footwear among goods and those of the item of Health, Transportation, Education and Restaurants & hotels among services are bigger than 1, which indicates the elderly households respond sensitively to changes in their income when they consume those items. On the other hand, the income elasticities of the item of Food & soft drinks, Alcoholic beverages & cigarette and Housing, water, electricity, gas & other fuels among goods and those of the item of Communication, Entertainment & culture and Other

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miscellaneous goods & services among services are smaller than 1, which shows a characteristic of the essential goods relatively reacting less sensitively to changes in income.

[Table 4] Income elasticity by an item

Item	The elderly	Non-elderly
Goods		
01.Food & soft drinks	0.9557	0.9787
02.Alcoholic beverages & cigarette	0.9168	0.8926
03.Clothing & footwear	1.1477	1.1020
04.Housing, water, electricity, gas & other fuels	0.9950	0.9350
05.Household equipment & housekeeping services	1.2062	1.1821
Service		
06.Health	1.0064	0.9327
07.Transportation	1.0155	1.0108
08.Communication	0.8555	0.8365
09.Entertainment & culture	0.9286	1.0353
10.Education	1.6170	1.3033
11.Restaurants & hotels	1.0765	0.9452
12.Other miscellaneous goods & services	0.9748	0.9585

The income elasticities of the elderly householder is bigger than those of the non-elderly householder from all items except for the item of Food & soft drinks and Entertainment & culture, which proves that consumption and expenditures of the elderly householder react very sharply to changes in income. That's why the household with the elderly householder does not have stable income sources and relatively lower average propensity to consume then others.

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Especially, the item of Housing, water, electricity, gas & other fuels seems the essential goods and the item of Health and Education appears the discretionary goods due to the economic vulnerability which indicates that the elder has relatively the low quality of life. With the private consumption continuing to stagnate and the aging population going on fast, it is analyzed that the mounting elderly households with relatively lower level of the income and consumption have high possibility to hinder fast-paced consumptions in Korean economy and then have a negative impact on its economic growth in the future since the elderly households decrease their consumptions more rapidly than their income due to the reduction in income caused by their retirement, financial anxiety about their later years and so on.

4. Conclusion

In this study, using micro-data"Household Income and Expenditure" from 2006 to 2015, I empirically analyzed effects that changes in the structure of household consumption expenditure led by the aging population have on the total economy in Korea. As a result, the income elasticities of the household with the elderly householder is bigger than those of the household without the elderly householder in all items except for Food & soft drinks and Entertainment & culture, which means the consumption expenditure from households with the elderly householder is significantly sensitive to volatility in the household income since the household with the elderly householder is not able to secure stable income sources and relatively lower average propensity to consume then others. With the private consumption continuing to stagnate and the aging population going on fast, it is analyzed that the mounting elderly households with relatively lower level of the income and consumption have high possibility to hinder fast-paced consumptions in Korean economy. In particular, the item of Housing, water, electricity, gas & other fuels seems the essential goods and the item of Health and Education appears the discretionary goods due to the economic vulnerability which shows there are a variety of elderly people who do not prepare any plans for their later years and there is the huge income gap among them.

Korea's population is currently aging at an alarmingly fastest rate around the world, which adds the burden of supporting the elderly to the economically active peopleaged 15 to 64. Therefore, Korean government should come up with the micro-policy considering the profile of the household's income and expenditure by age that can alleviate burdens of the elderly household for the spending of items of Housing, water, electricity, gas & other fuels and Health. In addition, it is required to prepare the supporting policy encouraging the elderly to acquire income resources. Since it is expected that aging population in the future has an average age of the householder increased and gets the portion of the elderly household kept expanding, We need to

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arrange and support a variety of working programs so that the elderly household can have the wherewithal to consume.

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Appendix. Relation between income and consumption

At first, I checked out the relation between income and consumption from the perspective of long-term time series so as to analyze the pattern of household consumption and expenditure from 2006 to 2015 using the model of Vector Auto Regression(VAR) since the Keynes's theory of Consumption Function mentioned in the "General Theory of Employment, Interest Rate and Money", Absolute income hypothesis explains the relation between income and consumption in the short term very well but it does not work in the long term.

```
. sureg (dln_consump L(1/4).(dln_inc dln_consump))(dln_inc L(1/4).(dln_inc dln_consump))

Seemingly unrelated regression
------------------------------------------------------------------------------
Equation          Obs  Parms        RMSE    "R-sq"       chi2         P
------------------------------------------------------------------------------
dln_consump        98      8    .0296921    0.7139     244.56    0.0000
dln_inc            98      8    .0279275    0.5758     133.01    0.0000
------------------------------------------------------------------------------
```

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
dln_consump						
dln_inc						
L1.	.3749057	.1725506	2.17	0.030	.0367128	.7130987
L2.	-.1818634	.1688027	-1.08	0.281	-.5127106	.1489838
L3.	-.5929703	.1553731	-3.82	0.000	-.8974959	-.2884446
L4.	-.0273133	.1616576	-0.17	0.866	-.3441563	.2895297
dln_consump						
L1.	-.3013484	.170738	-1.76	0.078	-.6359887	.033292
L2.	.2898344	.145996	1.99	0.047	.0036876	.5759813
L3.	.0756343	.1429569	0.53	0.597	-.204556	.3558247
L4.	.4211896	.1431257	2.94	0.003	.1406684	.7017107
_cons	-.0051845	.0032325	-1.60	0.109	-.0115202	.0011511
dln_inc						
dln_inc						
L1.	-.2106936	.1622962	-1.30	0.194	-.5287883	.107401
L2.	-.4102014	.158771	-2.58	0.010	-.7213868	-.099016
L3.	-.5322588	.1461395	-3.64	0.000	-.8186869	-.2458307
L4.	.2646826	.1520505	1.74	0.082	-.0333309	.5626961
dln_consump						
L1.	.2188908	.1605913	1.36	0.173	-.0958624	.5336439
L2.	.5158365	.1373196	3.76	0.000	.246695	.784978
L3.	.4017407	.1344611	2.99	0.003	.1382017	.6652797
L4.	.3220769	.1346199	2.39	0.017	.0582268	.5859271
_cons	-.003286	.0030404	-1.08	0.280	-.0092451	.0026731

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After analyzing the Impulse-Response Functions(IRF) to judge how significantly endogenous variables are all crossed over, the effect that a shock responding to the change in expenditures has on the change in income is as follows. This graph shows effects that a shock responding to the change in income has on the change in expenditures and vice versa, which indicates that in general, a shock from one unit seems to almost fade away in 5 or 6 terms.