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Nonlinear Effect of Household Debt on Consumption: Evidence from Household-level Panel Data in Korea

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Abstract

This paper attempts to answer the question of whether there exist thresholds for two household debt ratios, debt-to-disposable income and debt service ratios, beyond which consumption can be hampered by an additional increase in the ratios, using household-level panel data from 2000 to 2014 in Korea. The results of the panel estimation indicate that households begin to reduce their consumption spending when the debt-to-disposable income ratio exceeds 210% of their disposable income or when the debt service ratio exceeds 27% of their disposable income. In addition, the nonlinear effects become less significant in the estimations for consumption growth. Finally, the estimation results for consumption level according to sub-income groups indicate that the nonlinear effects of debt service ratio are more significant for higher income groups while the estimated threshold for the ratio is smaller for lower income households.

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1. Introduction

A household debt contract is in theory an inter-temporal financial transaction conducted based upon the borrower's future income, enabling consumption smoothing in response to changes in household income and leading to efficient resource allocation over time. Once the debt exceeds a certain level, however, it could have the opposite effects on economic fluctuations and growth as witnessed in the recent global financial crisis. The nonlinear effect of government or household debt on consumption and economic growth has been explored by Reinhart and Rogoff (2009) and Cecchetti *et al*. (2011). They estimate a sovereign debt of 80-90% of GDP to be growth-hampering. Cecchetti *et al*. (2011) also tried to estimate a threshold for household debt, but found its effects on economic growth to be statistically insignificant. Relatedly, Mendoza and Terrones (2008) identified credit boom thresholds by evaluating how far the private credit-to-GDP or the real private credit per capita ratios deviate from their long-term trends.

Many existing studies investigating the threshold debt ratio have used aggregate data. The household debt distribution, however, can be more relevant in identifying the threshold level, given that the share of total debt held by risky households, who are highly vulnerable to external shocks due to their excessive debt holdings, matters more than the sheer amount of total debt. In this vein, more research has focused on micro-level data reflecting household debt distribution. Dynan *et al*. (2012), Mian and Sufi (2012), Anderson *et al*. (2014), and Kukk (2015) report that household debt burden, variously represented by debt service ratio, debt to asset ratio, loan to value ratio and debt to income ratio, have more or less negative effects on consumption, particularly when focusing on the period after the 2008 global financial crisis. In the meantime, some other pre-crisis research such as McCarthy (1997), Maki (2002) and Johnson and Li (2007) found that the household borrowing or debt service ratio does not significantly modify consumption behaviors using macro or micro data. However, there have been few studies that directly investigated the threshold level of household debt associated with consumption behavior despite growing research interest on the subject of household debt across emerging and advanced economies.

Against this background, this paper attempts to answer the question of whether there exists a threshold level of household debt using household-level panel data in Korea. The data, which cover a long period of 14 years from 2000 to 2014, are highly relevant for observing more long-term consumption behavior associated with household debt ratios across business cycles and macroeconomic shocks. In addition, since the Korean household debt has continued increasing even after the crisis, the debt overhang problem has been regarded as one of the potential critical factor that could trigger another financial stress in the near future. Our study accordingly can shed some light on useful policy implications for financial stability associated with household debt both in emerging economies including Korea and advanced economies.

The overall estimation results indicate that there exists a significant nonlinear relationship between household consumption and debt. Specifically, households begin to reduce their consumption when their debt-to-disposable income ratio exceeds a threshold of around 210% or when the debt service payment is larger than 28% of their disposable income. The nonlinear effects become less significant in the consumption growth estimations while the debt service ratio has significant negative effects on consumption growth in the linear specification. Finally, the estimation results for the

level of consumption by sub-income groups indicate that the nonlinear effects of the debt service ratio are more evident in the higher income group, though the threshold level is smaller for the lower income group.

This paper comprises four sections. Section 2 provides the model specifications and explanations for the data. In Section 3, the main estimations to identify the threshold household debt ratios are conducted. Section 4 concludes the paper.

2. Model Specification

Following many previous theoretical research such as Hall and Mishkin (1982), Zeldes (1989) and Carroll (2001), we specify a model in which household consumption is determined by current income, future income expectation and individual wealth given uncertainty and borrowing constraints. The future income expectation can be represented by years of working experience or the household's education level. The wealth variables such as financial and real assets can yield non-labor income, enhancing current consumption through the wealth effect. Finally, the debt ratios are added to the usual independent variables to find a threshold level of household debt ratios beyond which additional increases in debt dampen the household's consumption spending. The consumption function is specified as in Equation (1) in which nonlinearity between debt ratios and consumption is allowed through quadratic functional form.

$$\log(C_{it}) = \beta_1 \log(DY_{it}) + \beta_2 RA_{it-1} + \beta_3 NFA_{it-1} + +\beta_4 DR_{it-1} + \beta_5 DR_{it-1}^2 + \beta_6 X_{it} + u_i + v_t + \varepsilon_{it} \quad (1)$$

In Equation (1), *C* represents the consumption spending excluding principal and interest payments, taxes and social contributions. *DY* represents household disposable income, *NFA* net financial assets, and *RA* real assets, composed mostly of housing assets. In the analysis, we use two types of debt burdens in households, represented as *DR*: (1) household debt-to-disposable income ratio and (2) debt service ratio compiled through the household's payments for principal and interests over disposable income. Finally, *X* is a vector for other control variables representing individual characteristics such as the age of the household head (*hhage*), number of household members (*family_size*), and the years of education of the household head (*schooling_year*). A fixed effect panel technique is adopted to control other unobserved individual shocks and time fixed effects (v_t) are also included to control aggregate macroeconomic shocks in a yearly panel structure. The variables of consumption (*C*), disposable income (*DY*), net financial assets (*NFA*) and real assets (*RA*) are all in real terms denominated by the consumer price index.

All independent variables except disposable income and individual characteristics are lagged in one year to mitigate the reverse causality problem. Like previous research, contemporary disposable income and individual characteristics are highly unlikely to be affected by current consumption at the household level. Since the consumption function has a squared term for *DR*, the threshold for the household debt ratios can be directly estimated through a nonlinear combination of estimates such as $-\beta_4/2\beta_5$ using the delta method. The standard estimation method for panel threshold regression was proposed by Hansen (1999). This method, however, is not applicable to an unbalanced

panel structure, which is common in household survey data including a considerable amount of missing observations across the time span. The balanced panel can be reconstructed from the original unbalanced one but the loss of observation comprises nearly one third of all observations. So, this paper employs the quadratic functional approach, utilizing all available observations from the original panel.

A number of empirical literature using household-level panels such as Coulibaly and Li (2006), Ogawa and Wan (2007), Dynan *et al*. (2012), Anderson *et al*. (2014), and Kukk (2015) report that household debt burden, variously represented by debt service ratio, debt to asset ratio, loan to value ratio or debt to income ratio, have more or less negative effects on consumption. In contrast, McCarthy (1997), Maki (2000) and Johnson and Li (2007) found that the household borrowing or debt service ratio does not significantly modify consumption behavior using macro or micro data. Following the above research, we further investigate the nonlinearity of household debt on consumption under a framework of determination for consumption growth ($\Delta\log(\mathrm{C_{it}})$) using Equation (2).

$$\Delta\log(C_{it}) = \beta_1\Delta\log(DY_{it}) + \beta_2\Delta RA_{it-1} + \beta_3\Delta NFA_{it-1} + \beta_4 DR_{it-1} + \beta_5 DR_{it-1}^2 + \beta_6 X_{it} + u_i + v_t + \varepsilon_{it} \quad (2)$$

The permanent income hypothesis suggests that changes in current income do not affect current consumption because consumption change is unpredictable provided that the consumption reveals the property of random walk (Hall 1978). Under incomplete financial market assumption, however, current income change could have significant effects on current consumption change when households are facing borrowing constraints.

We use the KLIPS (Korean Labor and Income Panel Study) household-level survey data from 2000 to 2014. The primary advantage of this data set is its long horizon that covers 14 years in which we can observe more long-term consumption behavior at the household level in response to changes in the debt ratios of households across business cycles and macroeconomic shocks. In particular, Korean households' debt holdings have continued increasing even after the financial crisis. This phenomenon combined with a dominant share (more than 70%) of housing assets in total household asset portfolio is very unique when compared to other OECD countries (Kim *et al*. 2014). Subsequently, the household debt to net disposable income ratio stands at 164.2% while the average figure in OECD countries is 135.2% (OECD 2016). The other advantage of using the KLIPS is its rich and detailed reports on the economic activities of households. Particularly, the consumption and income can be concretely decomposed into sub-categories, which enables us to directly compile disposable income and core consumption spending, excluding principal and interest payments, taxes, and social contribution.

More specific construction and related explanations for the variables are illustrated in Appendix 2. Following the usual rule of thumb, outliers in the debt service ratio (*DSR*), the household debt ratio (*DTI*), and net financial assets (*NFA*) and real assets (*RA*) are removed based on the criteria displayed in Appendix 2.

3. Estimation Results

3.1 Estimations with Linear Household Debt Ratios

Table I shows the estimation results for consumption level function with linear household debt ratios. The signs for the coefficients are mostly consistent with the theoretical expectations. Disposable income and real assets, mostly housing assets, have significant positive effects on consumption spending while the effects of net financial assets are insignificant. These estimation results indicate that households have been more likely to expand their expenditures through a wealth effect as housing prices appreciated rapidly in the 2000s. In the meantime, the households have had to use financial savings or mortgages in purchasing housing assets, which could ruin their net financial assets.

<Table I> Consumption Level with Linear Debt Ratios[1), 2)]

	(a)	(b)	(c)	(d)	(e)
Dependent variables	$\log(C_{it})$	$\log(C_{it})$	$\log(C_{it})$	$\log(C_{it})$	$\log(C_{it})$
Disposable income	0.2210***	0.2192***	0.2192***	0.2192***	0.2192***
($\log(DY_{it})$)	(0.0076)	(0.0076)	(0.0076)	(0.0076)	(0.0076)
Real assets, lagged	0.0089***	0.0072***	0.0072***	0.0072***	0.0072***
(RA_{it-1})	(0.0021)	(0.0021)	(0.0021)	(0.0021)	(0.0021)
Net financial assets, lagged	0.0013	0.0042	0.0043	0.0042	0.0043
(NFA_{it-1})	(0.0072)	(0.0071)	(0.0081)	(0.0071)	(0.0081)
Debt-to-disposable income ratio, lagged			**0.0001**		**0.0001**
($DR\text{-}DTI_{it-1}$)			**(0.0033)**		**(0.0033)**
Debt service ratio, lagged				**0.0001**	**0.00001**
($DR\text{-}DSR_{it-1}$)				**(0.0227)**	**(0.0228)**
Age of household head	-0.0025	0.0317***	0.0317***	0.0317***	0.0317***
($hhage_{it}$)	(0.0015)	(0.0041)	(0.0041)	(0.0041)	(0.0041)
Squarred age of household head		-0.0003***	-0.0003***	-0.0003***	-0.0003***
($hhage^2_{it}$)		(0.0000)	(0.0000)	(0.0000)	(0.0000)
Number of household members	0.1791***	0.1713***	0.1714***	0.1714***	0.1714***
($family\_size_{it}$)	(0.0065)	(0.0066)	(0.0066)	(0.0066)	(0.0066)
Schooling years of household head	0.0092**	0.0073**	0.0073**	0.0073**	0.0073**
($schooling\_year_{it}$)	(0.0038)	(0.0036)	(0.0036)	(0.0036)	(0.0036)
Individual fixed effects	Yes	Yes	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes	Yes	Yes
Number of observations	24,039	24,039	24,039	26,039	24,039
Number of groups	2,327	2,352	2,327	2,327	2,327
within R^2	0.275	0.282	0.282	0.282	0.282

Notes: 1) Figures in parenthesis are the standard errors from the heteroscedasticity and autocorrelation consistent estimations. 2) *** and ** denote significant levels of 1% and 5%, respectively.

Age and schooling years of household head and number of household members have significant positive effects on consumption level as expected. Interestingly, the two key variables, debt-to-disposable income and debt service ratios, do not show any significance in the linear setup, reminding us of the mixed effect of household debt on consumption. As previous theoretical and empirical research demonstrates, households can facilitate consumption smoothing across the present and the future through

borrowing. This so-called liquidity effect of debt on consumption, however, can only hold up to a certain level of debt, beyond which the debt overhang would cancel out or dominate the liquidity effect, leading to a reduction in household consumption.

In addition, the age of the household head shows significant nonlinear effects on consumption level. In Column (a), the age of the household head in its linear form has no significant effects on consumption spending. In Columns (b) to (e), however, it is shown that households expand their consumption until the head of the household reaches a certain age, 52 years old in this study, and then start to reduce their expenditure beyond that point. Here, the threshold age for the household head is estimated by nonlinear combination of the coefficients such as $-hhage/2hhage^2$ using the delta method. This consumption pattern can be explained by the fact that the retirement of older workers from the labor market usually occurs in their early 50s and then the retirees are likely to face a sharp decline in consumption spending due to the poor public pension system in Korea.

<Table II> Consumption Growth with Linear Debt Ratios[1), 2)]

	(a)	(b)	(c)	(d)
Dependent variables	$\Delta\log(C_{it})$	$\Delta\log(C_{it})$	$\Delta\log(C_{it})$	$\Delta\log(C_{it})$
Change in disposable income ($\Delta\log(DY_{it})$)	0.1426*** (0.0074)	0.1426*** (0.0074)	0.1453*** (0.0076)	0.1450*** (0.0076)
Change in real assets, lagged (ΔRA_{it-1})	0.0003 (0.0025)	0.0003 (0.0025)	0.0004 (0.0025)	0.0003 (0.0025)
Change in net financial assets, lagged (ΔNFA_{it-1})	-0.0039 (0.0076)	-0.0037 (0.0078)	-0.0051 (0.0076)	-0.0030 (0.0079)
Debt-to-disposable income ratio, lagged (*DR-DTI*$_{it-1}$)		**0.0002 (0.0036)**		**0.0036 (0.0037)**
Debt service ratio, lagged (*DR-DSR*$_{it-1}$)			**-0.1119*** (0.0305)**	**-0.1185*** (0.0319)**
Age of household head ($hhage_{it}$)	0.0005 (0.0010)	-0.0091*** (0.0029)	-0.0091*** (0.0029)	-0.0093*** (0.0029)
Squarred age of household head ($hhage^2_{it}$)		0.0001*** (0.0000)	0.0001*** (0.0000)	0.0001*** (0.0000)
Number of household members ($family\_size_{it}$)	-0.0147*** (0.0054)	-0.0128** (0.0056)	-0.0126** (0.0056)	-0.0126** (0.0056)
Schooling years of household head ($schooling\_year_{it}$)	-0.0027 (0.0033)	-0.0021 (0.0034)	-0.0019 (0.0033)	-0.0020 (0.0033)
Individual fixed effects	Yes	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes	Yes
Number of observations	21,276	21,276	21,276	21,276
Number of groups	2,299	2,299	2,299	2,299
within R^2	0.068	0.068	0.069	0.069

Notes: 1) Figures in parenthesis are the standard errors from the heteroscedasticity and autocorrelation consistent estimations. 2) *** and ** denote significant levels of 1% and 5%, respectively.

Table II shows the estimation results for consumption growth function with linear debt ratios. The overall explanatory powers decline when compared to those in consumption level estimations. Also, the results present several different features. First,

the lagged changes in real assets have no effects on current consumption growth. We conjecture that the development of valuations in real assets is more likely to affect current consumption changes than future changes given a one year time interval during which households will have enough time to adjust their consumption in response to the variations in real asset values. Secondly, the age of the household head still has nonlinear effects on consumption growth but this time in a reversed direction. The threshold estimated by $-hhage/2hhage^2$ indicates that the rate of consumption growth progressively slows until the age of the household head (*hhage*) reaches 54. Namely, the combined estimation results associated with household age from both consumption level and growth indicate that the consumption spending increases as the household members become older up to their early 50s, but with a diminishing speed in the growth. Similarly, the family size can increase the consumption spending with a diminishing speed. Thirdly, the debt service ratio has significant negative effects on consumption growth while the debt-to-disposable income ratio has no effects.

3.2 Estimations with Nonlinear Household Debt Ratios

The specifications involving linear debt ratios are overall confirmed to work poorly in accounting for consumption behavior. It is natural to check whether the lack of explanatory power of debt ratio on consumption comes from the linear restriction on the debt ratios or not. In other words, whether there exist nonlinear effects of the debt ratios on consumption, in which the focal point is to find a threshold beyond which debt overhang can reduce consumption whereas the household would exhibit increased consumption spending by facilitating consumption smoothing through raising debts before the threshold.

In this section, the linear restrictions are relaxed by allowing quadratic functional forms for the debt ratios as illustrated in Equations (1) and (2). Table III displays the estimation results for the consumption level, allowing nonlinear effects by debt ratios. As expected, the two debt ratio variables present significant nonlinear patterns in which debt ratios have positive effects on consumption before the thresholds while the relationships are reversed when the ratios exceed the thresholds. Specifically, the estimated threshold for the household debt-to-disposable income is 210% and that for the debt service ratio is around 27%. These estimated values are reasonable thresholds up to which households can expand their consumption spending before their debt holdings reach around 2 times their yearly disposable income through relaxed borrowing constraints by raising debt. Once the accumulated debt exceeds 2 times their yearly disposable income, however, households start to contain their spending due to the debt burden. This is also consistent with the estimated threshold for the household debt service ratio in which the households making principal and interest payments roughly one third of their disposable income must seriously consider reducing their expenses. In the meantime, the estimated coefficients for other independent variables are quite similar to those in the specifications involving linear debt ratios.

The estimation results for consumption growth allowing nonlinear effects from the debt ratios are displayed in Table IV. The estimated coefficients for changes in disposable income, wealth and other control variables are quite similar to those in the specifications with linear restrictions in Table 2. Overall, the degree of significance for

the debt ratio variables declines. Particularly, the debt service ratio no longer has significant nonlinear effects on consumption growth, which is consistent with the results in the linear specifications where the debt service ratio has significant negative effects on the rate of consumption growth. The debt-to-disposable income ratios have nonlinear effects on the consumption growth but the significance for each ratio variable shrinks. When the debt exceeds around 2.6 times a household's yearly disposable income, the debt burden can reduce the speed of consumption growth. Combining the estimation results from both consumption level and growth associated with the debt-to-disposable income ratio shows that the consumption level can be reduced when debt surpasses around 2 times a household's disposable income and the speed of reduction might accelerate when the debt exceeds 2.6 times the disposable income.

<Table III> Consumption Level with Nonlinear Debt Ratios[1), 2)]

	(a)	(b)	(c)	(d)
Dependent variables	$\log(C_{it})$	$\log(C_{it})$	$\log(C_{it})$	$\log(C_{it})$
Disposable income ($\log(DY_{it})$)	0.2192*** (0.0076)	0.2192*** (0.0076)	0.2192*** (0.0076)	0.2192*** (0.0076)
Real assets, lagged (RA_{it-1})	0.0072*** (0.0021)	0.0072*** (0.0021)	0.0070*** (0.0021)	0.0070*** (0.0021)
Net financial assets, lagged (NFA_{it-1})	0.0084 (0.0083)	0.0084 (0.0083)	0.0071 (0.0071)	0.0064 (0.0081)
Debt-to-disposable income ratio, lagged ($DR\text{-}DTI_{it-1}$)	**0.0161** (0.0072)**	**0.0161** (0.0072)**		**-0.0007 (0.0033)**
Squared debt-to-disposable income ratio, lagged($DR\text{-}DTI^2_{it-1}$)	**-0.0039*** (0.0015)**	**-0.0039*** (0.0015)**		
Debt service ratio, lagged ($DR\text{-}DSR_{it-1}$)		**-0.0008 (0.0227)**	**0.1702*** (0.0476)**	**0.1719*** (0.0474)**
Squared debt service ratio, lagged ($DR\text{-}DSR^2_{it-1}$)			**-0.3144*** (0.0227)**	**-0.3154*** (0.0804)**
Nonlinear combination of the debt ratio coefficients, lagged $(-\beta_4/2\beta_5)$[3)]	**2.079*** (0.422)**	**2.083*** (0.424)**	**0.271*** (0.036)**	**0.273*** (0.036)**
Other control variables[4)]	Yes	Yes	Yes	Yes
Individual fixed effects	Yes	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes	Yes
Number of observations	24,039	24,039	24,039	24,039
Number of groups	2,327	2,327	2,327	2,327
within R^2	0.282	0.282	0.283	0.283

Notes: 1) Figures in parenthesis are the standard errors from the heteroscedasticity and autocorrelation consistent estimations. 2) *** and ** denote significant levels of 1% and 5%, respectively. 3) The coefficients and standard errors are estimated using the delta method for nonlinear combination. 4) They include the age of household head, squared age of household head, number of household members, and schooling years of household head.

Finally, the estimation results for consumption level by sub-income groups allowing nonlinear debt ratios are displayed in Table V. The income groups are separated into two, with a lower income group (1~5 income quintile) and a higher income group (6~10 income quintile). The interesting features in the estimation results can be summarized as follows. First, the nonlinear effects are more significant in the higher income group than in the lower income group. This is plausible as higher income

households can respond more sensitively to the debt overhang given higher shares of inessential expenditures in total expenses. Secondly, households in the higher income group have a higher threshold for the debt service ratio. They begin to reduce their consumption when the ratio reaches 29.0% of their disposable income while the threshold for lower income households is 24.5%.

<Table IV> Consumption Growth with Nonlinear Debt Ratios[1), 2)]

	(a)	(b)	(c)	(d)
Dependent variables	$\Delta\log(C_{it})$	$\Delta\log(C_{it})$	$\Delta\log(C_{it})$	$\Delta\log(C_{it})$
Change in disposable income ($\Delta\log(DY_{it})$)	0.1427*** (0.0074)	0.1451*** (0.0076)	0.1452*** (0.0076)	0.1450*** (0.0076)
Change in real assets, lagged (ΔRA_{it-1})	0.0003 (0.0025)	0.0003 (0.0025)	0.0003 (0.0025)	0.0003 (0.0025)
Change in net financial assets, lagged (ΔNFA_{it-1})	-0.0028 (0.0079)	-0.0021 (0.0079)	-0.0049 (0.0076)	-0.0030 (0.0079)
Debt-to-disposable income ratio, lagged ($DR\text{-}DTI_{it-1}$)	**0.0119 (0.0079)**	**0.0157* (0.0080)**		**0.0034 (0.0038)**
Squared debt-to-disposable income ratio, lagged($DR\text{-}DTI^2_{it-1}$)	**-0.0030 (0.0019)**	**-0.0031 (0.0019)**		
Debt service ratio, lagged ($DR\text{-}DSR_{it-1}$)		**-0.1119*** (0.0319)**	**-0.0792 (0.0614)**	**-0.0904 (0.0642)**
Squared debt service ratio, lagged ($DR\text{-}DSR^2_{it-1}$)			**-0.0606 (0.1084)**	**-0.0516 (0.1098)**
Nonlinear combination of the debt ratio coefficients, lagged ($-\beta_4/2\beta_5$)[3)]	**1.985*** (0.597)**	**2.551*** (0.734)**	**no significance**	**no significance**
Other control variables[4)]	Yes	Yes	Yes	Yes
Individual fixed effects	Yes	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes	Yes
Number of observations	21,276	21,276	21,276	21,276
Number of groups	2,299	2,299	2,299	2,299
within R^2	0.068	0.069	0.069	0.069

Notes: 1) Figures in parenthesis are the standard errors from the heteroscedasticity and autocorrelation consistent estimations. 2) ***, ** and * denote significant levels of 1%, 5% and 10%, respectively. 3) The coefficients and standard errors are estimated using the delta method for nonlinear combination. 4) They include the age of household head, squared age of household head, number of household members, and schooling years of household head.

4. Conclusion

This paper presents an empirical study on whether there exist nonlinear effects from two household debt burden measures, debt-to-disposable income ratio and debt service ratio, on consumption using quadratic functional form assumption. We use the KLIPS (Korean Labor and Income Panel Study) household-level survey data from 2000 to 2014, which allow us to investigate more long-term consumption behavior at the household level across business cycles and macroeconomic shocks.

The overall estimation results indicate that households begin to reduce their consumption spending when the debt-to-disposable income ratio exceeds 210 % or when the debt service ratio exceeds 27 %. In addition, the nonlinear effects become less significant for the consumption growth while the debt service ratio has significant

negative effects on the consumption growth in the linear specification. Finally, the estimation results for the consumption level by sub-income groups indicate that the nonlinear effects of the debt service ratio are more significant in the higher income group, while the estimated threshold ratio beyond which households start to constrain consumption is smaller for lower income households.

<Table V> Consumption Level by Sub-Income Groups[1), 2)]

	Lower Income		Higher Income	
Dependent variables	$\log(C_{it})$	$\log(C_{it})$	$\log(C_{it})$	$\log(C_{it})$
Debt-to-disposable income ratio, lagged ($DR\text{-}DTI_{it-1}$)	**0.0117** **(0.0110)**	**-0.0006** **(0.0046)**	**0.0189*** **(0.0096)**	**-0.0021** **(0.0049)**
Squared debt-to-disposable income ratio, lagged($DR\text{-}DTI^2_{it-1}$)	**-0.0028** **(0.0022)**		**-0.0050**** **(0.0020)**	
Debt service ratio, lagged ($DR\text{-}DSR_{it-1}$)	**-0.0219** **(0.0349)**	**0.1764**** **(0.0476)**	**0.0129** **(0.0313)**	**0.1802***** **(0.0603)**
Squared debt service ratio, lagged ($DR\text{-}DSR^2_{it-1}$)		**-0.3600***** **(0.1343)**		**-0.3112***** **(0.0985)**
Nonlinear combination of the debt ratio coefficients, lagged $(-\beta_4/2\beta_5)$[3)]	**2.114**** **(0.833)**	**0.245***** **(0.049)**	**1.878***** **(0.494)**	**0.290***** **(0.050)**
Other control variables[4)]	Yes	Yes	Yes	Yes
Individual fixed effects	Yes	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes	Yes
Number of observations	11,455	11,455	11,812	11,812
Number of groups	1,104	1,104	1,103	1,103
within R^2	0.309	0.309	0.263	0.263

Notes: 1) Figures in parenthesis are the standard errors from the heteroscedasticity and autocorrelation consistent estimations. 2) *** and ** denote significant levels of 1% and 5%, respectively. Lower income groups comprised 1-5 sub-groups by income quintiles in 2014. 3) The coefficients and standard errors are estimated using the delta method for nonlinear combination. 4) They include disposable income, lagged real assets, lagged net financial assets, age of household head, squared age of household head, number of household members, and schooling years of household head.

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Appendix 1

Removal of Outliers[1]

- *DSR*	*DSR* cannot exceed household disposable income ($0 \leq DSR \leq 1$).
- *DTI*	Highest 2% in distribution is removed.
- *NFA*	Highest 1% and lowest 1% in distribution are removed.
- *RA*	Highest 2% is removed.

Appendix 2

Summary Statistics of Panel Data[1]

Variable	Mean	S.D.	Min	Max	Compilation
Household consumption (log(*C*))	7.40	0.71	4.05	10.05	- Logarithmic level of consumption spending excluding payments for principal and interest, social contributions and taxes
Household disposable income (log(*DY*))	7.70	0.93	0.82	11.66	- Logarithmic level of household disposable income - Comprehensive incomes including labor income, financial income, asset income, social transfers, etc.
Real assets (*RA*)	1.57	2.07	0.00	15.66	- Denominated by Consumer Price Index (2010=1.0) - 100 million Won
Net financial assets (*NFA*)	0.042	0.445	-2.110	2.303	- Financial asset excluding financial debt - Denominated by Consumer Price Index (2010=1.0) - 100 million Won
Household debt- to-disposable income ratio (*DTI*)	0.516	1.04	0.00	6.61	- Comprehensive debt including money borrowed from financial institutions, public funds, private persons, etc.
Debt service ratio (*DSR*)	0.05	1.04	0.00	1.00	- The ratio of principal and interest payments over household disposable income
Age of household head (*hhage*)	56.3	13.1	20.0	95.0	-
Number of family members (*family_size*)	3.1	1.3	1.0	10.0	-
Schooling years of household head (*schooling_year*)	10.0	4.4	0.0	23.0	-

Note: 1. All data are obtained and compiled from KLIPS (Korea Labor and Income Panel Study).