Ph.D. Dissertation of Economics

Income Volatility, Household Leverage, and Consumption in Korea

한국 가계의 소득 변동성과 부채, 소비 분석

August 2019

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Submitting a Ph.D. Dissertation of Economics

April 2019

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Abstract

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In this paper, we examine the effects of income volatility changes on households' leverage and consumption. We use the Survey of Household Finances and Living Conditions (SFLC) from year 2012 to year 2017 data. The main findings are as follow:

First, households who faced increased income volatility lowered their leverage ratio. For example, a one standard deviation increase in income volatility was associated with 1.3 ~ 1.5 percentage point decrease in the leverage ratio. The effects of income volatility changes on households' leverage choices varied among different household groups. Potentially borrowing-constrained households and households with 'net-short' position in their real estate assets lowered leverage ratio more quickly. This indicates households' leverage ratio responses to income volatility changes were affected by supply-side factors like borrowing-constraints; as well as demand-side factors like households' precautionary-saving motives. The demand-side factors in leverage ratio responses may reflect households' risk management incentives where they adjusted their financial net wealth risk exposure when faced with increased human wealth uncertainty.

Second, when faced with enlarged income uncertainty, households' income coefficients on consumption were lowered. The income coefficient of average households was estimated to be around

0.16, while households with increased income volatility were around 0.12. In particular, similar to the relations in leverage ratio changes, consumptions among potentially borrowing-constrained households and those with 'net-short' position in real estate assets were more affected by increases in income volatility. This can be understood that households smoothed their consumption during the periods of increased income volatility, and this was shown in the smaller consumption elasticity on income.

Combining household' leverage and consumption choices in response to income volatility changes, there may exist two transmission channels for income uncertainty changes in consumption. The first one is, by precautionary saving motives and consumption smoothing motives, households adjust their consumption less to the changes of income, when they face increased income volatility. The second channel is through households' deleveraging. Faced with increased income volatility, households lower the risk exposure of their financial net wealth by lowering their leverage ratio. Thus, households' net disposable income may decrease as they deleverage and increased debt-servicing burdens hinder consumptions. In light of this relationship, financial institutions may advise on households' optimal leverage choices before they face abrupt deleveraging needs which may be accompanied by considerable disutility. From a macroeconomic perspective, this indicates the possibility that considering households' risk management incentives between human wealth and financial net wealth, precautionary saving motives from increased income uncertainty may be reinforced. Accordingly, an economy with huge household debts, such as Korea, would be more vulnerable to the income uncertainty change shocks, since households may face more deleveraging needs that undermine net-disposable income.

Keywords : income volatility, household debt, leverage, consumption, precautionary saving, consumption smoothing
Student Number : 2014-30047

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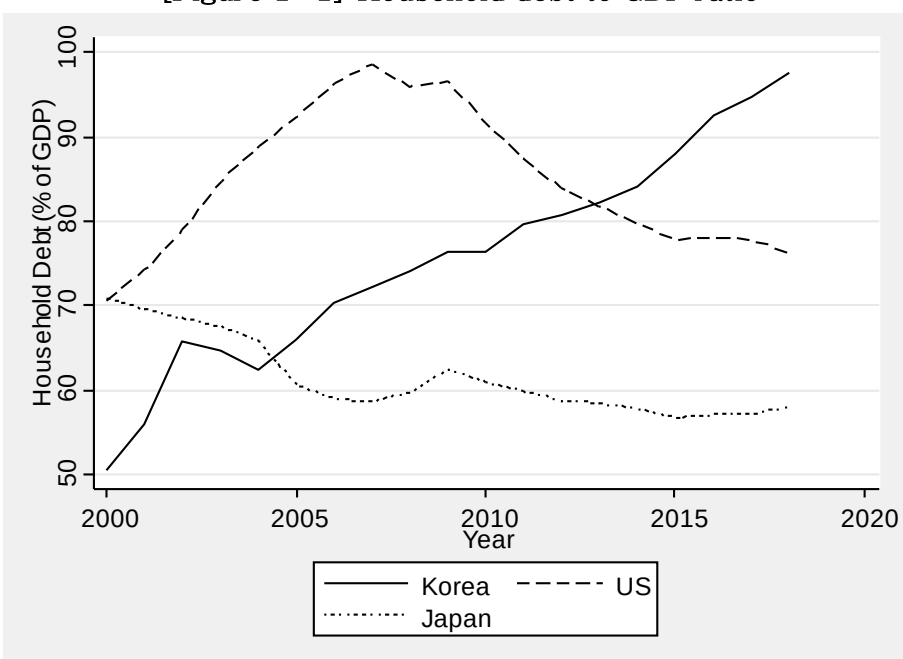
1. Introduction

1.1. Study background

Huge household debt has become one of the most significant risks in the Korean economy. This is especially alarming because of the rapid speed of debt accumulation and its vast size. Korean household debt compared to its GDP rose from 79.7% at the end of 2011 to 97.7% in 2018. If even a fraction of households fails to repay their liabilities, financial institutions' capital soundness will be harmed, causing financial market instability. Furthermore, as Büyükkarabacak & Valev (2010) noted, over-indebtedness restrains households' disposable income, suppressing private consumption. A variety of literatures noted that the huge household debt problem undercuts long run economic growth, either through its financial linkage, households' consumption linkage or both. For example, according to the threshold regression of Cecchetti et al (2011), economic growth will be damaged if household debt levels rise beyond 85 percent of GDP.

[Figure 1-1] Household debt to GDP ratio



Source: Bank for International Settlements

1.2. Previous studies and purpose of research

Households face different risks over time. Let us consider the following simple consumer choices:

$$\text{Max } U = \sum \beta^t \cdot u(C_t)$$

Subject to

$$\underbrace{P_t \cdot C_t}_{\text{consuming}} \leq \underbrace{(r_{t-1}^A A_{t-1} - A_t)}_{\text{saving and investing}} + \underbrace{(D_t - r_{t-1}^D D_{t-1})}_{\text{borrowing}} + \underbrace{Y_t}_{\text{earning}}$$

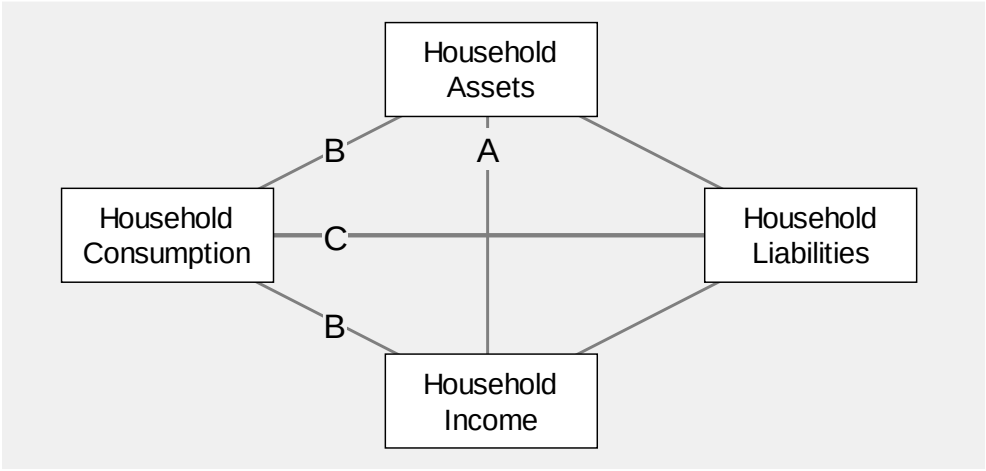
where β is the time discount factor, $u(\cdot)$ is a conventional utility function with discrete time, C_t is an amount of consumption at time t, P is a unit price of consumption, r^A is an average return on saving in safe assets and investing in risky assets, A is the total amount of saving and investing, D is the amount of debt-financing, r^D is interest rate paid on household's debt, and Y is household's income.

The simple example above represents households' major economic activities, spending, saving and investing, debt-financing, and earning. All those activities are closely related to each other. First, households have an incentive to smooth their consumption in order to maximize their life-time expected utility in the standard risk-averse preferences. In this regard, households choose their optimal composition of assets and liabilities. Second, households either save or invest. When households obtain assets with variable price (in the above example, r^A), they are exposed to price risk, and the degree of risk depends on the portfolio of assets. Next, households may borrow money in order to smooth their consumption or to obtain some assets if their budget constraints are binding without debts. However, too much debt-financing, compared to households' assets or earnings, creates a risk of default. Furthermore, the price risk in the asset side of view and the solvency risk in liability side are closely related. Other things being equal, highly indebted households would face more price risk because their assets are 'leveraged'. Finally, households have an income, either labor or business or property income. Regardless of the source, households

face uncertainty of current and future income, which is related to the precautionary saving motives.

Many studies have examined the relationships among household debt, income and consumption in Korea. For example, Choi et al (2015) and Park (2019) studied leveraged households' consumption behavior with detailed micro household data. Choi et al (2015), using micro data obtained from the credit bureau, found that the magnitude of wealth effects from rising house prices was greater in high income and older households. Park (2019) found similar relations that households with 'net-long' in real estate assets had bigger wealth effects. Song (2018) studied the relationship of household leverage and consumption. The author argued that in economic circumstances where households are highly in debt and have insufficient liquid assets, as in Korea, household consumption is likely to be vulnerable to negative income shocks, which could hamper aggregate spending growth.

[Figure 1-2] Simple illustration of previous literature



Note A) Chang et al (2019) studies the effects of household income volatility changes on households' asset portfolios.

B) Choi et al (2015) and Park (2019) studied the effects of house prices and income changes on household consumption.

C) Song (2018) studied the effects of household leverage on household consumption.

However, few studies examined the relationships between households' income uncertainty, leverage and consumption in Korea.

Considering the rapidly changing socioeconomic environment, such as demographic changes with aging populations and adverse external demand caused by trade tensions among major economies, Korean households face substantial changes in income uncertainty. Accordingly, we study the effects of households' income uncertainty changes on leverage and consumption choices.

Chang et al (2019), which furnished the main motivation for our research, analyzed the relations between household income uncertainty and household portfolio choices using detailed Norwegian household micro-level data. They defined household income uncertainty as income volatility changes with a certain threshold, such as the bottom 25 percentile of income volatility changes during the sample period. The portfolio choices were measured as the 'risky share,' which is the share of risky financial asset in total asset. They found that if households face enlarged income uncertainty, they adjust overall risk exposure by lowering risky share in their asset portfolio.

Considering Korean households' small share of financial assets and huge amount of debt, we focus on households' leverage and consumption choices when income uncertainty changes. According to the Bank of Korea (2017), the share of financial assets in households' total assets was 37.2 percent, which is only the half of United States' 69.9 percent. Other major advanced economies, such as Japan (63.5 percent), United Kingdom (52.8) and Germany (42.9) also showed a relatively larger share of financial assets. Therefore, in analyzing advanced economies' household behavior, it would be appropriate to associate households' response of asset portfolio when household faces changed income uncertainty. But considering the small share of financial assets and huge household debts of Korean households, it would be better focus on households' response of liability choices, when faced with increased income uncertainty. Gu (2007) argued that after the 1997 financial crisis, the volume and proportion of bank financing has grown as a result of low interest rate and risk-focused management of financial institutions. Coincided with low borrowing demand from corporate sector, household debts have grown

remarkably. Our key research question is as follows.

- *What are the effects of changes of income volatility on households' leverage and consumption choices?*
- *Under changed income uncertainty, are there any behavioral changes in choosing saving, borrowing and consuming?*

Households' leverage choices would be affected by changes of income volatility. A risk averse household would decrease his/her overall risk stemming from assets and liabilities, if the risk from human wealth increases, indicating households manage their overall risk exposure of human wealth and 'tangible' wealth. This 'risk management incentive' is the starting point of our intuition. And we further consider other aspects that can exert influences on the relationship of changes of income uncertainty and household leverage/consumption.

First, borrowing-constraints are a crucial factor in examining the effects of income volatility changes on the leverage ratio. As Deaton (1992) noted, if a person faces or expects to face a borrowing constraint, he or she would save more in order to guarantee the minimum consumption levels in future periods, since increased income volatility is associated with the probability increase of being borrowing-constrained. Therefore, this would be observed as lowered leverage ratio in response of increased income volatility.

Second, life-cycle theory suggests that old households' leverage ratio would be less affected by increased income volatility, since their remaining life-time income is smaller than that of young households. This indicates the possibility that young or middle aged households' leverage and consumption would be more affected by income volatility changes.

Third, as Brunnermeier et al (2008) noted, households' risk aversion may differ with their wealth level. Considering that real estate assets account for the largest share in wealth among Korean households, households who do not own houses would be more risk-averse, indicating their leverage and consumption would be more

affected by changes in income uncertainty.

Fourth, distinguishing permanent and transitory income shock is also an important factor in examining households' leverage and consumption responses. If households perceive the changed income uncertainty as a permanent one, they would adjust their leverage and consumption considerably. But if the income shock is perceived as just a temporary one, the adjustment would be little.

Finally, considering households' leverage and consumption choices at a same time, one can expect the possibility that changes in income volatility 'directly' affect consumption through income changes and 'indirectly' affect consumption through changes in debt-servicing burden. Standard consumption theory suggests that, by precautionary saving motives, increased income volatility would be associated with higher income growth rate, which is the result of decreasing current periods' consumption. At the same time, since increased income volatility affects households' leverage choices, changes of debt-servicing burden also indirectly affect consumption.

In order to examine these research questions, we use detailed micro household data in Korea, and divide households into different groups, in terms of borrowing constraints and household heterogeneity. Since it is not possible to directly observe whether a household is borrowing-constrained or not, we use various criteria regarding households' debt-burden and potential borrowing-constraints. With respect to household heterogeneity, we divide households into different age groups, in order to verify the standard life-cycle theory. We also divide households according to home-ownership criteria, in order to check whether households' wealth effects are affected by changes in income volatility or not. Finally, we consider households' job changes in order to distinguish permanent and temporary income shocks.

This paper is organized as follows: Chapter 2 discusses the relations between income volatility changes and leverage, with the consideration of borrowing constraints and heterogeneity across groups. Chapter 3 discusses the relationship of income volatility changes and consumption. And in Chapter 4, we conclude.

2. Household Income Volatility and Leverage

2.1. Data

The panel dataset in this research is obtained from “the Survey of Household Finances and Living Conditions (SFLC)” conducted annually by Statistics Korea, the Financial Supervisory Service of Korea, and the Bank of Korea since 2012. The sampled households are selected to represent all South Korean households with about twenty thousand household sample. The survey set is composed of Household Welfare Survey and Household Financial Survey. Each survey has ten thousand sample households. Household Welfare Survey contains detailed information of households’ consumption expenditure, and Household Financial Survey has detailed questions about households’ financial condition, such as the reason why household financial debt increased and the plan and mean for future debt service. Both surveys contain the socioeconomic characteristics of household members. As the samples of this dataset were modified markedly in 2018, we restrict the analysis period to 2012−2017.

From 2012 to 2017, a total of 33,694 individual households were surveyed in SFLC for at least one year. We restrict our sample to households included in the panel dataset for the whole of the sample periods. After this, 6,151 households remain. In order to delete outliers, we exclude households who reported total liabilities were 10 times bigger than their total assets. This criterion excludes a total of 87 households. Accordingly, in sum, we use a perfectly balanced panel dataset composed of 6,064 households over 6 years. Since in many cases we use log−transformed value of variables, we replace those variables into 1 if they were 0, making the log−transformed value 0, so we can calculate the mean or standard deviation of variables. In case of current income, total 23 households reported their current income were zero for 1 year, and 2 households reported their income were zero for 2 years. The other definitions of household income and descriptive statistics are explained in [Appendix A1].

2.2. Household income volatility change

We construct a measure of household income volatility change. Let $y_{i,t}$ denote the logged value of annual income of household i at time t, after controlling for a common age profile and the number of family members. We use current income as a primary measure for household income.

$$SD_{i,T-} \equiv SD_i[y_{i,t}|t < 2015],$$
$$SD_{i,T+} \equiv SD_i[y_{i,t}|t \geq 2015]. \quad (1)$$

Then, the change in income volatility before and after the threshold year 2015, ΔSD_i is:

$$\Delta SD_i \equiv SD_{i,T+} - SD_{i,T-} \quad (2)$$

[Table 2-1] shows the summary statistics for $y_{i,t}$ after control (residual) and our measure of income volatility $SD_i[y_{i,t}]$ (the standard deviation of logged income). On average, the household income volatility $SD_i[y_{i,t}]$ is 0.312 with a standard deviation of 0.291.

[Table 2-1] Summary statistics for income and volatility

	Mean	S.D.	Percentiles				
			10%	25%	50%	75%	90%
y_i	0.003	0.814	-1.072	-.0465	0.103	0.541	0.927
SD_i	0.312	0.291	0.105	0.163	0.255	0.379	0.535
$SD_{i,T-}$	0.254	0.306	0.051	0.098	0.187	0.322	0.503
$SD_{i,T+}$	0.230	0.286	0.040	0.083	0.164	0.290	0.461
ΔSD_i	-0.021	0.394	-0.309	-0.142	-0.018	0.104	0.261

By imposing a certain threshold, we can further identify the households who experienced a substantial increase(decrease) in household income. We consider two types: a significant increase or decrease in household income volatility.

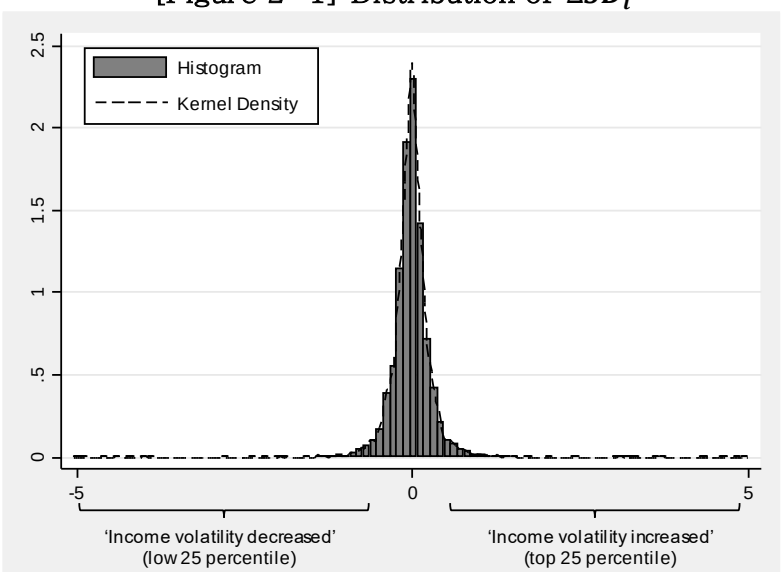
$$I\{\text{Volatility Increase}\}_i = \begin{cases} 1, \ if \ \ \Delta SD_i > \overline{SD} \\ 0 \ \ otherwise \end{cases}$$

Some households' income volatility may be bigger persistently. However, by differencing the volatility in two sub-periods in same household, we can measure the changes in households' income uncertainty with the consideration of households' idiosyncratic characteristics. Similarly, the dummy variable for the structural break of big decrease in income volatility can be defined as follows:

$$I\{\text{Volatility Decrease}\}_i = \begin{cases} 1, \ if \ \ \Delta SD_i \leq \underline{SD} \\ 0 \ \ otherwise \end{cases}$$

For our benchmark analysis, two thresholds, $\underline{SD}$ and $\overline{SD}$, are respectively, the 25 and 75 percentiles of the pooled cross-sectional distribution of ΔSD_i (−0.142 and 0.104). With these thresholds, we have 25% of the sample in each category. The rest of the sample is classified as 'no big change' in income volatility.

[Figure 2-1] Distribution of ΔSD_i



Before proceeding to the next section, we examine what factors were the sources of income volatility. In order to analyze what is associated with the income volatility changes, we look for observed changes in households' marital status, number of family members,

location of residence, home ownership and job status, with following regression equation.

$$\Delta SD_i = \beta X_i + \epsilon_i \quad (3)$$

where X_i is a vector of households' status changes. Some variables, such as marital status and number of family members, contain information about the direction of changes, while some variables, such as job industry changes, do not contain the information of the direction of changes. [Table 2-2] briefly explains the explanatory variables. Job status refers to the status that a worker is a permanent position or temporary, or own business or unemployed. Community change is whether households moved from Seoul metropolitan area to non-Seoul metropolitan are or vice-versa.

[Table 2-2] Source of income volatility

Variables	Description	Mean
Marital Status	-1 if married in first 3 years and single in last 3 years 0 if no change 1 if single in first 3 years and married in last 3 years	0.009
Family size	Difference of average family size between last 3 years and first 3 years	-0.038
Job industry	0 if no change 1 if job industry changed	0.445
Job status	0 if no change 1 if job status changed	0.428
Community	0 if no change 1 if the location of residence changed	0.017
Home ownership	-1 if home owners became renters 0 if no change 1 if renters became home owners	0.133

According to the regression results reported in [Table 2-3], marriage was associated with an increase in income volatility. If a man or woman marries, his or her households' income volatility increased by 0.118 unit, which is roughly one-third of the standard deviation of income volatility. This may reflect the prevalent social trend in Korea that a working man and woman marry, and after a

couple of years, the wife becomes pregnant and quits her job (or takes maternity leave). This increases households' income volatility. Unlike to the relations of marital status and income volatility, an increase in family size was associated with a decrease in income volatility. Note that a marriage is accompanied by a one person increase in the number of family members. This relation reflects the fact that if family size increases, workers' willingness to smooth their income increases, in order to guarantee household members' minimum consumption levels. As expected, workers' job industry changes were associated with an increase in income volatility. Changes of job status had an insignificant coefficient, but if we break the sample into 'volatility decrease' and 'volatility increase,' the coefficients were estimated to be significant in both samples, indicating the relations are non-linearly significant. Other variables, such as changes in community or home ownership had no significant relationship with changes in income volatility. We also divided the sources of volatility into 'event occurred in the first 3 years' and 'event occurred in the last 3 years', but the regression results were little different from the results obtained in [Table 2-3]

[Table 2-3] Estimation results of the source of income volatility

	Total (Baseline)	Vol. increase ($\Delta SD_i > 0$)	Vol. decrease $\Delta SD_i < 0$
Marital Status	0.118***	0.015	-0.096*
	(0.040)	(0.047)	(0.050)
Family size	-0.023**	-0.033***	0.013
	(0.010)	(0.012)	(0.012)
Job industry	0.040***	0.063***	0.001
	(0.012)	(0.016)	(0.013)
Job status	-0.004	0.084***	-0.086***
	(0.012)	(0.016)	(0.013)
Community	0.035	0.078	0.000
	(0.039)	(0.049)	(0.045)
Home ownership	0.002	-0.023	-0.021
	(0.015)	(0.023)	(0.017)
Obs.	6,064	2,724	3,340
R^2	0.0046	0.0428	0.0191

Note: The ***, **, * denote the statistical significance at 1%, 5%, 10% respectively.

2.3. Leverage ratio

According to Chang et al (2018), studies on household portfolio choices can be divided into two groups in terms of which wealth components to include in the measurement of risky share. One focuses on financial assets (for example, Ameriks & Zelds (2004); Cocco, Gomes & Maenhout (2005); Gomes & Michaelides (2005); and Huggett & Kaplan (2016), to name only a few) and the other focuses on broader portfolios that include housing and privately owned business (for example, Glover et al. 2014). Chang et al (2019) defined risky share as the total value of risky financial assets divided by the total amount of financial assets, safe and risky. They showed homeowners and renters exhibit a similar shape of age profile of risky share in financial assets, and when the value of house(s) is included as a part of risky investment, the risk share still increases with age.

Although those studies partly consider debt side of households, their 'risky share' definition mainly focused on the asset side of households' portfolio choices. But, even if the 'risky share' ratio are the same, one with no leverage at all and the other with full leverage (without its own capital) can have totally different meaning.

In order to consider the liability side of households, we adopt 'leverage ratio', which captures households' debt-financing activities. Basically, 'risky share' in asset side and 'leverage ratio' in debt side have a similar aspect, since both measures evaluate the risk exposure of household. Risky share captures the risk created from the price changes of households' assets. The higher the risky share, the bigger the household's risk stemming from asset price changes. On the other hand, leverage ratio measures households' solvency risk. As the leverage ratio goes up, the default risk for households rises.

There are several definitions regarding the leverage ratio. One of the most popular concepts is the 'debt-to-asset ratio,' which focuses on households' debt-financing activity. Song (2018) used the following definition in analyzing Korean households' micro-data.

$$Leverage\ \ Ratio_{i,t} = \frac{Financial\ \ Debt_{i,t} + Tenancy\ \ Deposit_{i,t}}{Total\ \ Asset_{i,t}}$$

where financial debt includes collateral loans, unsecured loans, loans granted by credit card companies, and installment balances for credit cards. If household i is a landlord and received some security deposits, the tenancy deposit in the above equation is greater than zero and zero otherwise.

Other measures pertaining to households' leverage activities can be listed as follows: 'Debt-to-income' ratio (consumer leverage ratio) 'Loan-to-value' ratio, and 'capital-assets' (debt to net assets). In some sense, the latest concept would be most suitable to the meaning "leverage". However, unfortunately, many households reported negative net assets, making their "capital-asset ratio" negative. In our sample, 140 households, which represents 2.73% of total households reported negative net assets.

Although many measures may have their own meaning and purpose in analyzing households' leverage choices, we use the most common 'debt-to-asset' ratio. The leverage ratio we define in this paper is as follows.

$$Leverage\ \ Ratio(LR)_{i,t} = \frac{Total\ \ Debt_{i,t}}{Total\ \ Asset_{i,t}}$$

where $Total\ \ Debt_{i,t}$ is household i's total debt, including either financial debt or tenancy deposits in period t. $Total\ \ Asset_{i,t}$ is total assets of household i at period t. Leverage ratio increases if households finance more debt or decrease their assets, and decreases vice versa. Generally, a rising leverage ratio can be interpreted as households taking more risk, and a lowered leverage ratio as households decreasing their risk exposure stemming from their asset and liability choices.

[Table 2-4] briefly reports the descriptive statistics of the leverage ratio with three different demographic factors: renters vs. homeowners, high school vs. college graduates, and singles vs. married. The variation in the leverage ratio is biggest in home

ownership, and in other groups, the variations are relatively small.

[Table 2-4] Average leverage ratio and the amount of debt

(unit: ratio, 10k Korean Won)

	Participation	Leverage Ratio (Amount of Debt)			
		Conditional		Total	
All Sample	**0.659**	**0.316**	**(9,402)**	**0.208**	**(6,203)**
Homeowner	0.708	0.229	(10,610)	0.162	(7,519)
Renter	0.580	0.488	(7,004)	0.283	(4,064)
Less than college	0.595	0.339	(7,562)	0.201	(4,499)
College degree	0.763	0.288	(11,689)	0.219	(8,918)
Single	0.517	0.360	(4,710)	0.182	(2,436)
Married	0.672	0.313	(9,714)	0.210	(6,529)

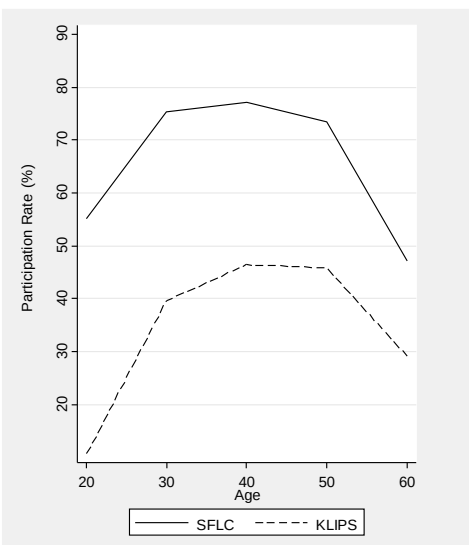
Note: "Participation" represents the participation rate in debt financing activity. "Conditional Leverage Ratio" represents the leverage ratio conditional on participating in debt financing activity. The "Total" means unconditional leverage ratio, that is, the average leverage ratio of whole sample, no matter whether household has debt or not.

[Figure 2-2] shows the participation rate and the conditional leverage ratio over the age of the head of the household, for both the SFLC and Korean Labor and Income Panel Study (KLIPS). KLIPS is a survey conducted by Korea Labor Institute. KLIPS also provides detailed micro-level household data, but its information about households' debt and asset is less complete than that of the SFLC, because of its method of surveying. In the SFLC, an educated expert helps each respondents answer questions, such as the amount of financial assets, the market price of the house, financial debt and its composition, etc. This enhances the reliability of the survey. However, KLIPS mainly focuses on households' labor activity. This

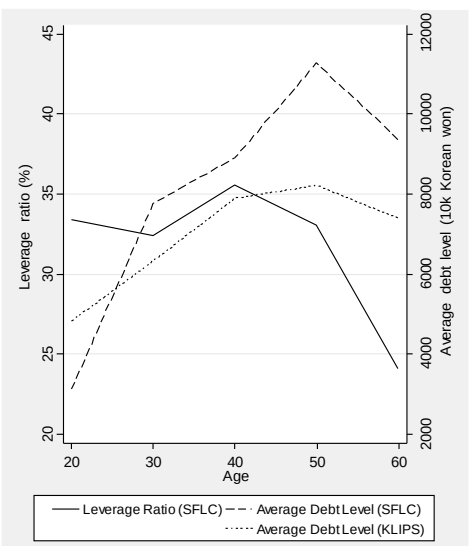
makes SFLC a good dataset for analyzing households' asset and liabilities activities and KLIPS a suitable dataset for studying households' labor activity. Nevertheless, we can compare both measures and check the robustness of overall debt-financing activities of Korean households. The participation rates (A in [Figure 2-2]) are hump-shaped with a peak around the age of 40. It increases from around 55 percent at age 20 to almost 80 percent at age 40, and decreases to about 50 percent at age 60. The conditional leverage ratio (B in [Figure 2-2]) also features a hump-shape. We do not show the leverage ratio in KLIPS for simplicity, since the average ratio is too high, partly due to the inaccurate information of households' asset. Although we do not directly compare leverage ratio with KLIPS data, average debt levels show a similar shape, with peak at around age 50. The conditional leverage ratio peaks around age 40, but the debt level still increases until age 50.

[Figure 2-2] Leverage ratio over the life cycle

A. Participation Rate



B. Conditional Leverage Ratio

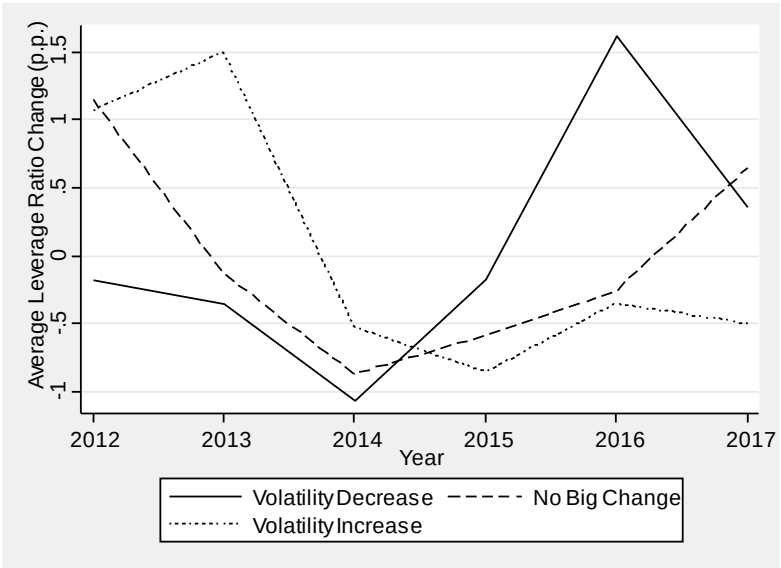


Note: Data are based on 10-year age segments. "20" refers to the age group where the household head's age is less than 30, "60" refers to those whose age is more than 60, and "30", "40," "50" each refer to those whose age is in the thirties, forties, and fifties respectively. Panel A shows the participation rate (the fraction of households that participate in debt-financing activity). Panel B shows the conditional (on participation) leverage ratio and the average debt level in Korean 10k Won.

2.4. Response of leverage ratio

We examine the links between the income volatility change and household's leverage choice. First, we compute the average leverage ratio change over time for three groups: households with a big decrease in income volatility, those with no big change, and those with big increase. It shows that the leverage ratio tended to increase over time in all three groups. However, the speed of the increase was highest in those whose income volatility decreased, and smallest for those whose income volatility increased.

[Figure 2-3] Leverage ratio change by volatility group (uncontrolled)

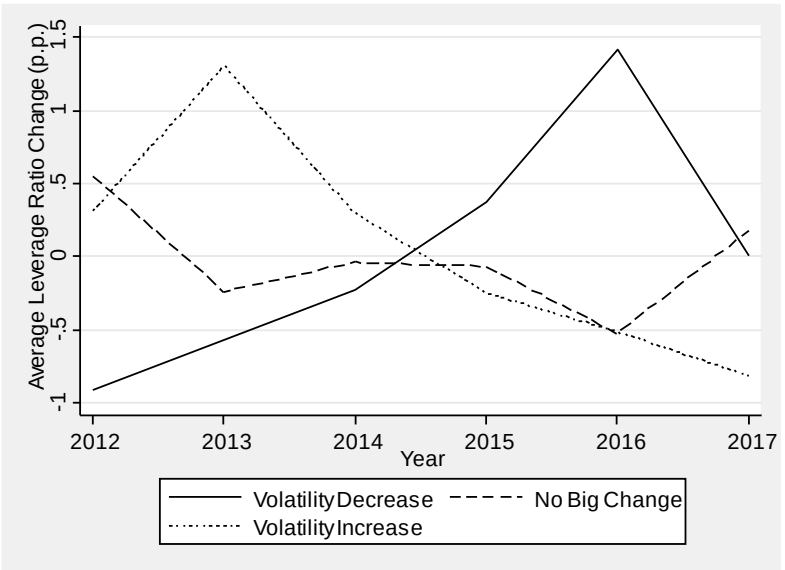


Note: "Volatility Decrease" is the group whose ΔSD_i was in low 25% percentile, "Volatility Increase" refers to those with ΔSD_i in high 25% percentile, and "No Big Change" means the rest, middle 50%.

Next, we show a controlled version of leverage ratio changes in [Figure 2-4]. This figure is computed as follows. First, we regress household's leverage ratio on age, age squared and year dummies to obtain the residual leverage ratio net of the average age profile and time effects. The regression results are reported in [Table 2-5]. Second, we subtract the household-mean leverage ratio to control for each households' unobserved effects (such as different preferences for debt).

The results are similar to those in [Figure 2-3]. It shows a negative relationship between income volatility changes and leverage ratios. Households who experienced a big increase in the income volatility (small-dotted line), which corresponds to top 25 percentile in ΔSD_i steadily reduced their leverage ratio: which decreased about 1~2 percentage points during the sample period. Households with decreased income volatility increased their leverage ratio by approximately more than 2 percentage points until 2016 and reduced it somewhat in 2017. Households with no big changes in income volatility decreased their leverage ratio slightly. Basic regression results say households' leverage ratio peaks around age 41.

[Figure 2-4] Leverage ratio change by volatility groups (controlled)



Note: "Volatility Decrease" is the group whose ΔSD_i was in low 25% percentile, "Volatility Increase" refers to those with ΔSD_i in high 25% percentile.

[Table 2-5] Regression Results

Dependent Variable: Leverage Raito		Obs.	R^2
age	age squared		
0.01247*** (0.00113)	-0.00015*** (0.00000)	36,714	0.0268

Note: The numbers in parenthesis are the robust standard errors. The regression also includes year dummies. The ***, **, * denote the statistical significance at three p-values: 1%, 5%, 10% respectively.

We now estimate the response of the leverage ratio to income volatility change using the following equation:

$$LR_{i,t+k} - LR_{i,t} = \beta_V \Delta SD_i + \beta_X X_i + \epsilon_i \qquad (4)$$

where $LR_{i,t}$ is household i's leverage ratio at year t, ΔSD_i is the income volatility change as defined earlier, and X_i is household i's other socioeconomic variable. Here, we use households' age, age square and the number of family members, as we did in previous analysis. In order to capture the time-gap of households' debt-financing activity, we estimated the regression with varying leverage ratio changes. First, we take leverage ratio changes between 2014 and 2015($LR_{i,2015} - LR_{i,2014}$) as a dependent variable, and we denote this as $k = 1$, since the year gap in leverage ratio change is one year. Next, we use leverage ratio changes from 2013 to 2016($LR_{i,2016} - LR_{i,2013}$), and this case is $k = 3$. Next, we compare 2012 to 2017, which is $LR_{i,2017} - LR_{i,2012}$, and this case is $k = 5$. Finally, we use the changes of the period average leverage ratio between first three year to the last three year, that is, $\overline{LR_{i,T+}} - \overline{LR_{i,T-}}$ as dependent variable.

[Table 2-6] reports the regression results. It seems clear that changes in income volatility affect households' debt-financing activity and this relation holds in varying degree of time gaps. This supports the hypothesis that households adjust their leverage ratio to decrease risk exposure if they face enlarged uncertainty in human wealth, which is the present value of household earnings. A one-unit increase in income volatility was associated with one to five percentage point decrease in the leverage ratio over time. The magnitude of leverage response was biggest in $k = 5$, and smallest in $k = 1$. This indicates that households' leverage adjustment in response of income volatility change takes some time. The relationship between income volatility change and leverage ratio holds even after controlling other variables, such as households' income, age and number of family members. One percent point increase in household income was associated with 0.01~0.035 percent point decrease in leverage ratio over time. This implies that

household saves more with increased income. One person increase in family member was associated with 1.3 percent point increase of leverage ratio over 5 years, but the relation changed in other time horizon. The magnitude of leverage ratio response was enlarged as the time gap(k) increases. The relationship between leverage response and age were estimated to be ambiguous. The sign of coefficients varies with different specifications.

[Table 2-6] Response of Leverage Ratio over Time

	Dependent Variable: Leverage Ratio change ($LR_{i,t+k} - LR_{i,t}$)					
	$k = 1$			$k = 3$		
ΔSD_i	-0.006 (0.010)	-0.007 (0.012)	-0.008 (0.012)	-0.033* (0.018)	-0.048** (0.021)	-0.049** (0.021)
Δy_i		-0.000 (0.010)	-0.001 (0.010)		-0.024 (0.017)	-0.025 (0.018)
age			0.000 (0.002)			-0.001 (0.003)
age^2			-0.000 (0.000)			0.000 (0.000)
F_S			-0.002 (0.003)			-0.004 (0.006)
Obs.	6,064	6,064	6,064	6,064	6,064	6,064
R^2	0.000	0.000	0.000	0.000	0.000	0.000
	$k = 5$			$\overline{LR_{i,T+}} - \overline{LR_{i,T-}}$		
ΔSD_i	-0.025* (0.020)	-0.046* (0.024)	-0.053** (0.024)	-0.022* (0.012)	-0.034** (0.014)	-0.037*** (0.014)
Δy_i		-0.035* (0.020)	-0.047** (0.020)		-0.020* (0.011)	-0.024** (0.012)
age			-0.010** (0.004)			-0.003 (0.002)
age^2			0.000** (0.000)			0.000 (0.000)
F_S			0.013* (0.007)			0.002 (0.004)
Obs.	6,064	6,064	6,064	6,064	6,064	6,064
R^2	0.000	0.000	0.003	0.000	0.000	0.002

Note: F_S is the number of family members. Numbers in parenthesis are standard errors. The ***, **, * denote the statistical significance at 1%, 5%, 10% respectively.

In [Table 2-6], we saw income level changes are also an important factor in the determination of households' leverage ratio, since financial institutions evaluate households' income in loan approval process. Furthermore, the Korean financial authorities adopted and strengthened many household debt restriction policies, such as the Debt-to-Service Ratio(DSR) regulations, so household income has become even more important when borrowing money from financial institutions. Here, we compare the average leverage ratio in first three years (2012~2014) to the average in last three years (2015~2017). In this analysis, we apply similar definition to income level changes. We use lower(upper) 25 percent threshold to divide households whose income level 'significantly' decreased(increased).

[Table 2-7] shows the average leverage ratio and leverage ratio changes in each group in terms of income volatility changes and income level changes. Those whose leverage ratio showed biggest decrease was the households with 'no big change in income volatility' and 'income level increased'. They lowered their leverage ratio by 1.7 percentage points from first 3 years to later 3 years. Households with 'volatility decreased' and 'income level increased' also lowered their leverage ratio by 0.5 percentage points. Those can be thought as savings by households with increased income. The row-total (lowest row) supports this relation. On average, households with increased income level lowered their leverage ratio by 0.9 percentage points, while households with decreased income level increased leverage ratio by 1.2 percentage points. Households with decreased income level might be in need of borrowing more money in order to smooth their consumption.

But households with 'volatility increased' and 'decreased income level' showed big drops of leverage ratio, around 1.4 percentage points during 6 years. For consumption smoothing purpose, households with increased income volatility and decreased income level would need more debts in order to smooth current periods' spending. But they lowered their leverage ratio even in unfavorable income situation. This suggest the possibility that they might face a 'borrowing-constraint' and de-leveraged their debt 'forcedly'. We

will address this issue in a later section further.

[Table 2-7] Leverage ratio change by groups

		Income Level			
		Dec.	Mid.	Inc.	Total
Income Volatility	Dec.	0.16 → 0.23 (+0.064)	0.20 → 0.21 (+0.014)	**0.24 → 0.24 (-0.005)***	0.21 → 0.22 (+0.017)
	Mid.	0.19 → 0.20 (+0.008)	0.20 → 0.20 (+0.009)	**0.24 → 0.23 (-0.017)***	0.20 → 0.21 (+0.004)
	Inc.	**0.18 → 0.17 (-0.014)***	**0.20 → 0.20 (-0.004)***	0.29 → 0.29 (+0.000)	**0.21 → 0.21 (-0.008)***
	Total	0.18 → 0.19 (+0.012)	0.20 → 0.20 (+0.008)	**0.25 → 0.24 (-0.009)***	0.21 → 0.21 (+0.004)

Note: The first number in each cell refers to the average leverage ratio during the first 3 years (2012~2014), the second refers to the average of last 3 years (2015~2017), and numbers in parenthesis are the changes in leverage ratios between these two periods, with a bold star if negative. "Dec" in Income volatility means income volatility change(ΔSD_i) was in the bottom 25%, "Inc" is in the top 25%, and "Mid" is the remaining middle 50%. "Dec" in Income level means income level change between these two periods was in the bottom 25%, "Inc" is in the top 25%, and "Mid" is the remaining middle 50%.

Here, we briefly look at household asset and liability changes. [Table 2-8] reports the simple growth rates for households' assets and liabilities between the first 3 years (2012~2014) and the last 3 years (2015~2017). Across the whole sampled households, all three groups in terms of income volatility changes increased their total assets and total liabilities. However, the group with decreased income volatility showed biggest increase in both total assets and liabilities. Their total assets and liabilities increased by 20.4 percent and 37.3 percent respectively, which are far greater than those with increased income volatility. In the liabilities side, the growth rate of secured loan of households with increased income volatility was about half of the rate of total average, and about one-third of those who experienced decreased income volatility.

Households with decreased income level showed more dramatic differences. For those of decreased income level, households with increased income volatility lowered their debts level by 3.2 percent, while households with decreased income volatility increased their debts by 18.8 percent. The later groups' leveraging activities can be attributed to borrowing more money in order to smooth their consumption, but the deleveraging by households with increased income volatility appears to be different.

The comparison between 2012 and 2017 also tells a similar story. Households with decreased income volatility exhibit on average 38.1 percent and 71.7 percent increases in total assets and total debts, respectively, whereas those who experienced a volatility increase exhibit 31.0 percent and 48.3 percent increase, respectively. This difference gets even larger in the comparison from 2012 to 2017.

[Table 2-8] Households' asset and liability composition changes

	Changes of Income Volatility			
	Dec.	Mid.	Inc.	Total
Comparison between the first 3 years and the last 3 years				
Total Assets	20.4%	20.0%	17.7%	19.5%
Real Assets	21.9%	21.1%	18.5%	20.6%
Financial Assets	16.3%	17.2%	15.4%	16.7%
Total Debts	37.3%	29.5%	19.1%	28.6%
Secured Loans	44.9%	40.0%	18.6%	35.3%
Credit Loans	21.0%	18.9%	12.4%	18.0%
Comparison between 2012 and 2017				
Total Assets	38.1%	37.7%	31.0%	34.0%
Real Assets	37.5%	33.4%	30.7%	33.6%
Financial Assets	39.8%	34.3%	32.2%	35.2%
Total Debts	71.7%	57.7%	48.3%	58.4%
Secured Loans	83.8%	74.8%	49.8%	70.0%
Credit Loans	30.9%	30.2%	25.4%	29.6%

2.5. Borrowing constraints and leverage response

We did not distinguish the supply and demand side of household debts in the previous analysis. On the demand side, households would need more debt in order to smooth their consumption, in response of income shocks, or pay back their debt (save) by precautionary motives. On the supply side, borrowing constraints are crucial in determining households' debt-financing activities. Even if households need more debt, if a household is credit-constrained, raising more debt is not possible.

But as Deaton (1992) and Jappelli & Pistaferri (2017) noted, it is not easy to find evidence for liquidity constraints. Since households anticipate 'potential' future borrowing-constraints by saving more, so the standard estimation on the Euler equation may not violated. Most of the time the tests regarding borrowing constraints do not find any violation of the Euler equation, not because credit markets are perfect but because households allow for the probability of future constraints.

Here, we take into account the effects of borrowing constraints on the aspects of income volatility changes. The main hypothesis of this section is that, if credit-constrained households face enlarged income uncertainty, they will deleverage sharply and save more, in order to ensure the minimum consumption spending for their current and future periods. Thus, borrowing-constrained households will de-leverage more sharply in response to increased income volatility.

Some microdata provided by the credit bureau contains individual's credit scores, which are highly related to individual borrowing constraints. Some of the KLIPS microdata also contains questions asking whether a household failed to obtain a loan within the past 2~3 years, or had not been able to borrow as much as they needed within the 2~3 years. However, in our micro household data, it is not possible to directly observe whether households face borrowing-constraints. Accordingly, we adopt various measures of borrowing-constraints. First, following the method of Choi et al (2015), we use LTV (Loan-to-Value) ratio as a proxy for borrowing

constraints. Next, we use households' net wealth level as a proxy for borrowing-constraints, as in Park (2019). Third, we use the method the Bank of Korea (2015) suggested, and construct an index that measures households' overall financial riskiness, in terms of stock (asset and liability) and flow (debt services and income). Finally, we use households' actual borrowing rates as a measure for borrowing-constraints. An individual or household is liquidity constrained if the borrowing rate they face differs from the rate at which they can lend.

The loan regulations in Korea had many changes during our sample period, varied with regions and financial sectors. The main change was that until 2015, the LTV regulation was the primary tool in household debt prudential policy. From 2015, the authority began to consider DSR (Debt-Service Ratio), and these days, LTV and DSR regulations stand for the two primary polity tool. The ratio in the LTV regulations is around 40~70 percent to its collateral real estate assets. Until August 2014, an LTV of 50 percent for the Seoul metropolitan area and 60 percent for other are was applied. The LTV ratio was then relaxed to 60 percent for the entirety of Korea. In the case of the DSR regulation, the authority defined 'high-DSR' as households with a DSR higher than 70 percent.

However, since the sample selection criteria in this section are closely related to households' leverage ratio, which is the dependent variable in our regression analysis, we are not free from sample selection bias. That is, since 'potentially' borrowing constrained households tend to have higher leverage ratio, and this would result more sensitive reaction to income volatility changes. in other words, potentially borrowing constrained households would have bigger coefficient of ΔSD_i in equation (3), not because of their borrowing-constraints, but because of their high leverage ratio. In order to handle this issue, we first divide households with various criteria which are related to borrowing constraints, and examine households' response of leverage ratio in the face of changed income volatility. After that, we deal with the sample selection bias in the end of this section.

LTV ratio

We define two different LTVs, first is a narrow definition, and the second one is wider definition. The first one, which we denote LTV^N, 'N' stands for 'narrow', is more suitable and exact definition, since we use collateral debt as numerator. The second definition, LTV^B, 'B' stands for 'broader', for the consideration of the overall debt-burden compared to households' assets, uses total debt as numerator. Therefore, by definition, LTV^B is higher than , LTV^N.

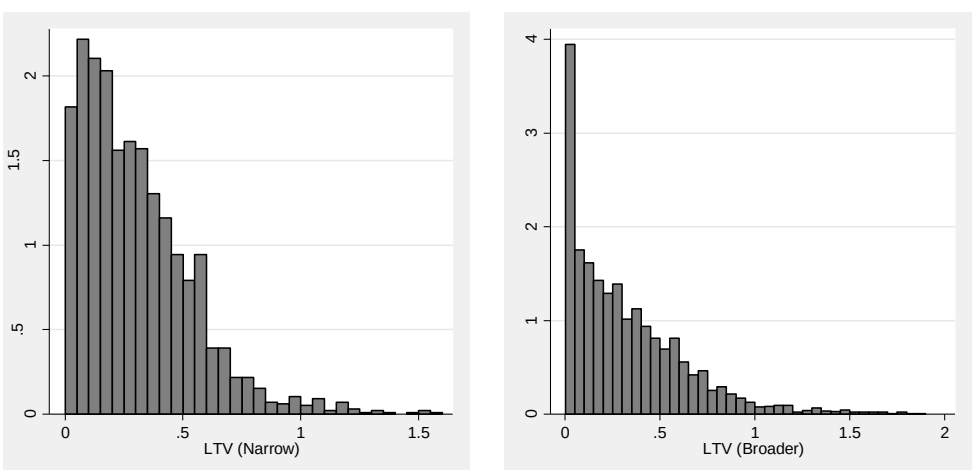
$$LTV_{i,t}^{N} = Collateral\ \ debt_{i,t}\ \ /\ \ Real\ \ estate\ \ asset_{i,t}$$

$$LTV_{i,t}^{B} = Total\ \ debt_{i,t}\ \ /\ \ Real\ \ estate\ \ asset_{i,t}$$

We can see households' narrow definition of the LTV ratio are concentrated around 60 percent, in Panel A of [Figure 2-5]. This can be interpreted as a result of the LTV regulation, though the definition of the collateral assets financial institutions use may differ from what is reported in the SFLC microdata. Financial institutions evaluate the collateral assets using the market price provided by KB Kookmin Bank or Korea Appraisal Board. According to our measure, about 10 percent of households with positive debts are potentially borrowing-constrained in terms of LTV regulations.

[Figure 2-5] Distribution of LTV

A. Narrow definition (LTV^N) B. Broader definition (LTV^W)



[Table 2-9] reports households with LTV ratio higher than 0.6. Around 10 percent of households were classified as 'potentially' borrowing constrained in terms of LTV^N and around 15 ~ 18 percent of households were borrowing-constrained in terms of LTV^B.

[Table 2-9] Potentially LTV regulation binding households

(unit: percent)

	2012	2013	2014	2015	2016	2017
LTV (narrow)	10.04	10.85	11.31	11.73	10.97	12.09
LTV (broader)	14.58	17.12	17.75	18.08	17.81	17.70

We compare leverage ratio changes of potentially borrowing-constrained households. We define a LTV regulation constrained households as households with LTV are higher than 0.6 at 2014, since 2014 is the end of first 3 years in our sample. LTV-constrained households with increased income volatility showed relatively bigger deleveraging.

[Table 2-10] Leverage ratio change by groups: LTV-constrained

		Total	$LTV^N > 0.6$	$LTV^B > 0.6$
Income Volatility	Dec.	0.207 → 0.224 (+0.017)	0.506 → 0.631 (+0.125)	0.485 → 0.536 (+0.051)
	Mid.	0.203 → 0.207 (+0.004)	0.572 → 0.585 (+0.013)	0.503 → 0.507 (+0.004)
	Inc.	**0.214 → 0.206 (-0.008)***	**0.532 → 0.507 (-0.025)***	**0.536 → 0.482 (-0.054)***
	Total	0.207 → 0.211 (+0.004)	0.545 → 0.580 (+0.035)	0.507 → 0.509 (+0.002)

Note: The first number in the table is the average leverage ratio in the first 3 years, the second number is the average in the second 3 years, and numbers in parentheses are the difference between the two periods.

In [Table 2-10], for households with increased income volatility,

LTV^N−constrained households lowered their leverage ratio by 2.5 percentage points, and LTV^B−constrained households lowered their ratio 5.4 percentage points, while total households with increased income volatility lowered their leverage ratio by 0.8 percentage points on average. This appears to be a substantial difference. Potentially borrowing−constrained households deleveraged more in response to increased income volatility.

We also estimate simple regressions to find the relationship between income volatility changes and leverage ratio. The dependent variable is the changes of leverage ratio between the first 3 years and the second 3 years, and the independent variables include ΔSD_i and Δy_i only, for simplicity. We saw those two variables had statistically significant relations with the leverage ratio changes in the previous section. (see [Table 2−6]) However, the regression results in [Table 2−11] indicate that for LTV−constrained households, the relationship between income volatility changes and leverage ratio is statistically insignificant. Though insignificant, the values of the coefficient were larger, implying borrowing−constrained households reacted more to income volatility changes.

[Table 2−11] Response of leverage ratio: LTV constrained

	Total	$LTV^N \geq 0.6$	$LTV^B \geq 0.6$
ΔSD_i	−0.034**	−0.118	−0.081
Δy_i	−0.020*	−0.018	−0.005
Obs.	6,064	219	535

Note: Each number in the first and second row of the table refers to the coefficient of explanatory variables. The ***, **, * denote the statistical significance at three p−values: 1%, 5%, 10% respectively.

Net wealth

Following Park (2019), we use households' net wealth as a measure that determines whether a household is borrowing−constrained. Though this measure does not contain information about human wealth, in light of the prevalent loan−approval process in

Korea, it is reasonable to say that collateral assets are more important than 'intangible' human wealth. According to the Bank of Korea's Economic Statistics System (ECOS), 58.5 percent of household loans from depository corporations were collateral loans at the end of 2018. Low or negative net wealth means households' overall financial conditions are weak and have little assets that can be provided as collaterals, so they may face difficulty in borrowing money from financial institutions.

Park (2019) used 3 thresholds, (−50,000,000), (0), and (+50,000,000) Korean won respectively. Note that 50,000,000 Korean won is roughly about 50,000 USD. However, in our sample, only 13 households reported their net wealth was less than −50,000,000 Korean won, so we use (0) and (+50,000,000) as a proxy to determine whether households face borrowing−constraints or not. In our sample, about two percent of households had negative net wealth, and about twenty percent reported their net wealth was less than 50,000,000 Korean won. And the overall proportion of households whose net wealth is less than the threshold decreases over time, reflecting households' net wealth has grown over time.

[Table 2−12] Borrowing−constrained households: Net wealth

(unit: percent)

	2012	2013	2014	2015	2016	2017
NW1	2.4	2.7	2.3	2.1	2.1	2.2
NW2	24.3	23.1	22.0	21.2	20.2	19.7

Note: NW1 refers to households with net wealth less than zero. NW2 refers to households with net wealth less than 50,000,000 Korean won.

We checked the statistical relationship between income volatility changes and leverage ratio, and found that for low net wealth group, households were more sensitive in income volatility changes. A one−unit increase in income volatility was associated with a 0.83−unit decrease in the leverage ratio. This indicates the possibility that households with low (or negative) net wealth are vulnerable to

income shocks. It is also interesting that households with net wealth greater than 50,000,000 Korean won had a smaller coefficient of ΔSD_i, implying that their leverage ratio were less sensitive to income volatility changes. This result would mean that households with relatively abundant net wealth did not alter their liability choices, since they could smooth their consumption with their assets. However, the statistical relationship between income volatility changes and leverage ratio was not significant for households with net wealth of less than 50,000,000 Korean won.

[Table 2-13] Response of leverage ratio: net wealth constrained

	Total	NW < 0	NW < 50,000,000	NW ≥ 50,000,000
ΔSD_i	-0.034**	-0.831**	-0.085	-0.017**
Δy_i	-0.020*	0.319	-0.065	-0.001
Obs.	6,064	137	1,405	4,659

Note: NW refers to 'net wealth'.

HDRI (Household Debt Risk Index)

Here, we employ the household debt risk index (HDRI) introduced by the Bank of Korea. This index was developed to assess household debts' riskiness with balanced consideration of risks in households' cash flow (DSR) and stock (DTA). (For more explanation and interpretation about HDRI, see the Bank of Korea, 2015). Previous measures only considered households' assets and liabilities. However, as the financial authority emphasizes the importance of DSR, it is appropriate to take the cash flow side of households into account. The definition of HDRI is as follows.

$$HDRI_{i,t} = \Big(\big(1 + \big(DSR_{i,t} - \alpha\big)\big) \times \big(1 + \big(DTA_{i,t} - \beta\big)\big)\Big) \times 100$$

$DSR_{i,t}$ is household i's interest and principal payments divided by disposable income. Here, the disposable income in the denominator refers to income before subtracting interest payments. $DTA_{i,t}$ is the

well-known 'Debt to Asset' ratio, but is different from the conventional LTV ratio, and not a simple summation of households' liabilities divided by assets. The Bank of Korea applied "hair-cut" ratios to each category of assets, in terms of liquidity, but the exact hair-cut ratio was not disclosed. Accordingly, we use the haircut ratio for each asset category as follows: Demand deposit for 0.00, since it can be liquidated without any transaction costs, installment deposit for 0.05, other savings for 0.10, down payments for 0.40, and real estate assets for 0.40. We use a very conservative (high) hair-cut ratio for real estate assets, since instant sale of those assets is accompanied by substantial transaction costs. If the hair-cut ratio decreases close to zero, the DTA value decreases and this results in the assessment of overall households' financial condition as safer.

The Bank of Korea used α and β for 0.40 and 1.00 respectively. We adopt the same threshold. The Bank of Korea assessed DSR higher than 0.40 as 'high-DSR,' meaning risky in cash-flow, and DTA higher than 1.00 as 'high-DTA,' meaning risky in asset and liability conditions. If HDRI exceeds 100, the Bank of Korea judged those households as 'highly risky households'. 'Highly risky households' increased from 6 percent in 2014 to 11 percent in 2017, reflecting the overall increase in household debts. Households with 'high DSR' were more numerous than households with 'high DTA'.

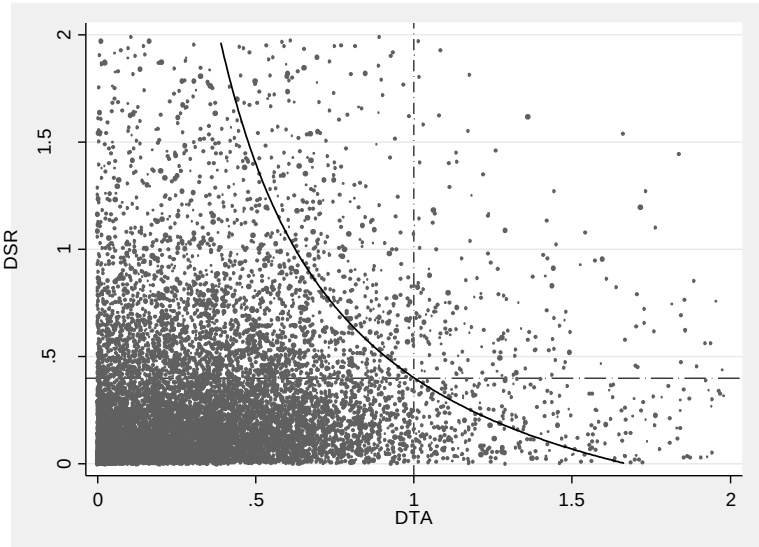
[Table 2-14] Risky households according to HDRI

(unit: percent)

	2014	2015	2016	2017
High DSR	20.7	22.6	26.4	24.4
High DTA	5.1	4.7	4.3	8.9
HDRI > 100 (A)	6.4	6.8	8.4	11.1
HDRI > 100 (B)	1.6	1.4	1.7	3.2

Note: DSR cannot be calculated in 2012 and 2013, since interest payments are not available before 2014 for the Household Welfare Survey. HDRI > 100 (A) refers to households with HDRI > 100. HDRI > 100 (B) refers to households with HDRI > 100, DSR > 0.4 and DTA > 1.0.

[Figure 2-6] Distribution of HDRI in DSR-DTA plane



Note: The vertical and horizontal dashed lines refer to the threshold for DTA and DSR respectively. The bold line represents iso-HDRI curve where HDRI equals 100, which is the threshold dividing risky and safe households.

[Table 2-15] Leverage ratio change by groups: HDRI

		Total	$HDRI > 100$	$HDRI \leq 100$
Income Volatility	Dec.	0.207 → 0.224 (+0.017)	**0.979 → 0.954 (-0.025)***	0.161 → 0.181 (+0.020)
	Mid.	0.203 → 0.207 (+0.004)	**1.201 → 1.089 (-0.112)***	0.166 → 0.173 (+0.007)
	Inc.	**0.214 → 0.206 (-0.008)***	**1.289 → 0.803 (-0.486)***	0.166 → 0.180 (+0.014)
	Total	0.207 → 0.211 (+0.004)	**1.150 → 0.974 (-0.176)***	0.165 → 0.177 (0.012)

Note: The first number in the table is the average leverage ratio for the first 3 years, the second number is the average for the last 3 years, and the numbers in parentheses are the difference between the two periods.

In [Table 2-15], we compare the leverage ratio changes over time by household groups divided by HDRI with a threshold of 100. On average, the 'high HDRI' group lowered their leverage ratio about 17.6 percentage points. The 'high HDRI' with 'income volatility

increased' group decreased their leverage ratio by 48.6 percentage points, which is a substantial change. However, households with HDRI equal to or below 100 showed little difference among volatility change groups. This indicates that income volatility change for 'high HDRI' households caused some difficulty in borrowing extra money, and made them to pay back their debts rapidly.

[Table 2-16] shows the regression results of the relationship between income volatility changes and leverage ratio over different groups divided by DSR, DTA and HDRI. Households with HDRI higher than 100 showed more sensitivity to income volatility changes, compared to the average group (total). A one-unit increase in the standard deviation of income was associated with a 25.3 percentage points decrease in the leverage ratio for them, which is about 8 times greater than the average households. At the same time, we also checked households with high DSR and high DTA separately, and found that household with high DTA were more sensitive to income volatility changes. Though the statistical relation was estimated to be insignificant in LTV criteria, DTA criteria reported a statistically significant relationship between income volatility changes and leverage ratio. DSR criteria also reported statistically significant coefficient, but the value of coefficient was relatively small in absolute terms, though it was bigger than the average household.

[Table 2-16] Response of leverage ratio: HDRI

	Total	HDRI > 100	DSR > 0.4	DTA > 1.0
ΔSD_i	-0.034**	-0.253**	-0.063*	-0.762**
Δy_i	-0.020*	-0.264*	-0.033	-0.309
Obs.	6,064	257	868	202

This suggest the possibility that facing with increased income volatility, households' leverage choices are more affected by asset and liability conditions (stock) than his (her) debt-payments burden (flow). In some sense, this is counter-intuitive since income volatility changes are more related to households' cash flow, earnings

and payments of interests and principals of debts. Thus, one can conjecture that households' leverage choices will be more affected by cash-flow related criteria, but our results show that stock related criteria had more explanatory power to the changes in leverage response when faced with income volatility changes.

In order to further investigate the different relations with leverage response, we checked the relationship between ΔSD_i and leverage ratio with a varying threshold of DSR and DTA. We started with DSR higher than 0.3, and increased the threshold by 0.1 until DSR reaches 0.9, which means households spend more than 90 percent of income to debt-servicing. For DTA, we started from DTA higher than 0.6, and increased the threshold by 0.1 until it reaches 1.2, which means households' total debts are 'underwater'. As the threshold increases, the sample size decreases. For DSR higher than 0.3, there were a total of 1,136 observations, but for DSR higher than 0.9, there only left 275 observations. As the DSR criteria increases, the coefficient of ΔSD_i slightly increased, staying around 0.1. But the coefficient of ΔSD_i rapidly increased as DTA threshold increases, from 0.177 to 0.847. This results support the strong relation with leverage response and DTA measures.

[Table 2-17] Response of leverage ratio: DSR and DTA

DSR			DTA		
threshold	Coef.	Obs.	Threshold	Coef.	Obs.
> 0.3	-0.099***	1,136	> 0.6	-0.177**	594
> 0.4	-0.063*	868	> 0.7	-0.313**	427
> 0.5	-0.078**	652	> 0.8	-0.397**	320
> 0.6	-0.095**	514	> 0.9	-0.560***	254
> 0.7	-0.103**	421	> 1.0	-0.762**	202
> 0.8	-0.089*	343	> 1.1	-0.753**	167
> 0.9	-0.101**	275	> 1.2	-0.847**	136

Note: The regression specification is the same as in the previous analysis in [Table 2-16]. 'Coef' refers to the estimated coefficient of ΔSD_i. The coefficient of Δy_i is not reported for simplicity.

Borrowing rate

The HDRI criterion in the previous section has several short falls. As mentioned earlier, HDRI's purpose is not to measure the borrowing-constraints, but to assess households' overall solvency risk or vulnerability of financial conditions. Here, we try to tackle households' borrowing constraints with more direct and objective measures.

A strong definition of borrowing-constrained household is that an individual or household is unable for whatever reason to borrow against future earnings or assets. (Attanasio 1995) A weak definition is that an individual or household is considered to be borrowing-constrained if the borrowing rate differs from the rate at which they can lend. (Crook 2003) If a household faces infinitely high borrowing rate, its budget constraint becomes vertical in the area above current net wealth plus earnings. Therefore, we construct an effective borrowing rate from our micro data. Song (2018) classified collateral loans and unsecured loans separately, and defined each households' effective borrowing rate of collateral and unsecured loans as annual interest payments divided by loan balance. For simplicity, we do not distinguish collateral and unsecured loan, and use following definition as households' effective borrowing rate.

$$r_{i,t}^{L} = \frac{annual\ \ interest\ \ payment_{i,t}}{loan\ \ balance_{i,t}}$$

where the loan balance is $\left(financial\ \ debt_{i,t-1} + financial\ \ debt_{i,t}\right)/2$. Current periods' interest payments are from the annual average loan balance. In order to consider that, we use period average loan balance as denominator. We replace the borrowing rate with the legal interest limit if it exceeds the limit. According to Financial Services Commission (FSC), the legal limit was 34.9 percent in 2012~2016, and from March 2016, it changed to 27.9 percent. After January 2018, it changed to 24.0 percent, but our sample period only includes the 2012~2017 period, so technically, the theoretically highest borrowing rate in our sample is 34.9 percent. However, there may be

some errors in the derived borrowing rates. First, if households' principal payments were not even and concentrated at the end (beginning) of the year, the derived borrowing rates may have a upward (downward) bias since the actual average loan balance would be larger (smaller) than the simple average of $t-1$ and t. Second, since in the SCLF dataset, every stock-related variable, such as loan balances, are as of the end of March each year, and every flow-related variable, such as interest payments and incomes, are as of the calendar year (from Jan. 1st to Dec. 31st), there exists 3 months time gap between our derived borrowing rates' numerator and denominator. Therefore, one should be aware that our derived borrowing rates of households are not flawless, and should be understood as one of proxy variables measuring households' 'real' borrowing rates with available data.

[Table 2-18] reports the calculated effective borrowing rate, and compares it with aggregate average household loans rates. Our derived borrowing rate tended to be higher than that of aggregate average, but in overall, all measures declined over time. The average borrowing rate was 6.01 percent in 2014, and it fell to 4.87 percent in 2017, as the Bank of Korea's Base Rate had been cut from 3.25 percent in 2012 to 1.25 percent in 2017. The gaps between derived rate and the aggregate average rate from the Bank of Korea were around 1.5 percentage points over time.

[Table 2-18] Households' derived borrowing rates

(unite: percent, percent point)

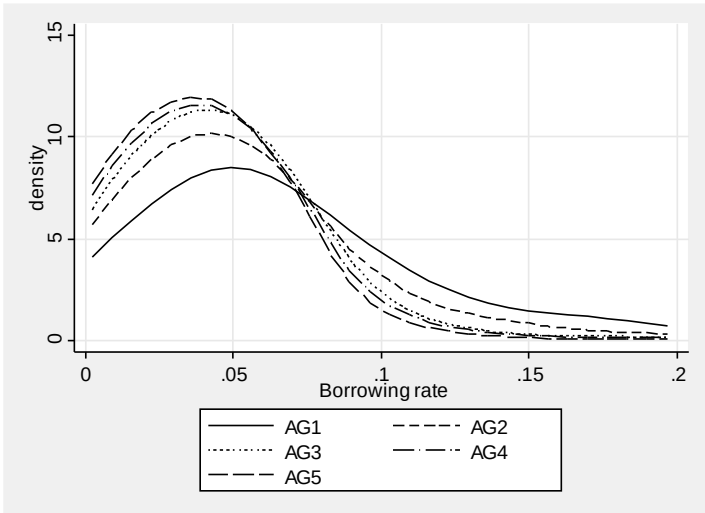
	2014	2015	2016	2017
Derived borrowing rate (A)	6.01	5.60	5.27	4.87
Newly extended loans	4.35	3.87	3.22	3.14
Outstanding loans (B)	4.54	4.02	3.35	3.18
(A – B)	1.47	1.58	1.92	1.69

Note: Interest rates for newly extended loans and outstanding loans refer to the rate of depository institutes, and retrieved from the Bank of Korea's database. Since the SFLC micro data's variables are reported with a one-year lag, we adjusted the year of interests of newly extended and outstanding loans.

The derived rates were higher, because they include all loans either from depositary institutions or other financial institutions such as credit card companies and life-insurance companies. But the aggregate average loan rate from the Bank of Korea database only includes loans from depositary institutions, which is thought to have relatively lower interest rates than other financial institutions.

We also looked the distribution of borrowing rate with different asset segment. [Figure 2-7] shows the kernel density functions with each asset segments. Households whose assets are in the low 20 percentile had relatively thick right tail, indicating their average borrowing rates were higher than others. In 2017 data of SFLC, average borrowing rates of the 'low 20 percentiles' in assets, were 7.72 percent, while the 'top 20 percentiles' were 4.01 percent.

[Figure 2-7] Distribution of households' borrowing rates



Note: The distribution is derived from 2017 data. AG1 stands for the low 20 percentile asset group, AG5 stands for the top 20 percentile asset group.

Since it is difficult to pin-point the exact threshold that distinguishes borrowing-constrained households and not-constrained households, we used various thresholds. First, households with borrowing rate higher than the average borrowing rate in depository institutes, second, borrowing rates higher than 1.5 times the average, thirdly, higher than 2.0 times higher, and finally,

borrowing rate higher than 2.5 times higher than the average are used. As the borrowing rate increases, the probability that households face borrowing-constraints increase. In fact, we are aware that the 'real' borrowing-constrained households would have 'infinitely high' borrowing rates, so one can neither observe it nor calculate it from the data. However, still, the effective borrowing rate derived from the interest payments and loan balances provides a good measure to distinguish potentially borrowing-constrained households.

We analyzed the relationship between income volatility changes and leverage ratio with various household groups divided by borrowing rates. The regression results are reported in [Table 2-19]. It is found that potentially borrowing-constrained households in terms of their borrowing rates, had a more sensitive leverage response to income volatility changes. Roughly, for households with borrowing rates higher than two times the average banks rate, a one-unit increase in income volatility change was associated with a 15.2 percentage points decrease in leverage ratio. This negative relationship strengthened as the threshold of borrowing rate rises.

[Table 2-19] Response of leverage ratio: borrowing rates

	Total	> 1.0	> 1.5	> 2.0	> 2.5
ΔSD_i	-0.034**	-0.082***	-0.108***	-0.152**	-0.183*
Δy_i	-0.020*	-0.065***	-0.119***	-0.199***	-0.211**
Obs.	6,064	1,681	888	454	266

Note: '> 1.0' refers to households with borrowing rates higher than 1.0 times of depository institutes' average loan rate.

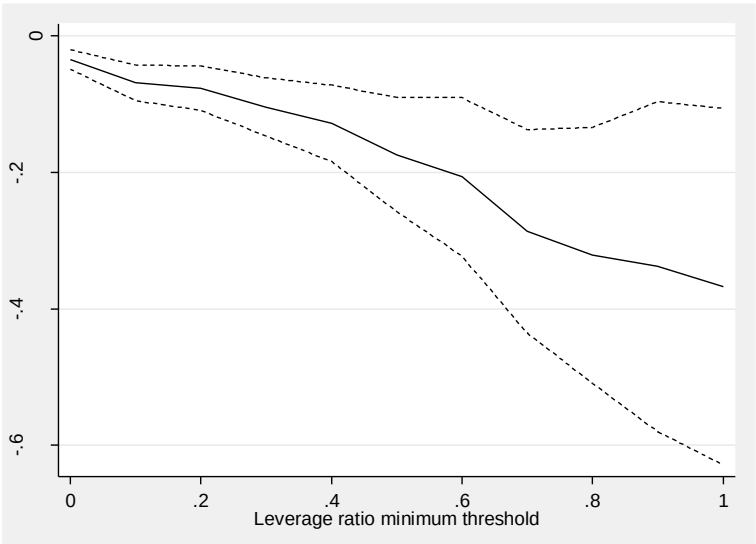
This result is somewhat odd. In the previous analysis, we saw that the asset-liability related measures, such as net-wealth and DTA, had statistically significant explanatory powers in linking the relationship between income volatility changes and leverage ratio. DSR, which contains the debt-burden in cash flow, had less explanatory power. In this sense, one can guess the borrowing rate would also have less explanatory power. However, we found a statistically significant relation in households' borrowing rates. This

indicates the possibility that borrowing costs affect households leverage choices in response to income volatility changes; but DSR, which measures households' free cash-flow after interest and principal payments of debts, has lesser effects. But as [Figure 2-7] indicates, households' effective borrowing rates are closely related to their assets, implying asset-related measures may be still valid in explaining the changes in households' leverage choices in response to income volatility changes.

Sample selection bias and asymmetric effects

As mentioned earlier, the criteria for borrowing constraints are closely related to leverage ratio itself, which is used as dependent variable. Purely exogenous variables are appropriate to be used as the sample classification criteria, but in our analysis, this was not. Therefore, the results in earlier analysis are not free from 'sample selection bias'. That is, potentially borrowing-constrained households' bigger coefficient of ΔSD_i would be not because they were borrowing-constrained, but because of their high leverage ratio.

[Figure 2-8] Coefficient of ΔSD_i with varying leverage ratio

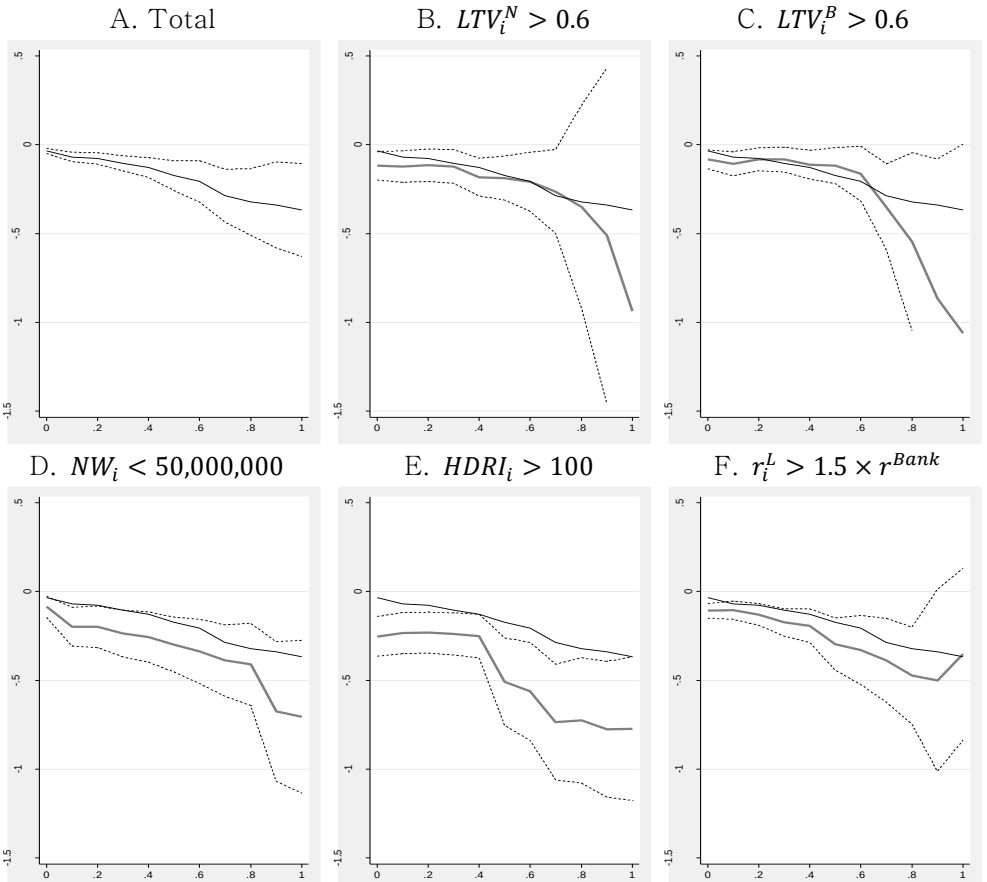


Note: The solid line refers to the estimated coefficient with the leverage ratio as the dependent variable and ΔSD_i, Δy_i as explanatory variables. Two dotted lines refer to the estimated coefficient +/- one standard error.

[Figure 2-8] shows the estimated coefficient of ΔSD_i with a varying degree for minimum leverage ratio threshold. Leverage ratio minimum threshold '0' means all samples were included, and '0.2' means households with leverage ratio higher than 0.2 were included in the sample.

It seems obvious that households with higher leverage ratio are more sensitive to income volatility changes. Note that as the minimum threshold of leverage ratio increases, the sample sizes rapidly decreases. Now, let us check the changes of estimated coefficient in borrowing-constrained households with varying degree of minimum leverage ratio thresholds. [Figure 2-9] shows changes of coefficients of ΔSD_i with various measure of borrowing constraints.

[Figure 2-9] Coefficient of ΔSD_i in borrowing constraints criteria



Note: For easier comparison, we draw the coefficients in a baseline model with a thin black line in each graph. The thick gray line is the changes of coefficient in each borrowing constraint measures with dotted lines +/- one standard deviation.

We find coefficients in LTV related measures are little different from that of baseline model. Therefore, it is difficult to say that more sensitive response in high LTV households were due to their borrowing constraints. However, the coefficients of households with small net wealth, high HDRI, and high borrowing rates had lower coefficients than that of baseline model. Households with small net wealth or high HDRI had persistently lower coefficient of ΔSD_i than that of baseline model, as the minimum threshold of leverage ratio increases. Households with high borrowing rates also had lower coefficients, however the statistical significance rapidly dissipated as leverage ratio increases. This may due to the rapidly decreasing sample size as the minimum threshold of leverage ratio rises.

Several measures of borrowing constraints seem to support the possible effects of borrowing constraints on leverage ratio changes as even after considering higher leverage ratio, potentially borrowing-constrained households were more sensitive to changes of income volatility. However, sample selection bias may still exist and the regression analysis may over-estimate the magnitude of the effects of income volatility changes on leverage ratio changes unless purely exogenous borrowing constraint criteria are used. Therefore, we should be aware of the biases when interpreting the analysis results. Detailed regression results are reported in [Appendix A2].

We also checked the possibility that changes in income volatility may have asymmetric effects on households' leverage choices. In this regard, we divided households into several groups, one with increased income volatility and the other with decreased income volatility. However, the statistically significant relationship became insignificant if we divide the sample. Though it is premature to conclude there is no asymmetric effects of income volatility changes on households' leverage, our data and income volatility measures do not show the asymmetric relations. We report the detailed regression results with the divided households sample in [Appendix A3].

Borrowing-constraints: summary

In this section, we analyzed the relationship between income volatility changes and leverage ratio with the consideration of borrowing-constraints. Since borrowing-constraints are not directly observable in our data, we employed various measures to overcome the lack of information. We found that in terms of net-wealth, HDRI, especially DTA, and borrowing rates, households that are potentially borrowing-constrained had a more sensitive response of leverage ratio when faced with increased income volatility. Potentially borrowing-constrained households decreased their leverage ratio more rapidly if their income volatility increase. These results indicate that asset-related borrowing constraint measures had more explanatory power in leverage ratio changes. This may reflect the prevalent loan approval practices in Korean financial institutions, where collateral assets are considered to be most important factor.

One possible scenario is that borrowing-constrained households' outstanding debts expire and have to be redeem or rolled-over. However, as these households are borrowing-constrained, and their increased income volatility hinder further debt-raising, they 'forcedly' deleverage some of their debts. It would be premature to conclude the exact relations among various measures regarding borrowing-constraints, but it seems clear that borrowing-constraints related measures make differences in households' leverage choices.

However, since the sample selection criteria in this section were highly related to the endogenous variable, the leverage ratio, our study is not free from sample selection bias. Therefore, we checked whether the more responsive relation holds when the minimum leverage ratio threshold increase, and found the net wealth, HDRI, and borrowing rate criteria had a greater (in absolute term) coefficient of ΔSD_i. This indicates that the borrowing constrained households actually adjusted more compared to other households with high leverage ratio. Nevertheless, we need to be careful in interpreting the analysis results.

2.6. Heterogeneity across groups

We now examine the response of leverage ratio to income volatility changes across different groups.

Age: young vs. old

A variety of literatures studied households' behavior in the aspects of the life-cycle theory. For example, Blundell et al (2008) and Kaplan & Violante (2010) showed that household savings and consumptions are more affected if the present value of human wealth divided by total wealth, which is the sum of human wealth and financial wealth, are high (close to 1) and vice-versa. For people far from the end of the life cycle, increased income volatility makes it harder to forecast future earnings, so they would have more precautionary savings motives. For older households, uncertainties in earning are less substantial, since their future earnings are smaller than younger households. This makes old households less responsive to income volatility changes.

[Table 2-20] Leverage ratio change by groups: age

		Total	Young	Middle	Old
Income Volatility	Dec.	0.21 → 0.22 (+0.017)	**0.24 → 0.23 (-0.005)***	0.29 → 0.33 (+0.039)	0.14 → 0.13 (-0.011)
	Mid.	0.20 → 0.21 (+0.004)	**0.23 → 0.22 (-0.008)***	**0.25 → 0.24 (-0.008)***	**0.14 → 0.13 (-0.009)***
	Inc.	**0.21 → 0.21 (-0.008)***	**0.25 → 0.21 (-0.037)***	**0.28 → 0.27 (-0.011)***	**0.15 → 0.15 (-0.009)***
	Total	0.21 → 0.21 (+0.004)	**0.24 → 0.22 (-0.014)***	0.26 → 0.27 (+0.002)	**0.14 → 0.13 (-0.009)***

Note: The first number in the table is the average leverage ratio for the first 3 years, the second number is the average for the second 3 years, and the numbers in parentheses are the difference between the two periods. "Young" is age ≤ 40, "Middle" is between 40~55 and "Old" is age > 55 at 2015.

As Chang et al (2019) did, we divide households' age segments into three groups: the "young" (younger than 40 years old), "middle" (40~55), and "old" (older than 55) based on household heads' age in 2015. Remember that households' leverage ratio peaks when the household head's age reaches approximately 41. A simple comparison of leverage ratio changes during our sample period with different volatility change groups shows that young households with increased income volatility decreased their leverage ratio most quickly, while middle aged households with decreased income volatility increased their leverage ratio the most.

[Table 2-21] shows a regression analysis of the relationship between income volatility changes and leverage ratio. Young household did not exhibit a sensitive reaction to income volatility changes. This may be due to the possibility that young households perceive their future income to be very uncertain, thus, current volatile income may be perceived as not a big change. As Guvenen (2007) and Chang et al (2018) noted, because of high unemployment rates, frequent job turnovers and unknown career paths, young workers have less knowledge about their true earning ability. On the other hand, middle aged households had very sensitive leverage responses to income volatility changes. For them, a one-unit increase in income volatility change was associated with a 9.8 percentage points decrease in leverage ratio. For old households, it was estimated that income volatility changes and household leverage choice did not have a statistically significant relation. This can be attributed to their remaining future earnings being small, volatility changes of their income did not affect their asset and liability choices.

[Table 2-21] Response of leverage ratio: age

	Total	Young	Middle	Old
ΔSD_i	-0.034**	-0.038	-0.098***	0.001
Δy_i	-0.020*	-0.021	-0.111***	0.028**
Obs.	6,064	1,015	2,267	2,782

Note: Young are age $\leq$ 40, the Middle is between 40~55, and old are age > 55.

Home ownership: renters vs homeowners

If a household is planning to purchase a house, enlarged income volatility will lead them to save more in order to buy a house, which is interpreted as precautionary saving motive. This implies that changes in income volatility will be negatively associated with leverage ratio for households with 'net-short position' of house. However, if a household already owns a house and does not plan to enlarge the house space or buy an additional house, increased income volatility will lead to more debt in order to temporarily smooth their consumption, since such households can pay back the liability later by sell off the house. In sum, net short of house would lower their leverage ratio in response of enlarged income volatility, while net long of house position would raise their leverage ratio. The questions related to the holdings of real estate assets in SFLC are as follows:

- *What is the contract type for the current residence?*
  (owner / Jeonse / monthly paying rent ('Wolse') / etc)
- *If you own your current residence, how much is its market price?*
- *If you have an additional house other than your current residence, how much is its market value?*
- *Do you have any installments (down payment) for your house? If so, how much is its market value?*

Using the above data regarding real estate assets, we divide households into three groups. The first group is households with no house. By definition, they are renters and do not own any house. The second group is households owning one house. The house may be either the current residence or another house with currently residence under a 'rental-contract'. The third group is households with holding more than two houses. The first group is obviously 'net-short' of house. The second group can be classified as 'net-long' of house, but if the household age is young, one should consider the possibility that the household will move to a larger house, meaning

they are effectively 'net-short' of house. In our data, households enlarged their house space until around age sixty, peaking at house space of 86.9 square meters. Finally, the third group is obviously considered 'net-long' position of real estate assets.

[Table 2-22] Basic statistics of house holdings (as of 2014)

	Number of house holdings (NHH)			Total
	0	At least more than 1	At least more than 2	
Renters	38.1%	0.8%	-	38.9%
Homeowners	0.0%	36.0%	25.1%	61.1%
Total	38.1%	36.8%	25.1%	100.0%

Note: "Renters" and "Homeowners" refers to the contract type for a households' current residence. By definition, the proportion of homeowners with holding no house is zero. For renters, distinguishing a household with holding one house and more than two houses is technically not possible, since the survey question is about the market value, not the number of real estate assets. However, for simplicity, we categorized renters with more than one house into renters, holding just one house, and we did not count the down payment as an independent real estate asset.

We briefly looked at the leverage ratio changes over 6 years. On average, households owning at least 2 houses seemed to have a very sensitive response to income volatility changes. Households with 'income volatility increased' and 'holding at least 2 houses' (NHH 2) lowered their leverage ratio by 2.3 percentage points, while households with 'increased income volatility' and 'owning no house at all' (NHH 0) increased their leverage ratio by 1.2 percentage points. This seems the opposite to our previous hypothesis that 'short-position' of households, which indicates 'holding no house' (NHH 0) would lower leverage ratio in response to increased income volatility. We will further check the hypothesis in regression analysis. Households with holding at least 1 house (NHH 1) increased their leverage ratio in response of income volatility increase. On average, the leverage ratio decreased as the number of house holding increases. For the later 3 year average, the average leverage ratio

for NHH 0 (holding no house) was 0.29, for NHH 1 (holding at least 1 house) was 0.17, and for NHH 2 (at least 2 houses) was 0.14.

[Table 2-23] Leverage ratio change by groups: number of house

		Total	NHH 0	NHH 1	NHH 2
Income Volatility	Dec.	0.21 → 0.22 (+0.017)	0.27 → 0.32 (+0.042)	0.17 → 0.16 (-0.012)	0.14 → 0.16 (+0.021)
	Mid.	0.20 → 0.21 (+0.004)	0.26 → 0.28 (+0.027)	0.17 → 0.18 (+0.002)	0.14 → 0.14 (-0.003)
	Inc.	**0.21 → 0.21 (-0.008)***	0.26 → 0.27 (+0.012)	0.18 → 0.18 (+0.008)	0.16 → 0.14 (-0.023)
	Total	0.21 → 0.21 (+0.004)	0.26 → 0.29 (+0.027)	0.17 → 0.17 (+0.000)	0.15 → 0.14 (-0.002)

Note: The first number in the table is the average leverage ratio for the first 3 years, the second number is the average for the last 3 years, and numbers in parentheses are the difference between the two periods. NHH 0 refers to households holding no house at all. NHH 1 is holding at least 1 house, NHH 2 is holding at least 2 houses.

[Table 2-24] reports the regression analysis results. For houses holding no house at all, a one-unit increase in income volatility was associated with a 6.7 percentage points decrease in the leverage ratio, which is a more sensitive response compared to the average households. This indicates the possibility that our previous hypothesis would be valid. Households with 'net-short' position in real estate assets would save more if they face increased income volatility, in order to prepare for future purchases of a house. However, for owners of one house, the relationship between income volatility changes and leverage seemed to be weak. For owners of more than two houses, increased income volatility was associated with deleveraging. This seems odd, since they already own abundant assets, and can raise more debt or sell off assets to respond to increased income volatility, and easily smooth their consumption. However, according to the regression analysis result, they de-leveraged in response to increased income volatility.

[Table 2-24] Response of leverage ratio: number of house holding

	Total	NHH 0	NHH 1	NHH 2
ΔSD_i	-0.034**	-0.067*	0.015	-0.040***
Δy_i	-0.020*	-0.056*	0.013	-0.010
Obs.	6,064	2,198	2,210	1,656

In order to further distinguish households into 'net-short' and 'net-long' positions in real estate assets, we add age criteria. Here, we define 'strong-net-short' and 'strong-net-long' for households as follows.

- *Strong-Net-Short (SNS): holding no house at all with the head of the household having an age younger than 40*
- *Strong-Net-Long (SNL): holding at least two houses with the head of the household having an age older than 60*

It is observed that for 'strong-net-short' (SNS) households, a one-unit increase of income volatility was associated with a 7.8 percentage point decrease in the leverage ratio, which supports our hypothesis. Compared to 'NHH 0,' the coefficient of ΔSD_i increases substantially in absolute terms, indicating younger households with no house were more sensitive to income volatility changes. Furthermore, the relatively large coefficient of Δy_i in absolute term indicates that they saved more if their income increases. For 'strong-net-long' (SNL) households, the coefficient of ΔSD_i was smaller in absolute terms, but still negative, indicating they also deleveraged in response to increased income volatility.

[Table 2-25] Response of leverage ratio: number of house holding

	Total	Strong-net-short	Strong-net-long
ΔSD_i	-0.034**	-0.078*	-0.017*
Δy_i	-0.020*	-0.074*	0.020*
Obs.	6,064	470	826

Job industry: safe vs. risky

It is crucial to consider how households perceive the income volatility changes. If they perceive it as a temporary shock, they will not make many adjustments, while if the shock is perceived as permanent, they will adjust their asset and liability choices more proactively. However, the way in which households perceive income volatility shock is not directly observable. One way of overcoming this problem is to consider job industry changes. If a person changes his (her) job from a safe to a risky industry, it is reasonable to say that he (she) will perceive income volatility change as permanent.

SCFL micro data classifies job industries into 21 groups. We restricted households to those who did not change their job industry during our sample periods, and calculated the average of standard deviation of income volatility in each job industry. This calculated income volatility of job industry is reported in [Appendix A4]. Following a rule of thumb, we defined a safe industry as one with the lowest volatility top 7 industries, and risky industry as the highest volatility top 7 industries. The safest 7 industries were 'international organization' (standard deviation of income 0.079), 'electricity supply' (0.143), 'public administration' (0.180), 'finance' (0.190), 'scientific research' (0.196), 'social welfare' (0.207) and 'telecommunication' (0.208). The riskiest 7 industries were 'etc' (0.532), 'agriculture' (0.367), 'lodging' (0.329), 'retail' (0.282), 'real estate' (0.279), 'water supply' (0.277) and 'mining' (0.271). Then, we defined households who changed from a safe to a risky, and from a risky to a safe industry as follow:

- *Safe to risky (STR): Changed their job from a safe to a risky industry between the first 3 years and the last 3 years*

- *Risky to Safe (RTS): The job industry was risky in the first 3 years, and changed to a safe industry during the last 3 years*

- *No change (NC): households who did not change their job industry during the whole sample period*

[Table 2-26] reports the average leverage ratio changes across different groups. Households who changed their job from a safe to a risky industry lowered their leverage ratio by 0.7 percentage points, while those who changed their job from a risky to a safe industry lowered their leverage ratio by only 0.2 percentage points. On the other hand, those who did not change their job industry at all increased their leverage ratio by 0.3 percentage points. This may indicate that households who changed their job industry, no matter whether from risky to safe, or safe to risky, saved more money in response to their changed future income process. Even RTS (from risky to safe) households deleveraged, and this can be thought that job industry change itself is a very major change for a household, so they would feel more need for precautionary savings. However, we could not observe a clear relationship between income volatility changes and leverage ratio changes in those who changed their job industry, either from safe to risky or risky to safe.

[Table 2-26] Leverage ratio change by groups: job industry

		Total	Safe to risky	Risky to safe	No change
Income Volatility	Dec.	0.21 → 0.22 (+0.017)	0.42 → 0.27 (-0.147)	0.17 → 0.19 (+0.019)	0.21 → 0.22 (+0.009)
	Mid.	0.20 → 0.21 (+0.004)	0.27 → 0.32 (+0.051)	0.23 → 0.21 (-0.016)	0.19 → 0.20 (+0.007)
	Inc.	**0.21 → 0.21 (-0.008)***	0.20 → 0.20 (-0.001)	0.23 → 0.24 (+0.006)	0.23 → 0.21 (-0.015)
	Total	0.21 → 0.21 (+0.004)	0.27 → 0.26 (-0.007)	0.21 → 0.21 (-0.002)	0.20 → 0.21 (+0.003)

Note: The first number in the table is the average leverage ratio for the first 3 years, the second number is the average for the last 3 years, and numbers in parentheses are the difference between the two periods.

We also estimated the relationship between ΔSD_i and leverage ratio, but the estimated coefficients were insignificant for those who changed their job from 'safe to risky' and 'risky to safe'. Thus, we

further narrowed down the targets to those who changed their job from safe to risky industries and their income volatility 'actually' increased. The sample size shows that about half of households faced 'real' increased income volatility when they changed their job from a safe to a risky industry. Those who actually faced increased income volatility had a significant relationship between income volatility changes and leverage ratio. For them, a one-unit increase in income volatility was associated with an 18.4 percentage points decrease of leverage ratio, which seems consistent with our hypothesis. We also considered workers' job status changes, such as from temporary to permanent job. However, the results were statistically insignificant.

[Table 2-27] Response of leverage ratio: job industry change

	Total	STR	STR & Inc	RTS	No change
ΔSD_i	-0.034**	-0.008	-0.184***	-0.028	-0.042**
Δy_i	-0.020*	0.013	-0.110**	-0.004	-0.037**
Obs.	6,064	287	124	105	2,586

Note: 'STR & Inc' refers to households who changed their job from a safe to a risky industry and faced increased income volatility.

Household heterogeneity: summary

In this section, we analyzed the relationship between income volatility changes and leverage ratio with the consideration of households' heterogeneity. It is found that middle-aged households and households with 'net-short' of real estate assets (holding no house and young) were more sensitive to income volatility changes. For them, income volatility changes were negatively associated with leverage ratio, and the sensitivity was higher than other groups.

We also tried to identify the different effects of permanent temporary changes in income volatility by considering job industry changes. Those who changed their job from a safe to a risky industry and faced increased income volatility actually decreased their leverage ratio in response to income volatility changes. However, the relations and effects of job industry changes were not very clear.

2.7. Robustness check

Different sources of income volatility

The key variable in our analysis is the changes in income volatility. We constructed a measure of household income volatility changes as the standard deviation of households' current income, after controlling for a common age profile and the number of family members. Thereafter we divided households into three groups, 'income volatility decreased,' 'income volatility increased,' and 'no big change'. Thus, if we change the definition of income, then the income volatility changes and the household groups divided by changes in income volatility will also change. This issue is also important since the 'source of volatility' also matters.

In this section, we change the definition of income, and check whether the changed definition of income affects the main results of our analysis. As reported in [Appendix A1], there are many alternative definitions of household income. [Table 2-28] briefly explains the alternative definitions of household income. As mentioned earlier, our standard was households' current income, which is denoted y1 which includes all sources of household income.

[Table 2-28] Alternative definitions of household income

(unite: 10k Korean won)

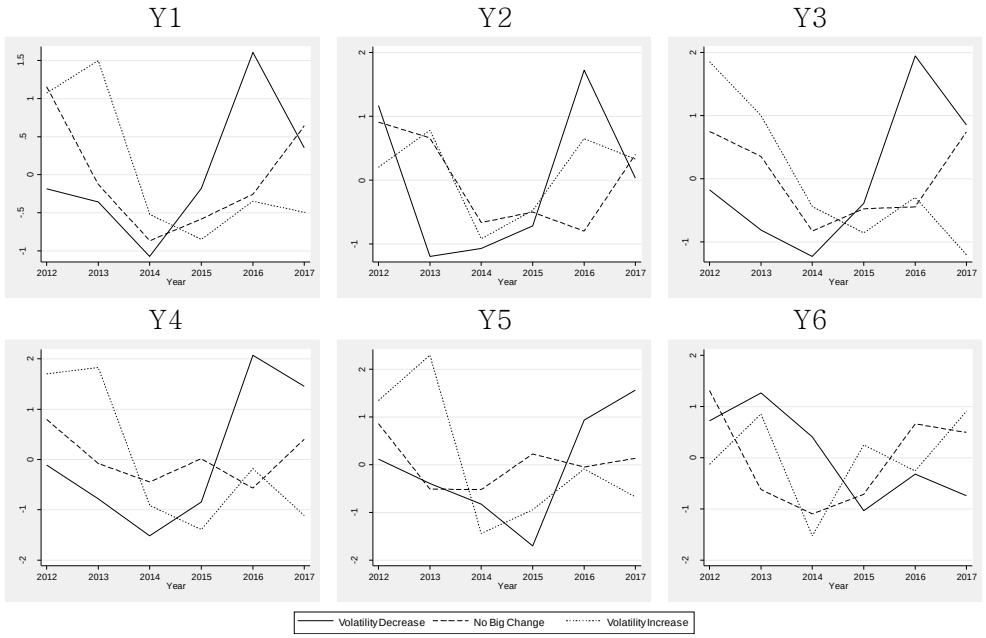
	Y1	Y2	Y3	Y4	Y5	Y6
Labor income	○	○	○	○	○	
Business income	○	○	○	○		
Property income	○	○	○			
Public transfer income	○	○				
Private transfer income	○					
Disposable income						○
Total (average)	4,562	4,478	4,191	3,964	2,800	3,753

Note 1) Current income = labor + business + property + public transfer + private transfer income

2) Disposable income = Current income – non-consumption expenditures

We re-examine the links between the income volatility changes and household's leverage choices using different definitions of household income. As we do in [Section 2.4], we compute the changes of standard deviation of household income after controlling for a common age profile and the number of family members. Then we apply same threshold to divide households into three groups, low 25 percentiles, top 25 percentile and rest in terms of the changes of income volatility. Then, we draw the uncontrolled and controlled version of leverage ratio change over time with same method.

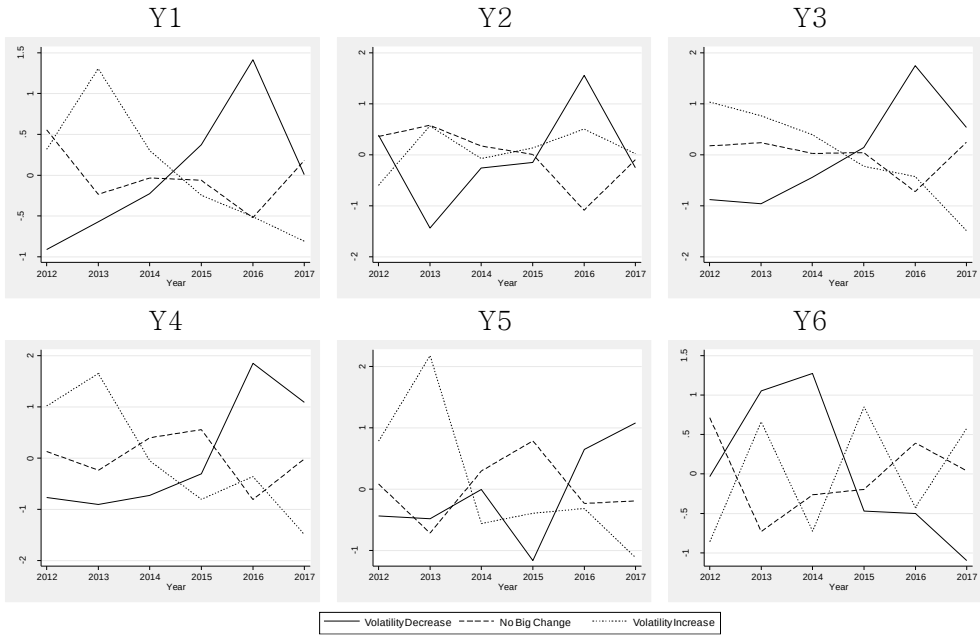
[Figure 2-10] Leverage ratio change by groups (uncontrolled)



Panel Y1 is the definition we adopted in the previous analysis. Though there are some variations, households with increased income volatility (small dotted line) showed the smallest growth in the leverage ratio, both in the uncontrolled version and controlled version. However, it is found that unlike other definitions of household income, income volatility changes in terms of households' disposable income showed different results. Panel Y6 shows the leverage ratio changes over time in different households group divided by the changes in disposable income volatility. Since disposable income is household current income minus non-consumption expenditures, which

includes households' interest payments, highly indebted households' disposable income will be lowered due to interest burden. This may cause the differences with other measures of income, which do not include households' debt burden.

[Figure 2-11] Leverage ratio change by groups (controlled)



Generally, Y1, Y3, Y4 and Y5 shared similar patterns. This reflects the possibility that households perceive changes of labor, business and property income most importantly, whereas other sources of income are perceived less importantly, affecting households' assets and liability choices less. This may due to the fact that labor income itself accounts for the largest share in households' current income. Labor income alone accounts for 61.4% of income for average households.

Different micro dataset: KLIPS

We obtained micro panel data from "the Survey of Household Finances and Living Conditions (SFLC)". Thus, the results of our quantitative analysis heavily depends on this dataset. In here, we examine whether the key results that households whose income volatility increased lowered their leverage ratio rapidly with other micro dataset, Korean Labor and Income Panel Study (KLIPS).

As mentioned earlier, KLIPS mainly focuses on households' labor and income profiles, survey answers in household assets and liabilities condition contain lots of missing information. For example, in the 20th survey, which is equivalent to year 2017, 656 home owners answered they do not know the market price of their house, and only 541 households reported they know the market price of house. Similar problem also arises in questions about liabilities. This asset and liability incompleteness makes leverage ratio very instable. In SFLC, if respondents do not know exact information of assets and liabilities, survey instructor help to acquire the related information. [Table 2-29] compares the distribution of leverage ratio derived from SFLC and KLIPS respectively.

[Table 2-29] Comparison of leverage ratio: SFLC and KLIPS

	Mean	S.D.	Percentiles				
			10%	25%	50%	75%	90%
SFLC	0.317	0.574	0.014	0.067	0.201	0.383	0.598
KLIPS	2.841	2.656	0.279	0.750	2.000	4.185	7.000

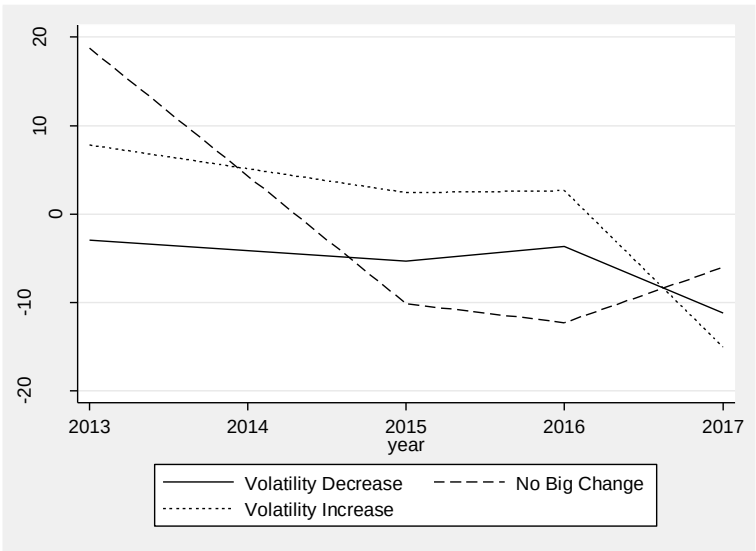
Note: Leverage ratio is calculated as "total debt over total assets". Only households with positive leverage ratio were included in this table for direct comparison.

Because of the instability of leverage ratio in KLIPS, direct comparison of SFLC and KLIPS using leverage ratio may induce misleading results. But as we saw in [Figure 2-2] panel B, the average debt level showed similar shape. Thus, though there are some level-differences, we calculate the average leverage ratio changes over time. In order to do it, we divided households into three

groups, ‘income volatility decreased’, ‘income volatility increased’, and ‘no big change’ according to the same criteria we used in the earlier section.

[Figure 2-12] shows the average leverage ratio changes over time. We only subtracted the period average leverage ratio in order to make the mean of debt level changes of different groups same. We see the overall leverage ratio decreases over time. In this figure, we can see the ‘volatility increase’ lowered their leverage ratio rapidly. This supports the results in previous section using SFLC dataset.

[Figure 2-12] Debt Level Change by Groups (KLIPS, uncontrolled)

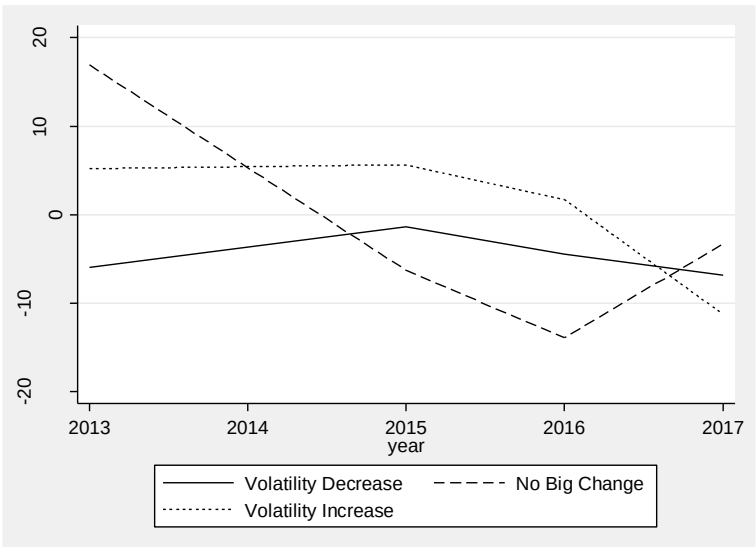


Note: “Volatility Decrease” is the group whose ΔSD_i was in the low 25th percentile, “Volatility Increase” refers to those with ΔSD_i in the high 25th percentile, and “No Big Change” refers to the remaining middle 50 percent.

Next, we show a controlled version of leverage ratio changes. [Figure 2-13] is computed as follows. First, we regress household’s leverage ratio on age, age squared and year dummies to obtain the residual leverage ratio net of the average age profile and time effects. The regression results are reported in [Table 2-30]. Second, we subtract the household-mean leverage ratio over sample period to control for each households’ unobserved effects (such as different preferences for debt). The results are similar to those of [Figure 2-12].

This shows a negative relationship between the income volatility changes and leverage ratio changes. Households who experienced a big increase in the income volatility (small-dotted line), which corresponds to 75th percentile in ΔSD_i reduced their leverage ratio rapidly compared to other groups. Although the gaps between groups were not as big as in [Figure 2-4] with SFLC data, it convincingly demonstrates that enlarged income uncertainty induces households to be more conservative in their debt-financing.

[Figure 2-13] Debt Level Change by Groups (KLIPS, controlled)



Note: "Volatility Decrease" is the group whose ΔSD_i was in low 25% percentile, "Volatility Increase" refers to those with ΔSD_i in high 25% percentile.

[Table 2-30] Regression Results

Dependent Variable: Leverage Raito		Obs.	R^2
age	age squared		
0.0825***	-0.0008***	21,893	0.0185
(0.0071)	(0.0001)		

Note: The numbers in parentheses are the robust standard errors. The regression also includes year dummies. The ***, **, * denote the statistical significance at three p-values: 1%, 5%, 10% respectively.

2.8. Section summary

We analyzed the relationship among changes in income volatility and leverage ratio. Many literatures studied the relationships between household debt and income. However, we tried to link household leverage choices and the changes of second moment of income. This is the main differentiating factor in our analysis. We obtained data from the Survey of Financial and Living Condition from 2012 to 2017. We defined changes in income volatility as a difference of standard deviation of household income between two sub-periods. We divided households into 'volatility decreased', 'increased', and 'no big change' groups. The main results are as follow:

First, we found a negative relationship between income volatility changes and leverage ratio. On average, a one standard deviation increase in income volatility was associated with 1.3 ~ 1.5 percentage point decrease in the leverage ratio. As income volatility increases, households would feel more need to save (precautionary) in order to guarantee future consumption.

Second, potentially borrowing constrained households were more responsive in income volatility changes, indicating that supply-side factors had significant effects on households' leverage responses. Since borrowing-constraints are not directly observable in our data, we employed various measures related to households' borrowing constraints. We found that in terms of net-wealth, HDRI, especially DTA, and borrowing rates, households that were potentially borrowing-constrained had statistically different responses in their leverage choices when faced with increased income volatility.

Third, household heterogeneity also had significant effects on households' leverage response to income volatility changes. Middle aged households, households with 'net-short' of real estate assets were more sensitive in income volatility changes. They deleveraged more when faced with increased income volatility.

Finally, we checked for the robustness. Alternative definitions of income and other micro data support our main results that households with increased income volatility lowered leverage ratio over time.

3. Household Leverage and Consumption

3.1. Data and stylized consumption patterns

In this section, we turn our attention to household consumption, and analyze the relationship between consumption and income volatility changes. We use the Survey of Financial and Living Conditions (SFLC) micro household data, which is the same with the previous section. The only difference is that since the half of SFLC, Household Financial Survey does not contain households' consumption data, we use the other half, Household Welfare Survey only. Therefore, our sample decreases from 6,064 households to 2,989 households with complete consumption data. We analyze the links between households' consumption behavior and changes in income volatility with a balanced panel of N = 2,989 and T = 6 years.

Before estimating the consumption function of Korean households with an econometric model, we search if there is any stylized consumption pattern across different household groups. We divide households into several groups by age, income, job status, and home ownership. Unfortunately, the Household Welfare Survey did not provide households' principal payments before 2014. And as mentioned earlier, since 2018 survey, Statistics Korea, the authority in charge of SFLC, merged other administrative data from National Tax Office (households' tax paying records) and Ministry of Health and Welfare (households' national pension fund records, etc) into their survey data. This greatly improved and enhanced the reliability and accuracy of households' income, financial assets, liabilities, and consumption expenditures, possibly overcoming the biggest short-coming of survey data, the survey biases. But as a result, there occurred a structural break between 2017 and 2018. See [Appendix A5] for the example of structural breaks. Therefore, in here, we compare households' consumption, debt-financing, earning and debt-servicing behaviors between 2014 and 2017. The reason why we start from 2014 is that the Household Welfare Survey began to provide households' debt repayments record since 2014.

By age

First, we divided households into age segments. Following the threshold in previous sections, young households are those with age less than 40, middles are between 40 and 55, and old households are age older than 55. Old households showed the lowest consumption growth. Over 3 years, their consumption increased only 3.0 percent, which is much lower than the total average of 12.1 percent. Furthermore, the old households reported the highest growth rate in income level, and biggest increase in debt level, and the lowest increases in income level. This indicates that old households' low growth rate of consumption were related with low income growth rate. Households with highest debt level growth rate were young households. Their debt level increased 53.6 percent during 3 years. This resulted highest increase in DSR, which is measured as $\frac{(principal\ payments+interest\ payments)}{disposable\ income}$. As before, the disposable income is before interest payments.

[Table 3-1] Consumption and debt changes by age

(unit: %, %p, 10k Korean won)

Age Segments	Consumption growth	Debt Level growth	Income growth	DSR changes
Young	20.5% (2,879)	**53.6%** **(8,533)**	14.7% (5,752)	**12.1%p** **(34.7%)**
Middle	12.1% (3,102)	21.9% (8,370)	16.6% (6,411)	8.7%p (34.2%)
Old	**3.0%** **(1,691)**	27.2% (5,952)	**12.2%** **(3,438)**	2.2%p (25.5%)
Total	12.1% (2,507)	27.2% (7,484)	12.2% (5,137)	7.0%p (31.0%)

Note: Age groups are as of 2014. Growth rates are a comparison between 2014 and 2017. Bold numbers refers to the groups with the most adverse changes, which are the lowest in consumption growth, the highest in debt level growth, the lowest in income growth, and the highest in DSR changes. Numbers in parentheses are the average values in 2017.

By income

[Table 3-2] reports the consumption and leverage changes by income segment, but it's hard to find any stylized patterns among groups. The consumption growth was weakest in the top 20th percentiles, which recorded 5.9 percent growth rate, only half of the total average of 12.1 percent. Debt growth was highest in 40th~60th percentiles, at 41.5 percent. But the debt-growth rate of low income households was very low. The lowest 20 percentile households' debt growth rate was 15.2 percent, and low 20~40 percent group's debt growth rate was only 3.1 percent. This may reflect that low income households were excluded in debt-financing activities as the authority adopted new loan regulation such as DSR. Lowest income growth and highest DSR change were in the top 20th percentile.

[Table 3-2] Consumption and debt changes by income

(unit: %, %p, 10k Korean won)

Income Segments	Consumption growth	Debt Level growth	Income growth	DSR changes
Low 20th percentile	15.4% (891)	15.2% (1,281)	55.3% (1,298)	-14.7%p (15.5%)
20~40th percentile	16.0% (1,848)	3.1% (3,806)	33.1% (3,070)	6.3%p (31.5%)
40~60th percentile	13.7% (2,510)	**41.5%** **(6,519)**	21.5% (4,594)	8.3%p (30.4%)
60~80th percentile	10.5% (3,067)	32.2% (9,026)	9.0% (6,153)	16.7%p (39.0%)
Top 20th percentile	**5.9%** **(4,247)**	22.0% (16,298)	**-1.6%** **(1,028)**	**18.1%p** **(38.1%)**
Total	12.1% (2,507)	27.2% (7,484)	12.2% (5,137)	7.0%p (31.0%)

Note: Income segments are as of 2014. Growth rates are comparisons between 2014 and 2017. Bold numbers refers to the groups with the most adverse changes, which are lowest in consumption growth, highest in debt level growth, lowest in income growth, and highest in DSR changes. Numbers in parentheses is the average in 2017.

By job status

In [Table 3-3], we divided households by job status criteria in 2014. Consumption growth of own business was weakest. Households with permanent job showed biggest increase in debt-level. This indicates that relatively stable income was helpful in raising more debts. Own business households' income growth rates were lowest and DSR changes were highest. This seems closely related to the lowest consumption growth of own business households. In overall, their income changes were most adverse, and considering the relatively high debt level growth and DSR changes, own business households' overall financial soundness has been weakened. It is interesting that permanent job households' debt level growth was highest, but their DSR changes were relatively moderate. This seems to indicate that their loans were mainly 'straight' loans, which do not involve principal payments before the maturity.

[Table 3-3] Consumption and debt changes by job status

(unit: %, %p, 10k Korean won)

Job status	Consumption growth	Debt Level growth	Income growth	DSR changes
Permanent	13.0% (3,161)	**41.5% (8,890)**	12.2% (6,687)	6.5%p (27.8%)
Temporary	10.2% (1,713)	24.3% (3,146)	13.3% (3,061)	3.0%p (23.6%)
Own business	**8.3% (2,668)**	13.4% (10,149)	**8.2% (5,714)**	**16.6%p (46.5%)**
etc	12.5% (1,428)	12.5% (3,984)	15.6% (2,363)	-1.2%p (23.5%)
Total	12.1% (2,507)	27.2% (7,484)	12.2% (5,137)	7.0%p (31.0%)

Note: Job status is as of 2014. Growth rates are comparisons between 2014 and 2017. Bold numbers refers to the groups with most adverse changes, which are lowest in consumption growth, highest in debt level growth, lowest in income growth, and highest in DSR changes. Numbers in parentheses are the average value in 2017.

By home ownership

[Table 3-4] shows consumption and leverage changes in home ownership criteria. Consumption growth was lowest in households with holding at least two houses. Their income growth rates were also lowest, and DSR changes were highest. This indicates that their low consumption growth was closely related to low income growth and increased debt-service burdens. On the other hand, households with holding no house at all showed the highest debt level growth, but debt-servicing burdens for them showed no big changes. This may be due to the possibility that households with no house needed additional debts in order to pay increased prices for Jeonse, and that Jeonse-collateral loans are almost straight loans with a 2-year maturity. The jeonse price index rose 9.9 percent from March 2014 to March 2017, according to KB Kookmin Bank. Note that SFLC assets and liabilities are as of the end of March each year. Therefore, even though "Jeonse" households' debt growth was highest, their debt-servicing burden did not increase much.

[Table 3-4] Consumption and debt changes by home-ownership

(unit: %, %p, 10k Korean won)

Number of house holding	Consumption growth	Debt Level growth	Income growth	DSR changes
0	17.3% (2,253)	**39.9%** **(5,837)**	17.0% (4,378)	6.5%p (27.4%)
At least 1	12.4% (2,544)	30.9% (6,064)	12.3% (5,119)	4.2%p (29.0%)
At least 2	**6.1%** **(2,841)**	17.7% (12,139)	**7.7%** **(6,331)**	**12.1%p** **(39.6%)**
Total	12.1% (2,507)	27.2% (7,484)	12.2% (5,137)	7.0%p (31.0%)

Note: Home ownership criterion is as of 2014 base. Growth rates are comparisons between 2014 and 2017. Bold numbers refers to the groups with most adverse changes, which are lowest in consumption growth, highest in debt level growth, lowest in income growth, and highest in DSR changes. Numbers in parentheses are the average value in 2017.

By income volatility changes

We also divided households with income volatility change criteria we used in previous chapter. Consumption growth was lowest in 'income volatility increased'. Considering their rapidly increased debt-service burden, their low consumption growth seems to be related to their debt-servicing burdens. We saw that households with increased income volatility lowered their leverage ratio. This implies they paid back (redeemed) some of their debts and this is shown in increased DSR, which includes principal payments for debts.

On the other hand, households with decreased income volatility showed high consumption growth rate and debt level growth rate. This can be attributed to the fact that such households can raise more debt with stable income, which may be helpful in the loan approval process. Notably, their income growth was lowest. Coinciding with rapidly increased debt levels and low income growth, one can conjecture that high consumption growth may be a result of debt-financing for consumption.

[Table 3-5] Consumption and debt changes by income volatility

(unit: %, %p, 10k Korean won)

Income volatility	Consumption growth	Debt Level growth	Income growth	DSR changes
Volatility decreased	13.6% (2,291)	**35.5%** **(7,603)**	10.0% (4,640)	-3.0%p (29.0%)
No big change	12.8% (2,708)	26.2% (7,397)	12.3% (5,513)	4.3%p (25.3%)
Volatility increased	**8.6%** **(2,301)**	21.7% (7,542)	**13.8%** **(4,868)**	**22.8%p** **(44.6%)**
Total	12.1% (2,507)	27.2% (7,484)	12.2% (5,137)	7.0%p (31.0%)

Note: Growth rates are comparisons between 2014 and 2017. Bold numbers refers to the groups with most adverse changes, which are lowest in consumption growth, highest in debt level growth, lowest in income growth, and highest in DSR changes. Numbers in parentheses are the average value in 2017.

We found some stylized patterns in consumption growth. In the standard criteria for household socioeconomic variables, such as age, income, job status and home ownership, household groups that showed the lowest consumption growth also had the lowest income growth. This indicates a close relationship between consumption and income. The main findings in this patterns are as follow:

In age criterion, old households showed the lowest growth in consumption. This seems to be related to their low income growth. In income criterion, the highest income group (top 20th percentile in income) showed the lowest consumption growth, and this also seems to be related to their low income growth. In job status criterion, own business households showed the lowest consumption growth and lowest income growth. Their debt-service burden also increased most rapidly. In home ownership criterion, households with holding at least two houses had the lowest consumption growth. Their income growth was also the lowest, and their debt service burden showed highest increase.

However, in income volatility change criterion, the relationship between consumption growth and income growth breaks. Households with increased income volatility had the lowest consumption growth, even though their income growth rates were highest among groups. This seems to be due to the increased income volatility, as they lowered their leverage ratio, redeemed some of their debts and reduced their spendable money.

[Table 3-6] Some stylized patterns in consumption growth

Criteria	Consumption growth	
	Lowest	Highest
Age	Old	Young
Income segment	Top 20 percentile	Low 20~40 percentile
Job status	Own business	Permanent
Number of house holding	At least 2 houses	no house
Income volatility changes	increased	decreased

3.2. Baseline regression

In this section, we estimate household's consumption equation in order to identify the effects of income, wealth and debt level changes on consumption with the consideration of changes of income volatility. Following Campbell & Cocco (2007), Yoo & Byun (2012), Choi et al (2015) and Park (2019), we estimate consumption equation using following specification. We use GMM dynamic panel estimation method proposed by Arellano & Bond (1998). The estimation method is known to be designed for dynamic "small−T, large−N" panels. The basic model is as follows:

$$\ln c_{i,t} = \alpha + \beta_0 \ln c_{i,t-1} + \beta_1 \ln y_{i,t} + \beta_2 Z_{i,t} + u_i + e_{i,t} \qquad (5)$$

where the subscript i denotes each household, t is the year, c is the logged value of consumption, y is logged household income, and Z is a vector of household characteristics. We include number of family members as a demographic variable and the value of households' real estate asset values in order to capture the wealth effects. To evaluate the relationship between debt changes and consumption, we include debt levels. Finally, interest rates households face in loan market are included. All variables, except the number of family members, are deflated by consumer price index (CPI) and log−transformed, so that all variables are in real terms. u_i is household i's idiosyncratic effect which is invariant with time. e is an error term. Since dynamic panel estimation includes lagged value of dependent variable in explanatory variables, controlling the endogeneity is needed. We follow the method Arellano & Bond (1991) suggested. Difference equation form of equation (5) can be expressed as follows:

$$\begin{aligned} \ln c_{i,t} - \ln c_{i,t-1} = {} & \beta_0 (\ln c_{i,t-1} - \ln c_{i,t-2}) + \beta_1 (\ln y_{i,t} - \ln y_{i,t-1}) \\ & + \beta_2 (Z_{i,t} - Z_{i,t-1}) + (e_{i,t} - e_{i,t-1}) \end{aligned} \qquad (6)$$

The lagged variables in level terms are used when estimating the

difference equation, such as equation (6). But in many cases, household income, house price and debt level are variables with a unit root with random walk. Therefore, we use two-stage system GMM estimation suggested by Arellano & Bover (1995) and Windmeijer (2005) that use both equation, the level equation (5) and difference equation (6). We also report the Arellano-Bond test statistic that affirms the adequacy of the use of instrumental variables. Rejecting the AR(1) hypothesis while not rejecting the AR(2) hypothesis implies the use of instrumental variables was proper.

Standard consumption theory tells that when permanent income hypothesis (PIH) holds and credit market is perfect, coefficient of households' income is near zero, if income shock is temporary. Income coefficient would be positive if households are borrowing-constrained or the income shock is perceived as a permanent one, in particular, for young households whose the net present value of future earnings (human wealth) is large. If the borrowing constraint is binding, consumers must forcedly defer consumption, meaning that consumption grows more over time than it would with perfect credit markets. There is another important reason why consumers may want to postpone consumption, which is the desire to protect against income risk, the precautionary saving motives. If households face live just two periods, the second period's income uncertainty makes household to save more in first period. Yoo & Byun (2012) and Choi et al (2015) reported positive coefficient of income, ranging from 0.09 to 0.15 with Korean household micro panel data. Campbell & Cocco (2007) reported income coefficient around 0.3. with UK household micro repeated cross sectional data. Park (2019) reported a negative coefficient of income with Korean household micro panel data, but their coefficients were statistically insignificant.

Wealth effects are known to have two kinds of effects on consumption. The first is that increasing households' perceived wealth increases life-time budget constraints. The second is through relaxation of borrowing constraints. Households can raise more debt with increased wealth, allowing them to consume more. Choi et al (2015) reported that wealth effects increase with age, though the

absolute value of wealth effects were smaller than income effects. Park (2019) reported that old households had about 9 times greater wealth effects than the average, and young households had 'negative' wealth effects, meaning house price increases were related to decreases in consumption. These results can be attributed to households with 'net-short' position in house having relatively small (or even negative) wealth effects, while households with 'net-long' position in house having larger wealth effects.

Finally, if the purpose of households' debt-raising is for consumption expenditures, the relationship between debt and consumption will be positive. The second channel of wealth effects (relaxation of borrowing constraints) implicitly assumes that more debt-raising will be related to more consumption. On the contrary, households' deleveraging, which is essentially equivalent to saving, will be associated with less consumption. All these relations suggest a positive relationship between debt and consumption. However, for highly indebted households, leverage and consumption will be negatively related if high debt levels induce increased debt servicing burdens. Therefore, it is difficult to postulate a single-direction relationship between household leverage and consumption, and such conjectures are needed to be checked with empirical data.

Then, let us focus on the relationship of changes in income volatility and consumption. Changes in income uncertainty are related to 'more precautionary saving' and 'more likely to be borrowing-constrained' as we saw in Chapter 2.

When faced with increased income volatility,

- *Households' income elasticity on consumption will be lowered in order to smooth their consumption.*
- *Wealth effects will be smaller because households feel more need to save money to deal with enlarged income uncertainty. This relationship will be more significant among young and middle aged households since their share of human wealth in total assets is bigger.*
- *The relationship between debt and consumption will be*

strengthened, since as the increased income volatility was associated with delivering, their net disposable income after debt-servicing being lowered.

[Table 3-7] briefly summarizes the relationship between consumption and other key variables. In addition to the theoretical and expected relations between consumption and other variables, increased income volatility will strengthen or alter existing direction of relations of consumptions. We will look into these relations with consumption equations estimation.

[Table 3-7] Relationship of consumption and other key variables

Variable	Theoretical / Expected relation (sign)	If income volatility increases
Income	(0): PIH with temporary shock with perfect credit market (+) : PIH with permanent shock or borrowing constraints	(↓) : If it is a temporary shock, households will not adjust consumption levels much
Wealth	(+) : Increased life-time budget constraint, Relaxation of borrowing constraint (especially larger for 'net-long')	(↓): Precautionary saving motives hinder extra consumption
Debts	(+) : Debt-raising for consumption smoothing (related to 'relaxing borrowing constraints' in wealth effects) (deleveraging or precautionary saving lowers disposable income) (-) : Lowered disposable income due to debt-servicing burdens	(↑): Income volatility increases were associated with deleveraging, making net disposable income lower.

Note: +/- indicate the expected sign of the relations. ↑/↓ indicates the direction of the changes of the magnitude of effects.

Before estimating the regression equation, we report descriptive statistics of variables. We changed all nominal values to real ones and log-transformed. In order to help understand the overall values in Korean won terms, we also report nominal values before log-transformation in parentheses in [Table 3-8]. [Table 3-9] reports correlations among variables. It seems that there are no major correlations other than 'consumption-income' and 'consumption-family size'. But those relations seemed to be natural.

[Table 3-8] Summary Statistics of regression variables

	Mean	S.D.	Percentiles		
			25%	50%	75%
Consumption	2.915 (2,307)	0.738 (1,535)	2.443 (1,132)	3.026 (2,031)	3.449 (3,100)
Income	3.478 (4,586)	0.952 (3,850)	2.935 (1,840)	3.637 (3,720)	4.139 (6,200)
Interest rate	0.017	0.018	0.021	0.025	0.026
Family size	2.894	1.301	2.000	3.000	4.000
House price	3.777 (23,698)	2.577 (40,615)	0.000 (0)	4.874 (13,000)	5.703 (30,000)
Debt	2.233 (5,948)	2.199 (12,892)	0.000 (0)	2.335 (1,000)	4.233 (6,770)

Note: All variables except interest rate and family size, are deflated by CPI and log transformed. Before log-transformation, we replaced with 1 if the value is zero. Numbers in parentheses are in 10k Korean won unit.

[Table 3-9] Correlations of variables

		(a)	(b)	(c)	(d)	(e)	(f)
Consumption	(a)	1.000					
Income	(b)	0.813	1.000				
Interest rate	(c)	0.007	0.021	1.000			
Family size	(d)	0.671	0.586	0.001	1.000		
House price	(e)	0.336	0.365	0.030	0.228	1.000	
Debt	(f)	0.440	0.426	0.019	0.352	0.422	1.000

[Table 3-10] reports the estimation results for equation (5). On average, the lagged value of consumption exerted the biggest influence on current consumption, reflecting the high persistency of consumption Coefficients of income were estimated at about 0.16, implying a one percent increase of income was associated with 0.16 percent increase in consumption. This result is similar to the estimation by Choi et al (2015). They reported the income coefficient was around 0.14. Turning back to our estimation results, and to understand what such a value means in Korean won terms, let us consider the average annual household income in the sample, which was 45.86 million Korean won. The average annual consumption of households was 23.07 million won. Thus, an increase in income by 1 percent, or 458.6 thousand won would lead to an increase in annual consumption by 0.16 percent, which is equivalent to 36.91 thousand won. This means about 8 percent of income increases were spent on the current period's consumption.

Interest rate, which is defined as the rate of newly extended loans by depository institutions, had negative sign, which is consistent with the conventional intertemporal consumption model, but this was estimated to be insignificant. We also tried other versions of estimation with different setting of interest rates. We adopted the deposit rates as interest rates, and we dropped the interest rate variable in explanatory variable, but the results were similar to [Table 3-9], and the differences were modest.

A one person increase in family member was estimated to be associated with 10 percent increase in consumption. House price was estimated to be insignificant in our baseline model. This indicates that the wealth effects for average households are small. We will address this issue later by considering the number of houses held.

Finally, the coefficient of debt was estimated to be positive and it was statistically significant. A one percent increase in debt was associated with 0.008 percent increase in consumption. To understand the relations in Korean won terms, 594.8 thousand won increase in debt was associated with 1,846 won increase in current period's consumption.

Arellano-Bond test statistics that are reported in the bottom row of [Table 3-10] affirms the adequacy of the use of instrumental variables. Rejecting the AR(1) hypothesis while not rejecting the AR(2) hypothesis implies that the use of instrumental variables was proper. We also tried other versions of estimation with different variables. For example, we included age squared to capture the standard hump-shaped consumption pattern over life-cycle, but the coefficient of age squared was estimated to be positive, which implies a convex pattern over life-cycle. We thought the hump-shaped consumption pattern could be captured by income changes over time, since income level exhibits a hump-shaped over life-cycle.

[Table 3-10] Estimation results for basic model

Dep. Variable: Consumption	(i)	(ii)	(iii)	(iv) -baseline-
Consumption (lag1)	0.189*** (0.032)	0.185*** (0.032)	0.183*** (0.032)	0.183*** (0.032)
Income	0.164*** (0.024)	0.163*** (0.026)	0.163*** (0.026)	0.162*** (0.026)
Interest rate	-0.157 (0.134)	-0.093 (0.135)	-0.089 (0.136)	-0.087 (0.136)
Family size		0.104*** (0.013)	0.105*** (0.013)	0.104*** (0.013)
House price			-0.002 (0.004)	-0.005 (0.004)
Debt level				0.008** (0.003)
Observations	11,956	11,956	11,956	11,956
Arellano-Bond test p-value				
AR(1)	0.000	0.000	0.000	0.000
AR(2)	0.965	0.741	0.727	0.833

Note: This model was estimated by the two-stage system GMM method. ***, **, * denote statistical significance at 1%, 5%, 10% levels, respectively.

3.3. Income volatility changes and consumption

In order to consider the effects of changes in income volatility on consumption, we estimated the same consumption equation with different household groups divided by the income volatility changes. Households who faced big changes, either increases of decreases, had a lower coefficient of income. This indicates households did not alter their consumption much in response to income volatility changes. Households with no big changes in income volatility had bigger coefficient of income. Households with decreased income volatility had relatively big coefficient of debt, indicating their consumption was more related to debt level changes. For other groups, the coefficients of debt were estimated to be insignificant.

[Table 3-11] Estimation results for different volatility groups

Dep. Variable: Consumption	Income volatility decreased	No big change	Income volatility increased
Consumption (lag1)	0.181*** (0.053)	0.221*** (0.042)	0.218*** (0.077)
Income	0.154*** (0.048)	0.282*** (0.021)	0.118*** (0.029)
Interest rate	0.434 (0.299)	-0.268 (0.183)	-0.352 (0.262)
Family size	0.120*** (0.025)	0.075*** (0.018)	0.109*** (0.022)
House price	-0.015* (0.008)	-0.000 (0.006)	-0.001 (0.007)
Debt level	0.021*** (0.007)	0.003 (0.004)	0.010 (0.007)
Observations	2,924	6,064	2,968

Note: This model is estimated by the two-stage system GMM method. ***, **, * denote statistical significance at 1%, 5%, 10% levels, respectively.

In order to double-check households' consumption behavior changes in response to increased income volatility, we use the interaction term between $I\{Volatility\ Increase\}_i$ and each variable.

As mentioned earlier, $I\{\text{Volatility Increase}\}$ is 1 if households faced a substantial increase of income volatility, and becomes 0 otherwise. For simplicity, we only consider the marginal effects of households with increased income volatility. We also considered cross-terms using ΔSD_i, but the estimation results were similar. Only the 'Income × $I\{Volatility\ Increase\}_i$ ' term was statistically significant. Households with increased volatility did not adjust their consumption on income changes. The coefficient even indicates if income rises, consumption would be lowered, since their income responses are $0.476\ (\text{income}) - 0.549\ (\text{income} \times I_{Vol\_Inc}) = -0.073$. This implies that when faced with a substantial increase in income volatility, households maintained their consumption expenditure level even under more volatile income changes Other cross-terms were estimated to be statistically insignificant, implying that there are no clear effects of income volatility changes on households' wealth effects and debt-raising effects.

[Table 3-12] Estimation with cross-term

Dep. Variable: Consumption	(A)	(B)	(C)
Income	0.476***	0.154***	0.166***
	(0.103)	(0.031)	(0.026)
Interest rate	-0.378**	-0.213	-0.166
	(0.166)	(0.169)	(0.156)
Family size	0.090***	0.108***	0.111***
	(0.016)	(0.015)	(0.015)
House price	-0.007*	0.044	-0.007
	(0.004)	(0.036)	(0.005)
Debt level	0.008**	0.005	0.045
	(0.003)	(0.005)	(0.034)
Income × I_{VOL_INC}	-0.549***		
	(0.154)		
House price × I_{VOL_INC}		-0.163	
		(0.125)	
Debt × I_{VOL_INC}			-0.140
			(0.127)
Observations	11,956	11,956	11,956

Note: This model is estimated by the two-stage system GMM method. ***, **, * denote statistical significance at 1%, 5%, 10% levels, respectively.

3.4. Borrowing constraints and consumption

In this section, we search changes of consumption behaviors among (potentially) borrowing constrained households.

By LTV

We used two kinds of LTV measures in Chapter 2. One was narrowly defined LTV, which we denote LTV_i^N which is 'secured loans divided by real estate assets'. The other one, denoted by LTV_i^B, was broadly defined LTV, 'total debt divided by real estate assets'. One of the main questions regarding households with borrowing constraints is that whether the coefficient of income is far from zero or not. According to standard consumption theory, borrowing-constrained households would have bigger income coefficient, while coefficient of income for households without borrowing constraint would be near zero. In [Table 3-12], the coefficient of income for potentially borrowing constrained households was bigger in LTV_i^N, while potentially borrowing constrained households' coefficient was smaller in LTV_i^B criteria. Thus, it is difficult to conclude borrowing constrained households had bigger income coefficient.

[Table 3-13] Estimation results: LTV

Dep. Variable: Consumption	$LTV_i^N \leq 0.6$	$LTV_i^N > 0.6$	$LTV_i^B \leq 0.6$	$LTV_i^B > 0.6$
Income	0.153***	0.198***	0.160***	0.107*
	(0.025)	(0.047)	(0.026)	(0.059)
Interest rate	-0.066	-1.501**	-0.138	-0.363
	(0.138)	(0.645)	(0.141)	(0.482)
Family size	0.109***	0.053	0.107***	0.105**
	(0.013)	(0.071)	(0.013)	(0.045)
House price	-0.001	-0.032***	-0.002	-0.015
	(0.004)	(0.011)	(0.004)	(0.010)
Debt level	0.007*	0.026**	0.005	0.031***
	(0.003)	(0.010)	(0.003)	(0.010)
Observations	11,434	522	10,862	1,094

Note: This model is estimated by the two-stage system GMM method. ***, **, * denote statistical significance at 1%, 5%, 10% levels, respectively.

In LTV ratio criteria, 'potentially' borrowing constrained households had bigger coefficient of debt levels. Compared to the average households' debt coefficient 0.008, households with LTV ratio higher than 0.6 had debt coefficients of 0.026 ~ 0.031. This indicate their consumptions were more affected by their debt-financing activities. This also implies if they deleverage their debt level, their consumption would be lowered further. A one percent increase (decrease) in debt was associated with 0.026 ~ 0.031 percent increase (decrease) in consumption.

Other coefficients, such as income and family size and house prices, were similar to that of average households, and the coefficient of interest rates were estimated to be statistically insignificant, as it was in the estimation for the average households.

By net wealth

We used net wealth as a criterion for borrowing constraints in Chapter 2. The thresholds we used was [less than 50,000,000 Korean won], [less than 0] and [less than 50,000,000 Korean won]. Since the number of observations were too small, we use second and third thresholds only.

The income coefficient for households with net wealth of less than 5000 10k Korean won was 0.270, which is bigger than the average households and households with net wealth larger than 5000 10k Korean won. This results may imply the standard consumption theory about income coefficient holds. Households with net wealth less than zero had smaller income coefficient, but it was statistically insignificant, possibility due to the small sample size.

Coefficient of debt for potentially borrowing-constrained households was estimated to be higher than the average households, and this seems to be consistent to the results we obtained in LTV criteria. Coefficient of house price was estimated to be negative and statistically significant, implying they are 'net-short' of real estate assets. Other variables were estimated to be roughly not very different from those of LTV criteria.

[Table 3-14] Estimation results: net wealth

Dep. Variable: Consumption	$NW_i < 0$	$NW_i < 5000$	$NW_i \geq 5000$
Income	0.104 (0.075)	0.270*** (0.078)	0.131*** (0.023)
Interest rate	1.077 (0.907)	0.002 (0.269)	-0.148 (0.155)
Family size	0.190*** (0.053)	0.124*** (0.030)	0.100*** (0.014)
House price	-0.033 (0.023)	-0.032*** (0.008)	0.000 (0.004)
Debt level	0.041* (0.021)	0.018** (0.008)	0.005 (0.004)
Observations	218	2,721	9,235

Note: $NW_i < 5000$ refers to households with net wealth less than 5000 10k Korean won. This model is estimated by the two-stage system GMM method. ***, **, * denote statistical significance at 1%, 5%, 10% levels, respectively.

By HDRI

Here, we use the Household Debt Risk Index (HDRI) we used in Chapter 2. As explained earlier, HDRI is composed of a flow part (DSR) and a stock part (DTA), so we compare the DSR and DTA with certain threshold, 0.4 and 0.6 respectively. In this criteria, households with either HDRI higher than 100, DSR higher than 0.4 or DTA higher than 0.6 are 'potentially' borrowing constrained.

The estimation results of income coefficients seem to reject the standard consumption theory that borrowing constrained households would have higher income coefficient on consumption. 'Potentially not' borrowing constrained households, whose HDRI were less than 100, had highest value of income coefficient.

On the other hand, as we found in LTV and net wealth criteria, borrowing constrained households had a higher coefficient of debt, implying their consumptions were more related to debt. Households with HDRI higher than 100 had a debt coefficient 0.038, which is six times bigger than households with HDRI less than 100. However, households with DSR higher than 0.4 had relatively small coefficient

of debt and it was statistically insignificant. This seems to be consistent to the result we found in Chapter 2.5 that households' leverage response was more related to DTA measure, and DSR measure seemed to have little power in explaining households' leverage choices.

[Table 3-15] Estimation results: HDRI

Dep. Variable: Consumption	$HDRI_i \leq 100$	$HDRI_i > 100$	$DSR_i > 0.4$	$DTA_i > 1.0$
Income	0.173***	0.071***	0.071***	0.170**
	(0.025)	(0.022)	(0.015)	(0.081)
Interest rate	-0.147	-0.337	0.064	-0.105
	(0.141)	(0.635)	(0.391)	(0.692)
Family size	0.098***	0.147***	0.146***	0.160***
	(0.014)	(0.035)	(0.032)	(0.042)
House price	-0.005	-0.013	-0.010	-0.022
	(0.004)	(0.019)	(0.008)	(0.016)
Debt level	0.006**	0.038*	0.004	0.034**
	(0.003)	(0.020)	(0.006)	(0.013)
Observations	11,369	587	1,819	414

Note: This model is estimated by the two-stage system GMM method. ***, **, * denote statistical significance at 1%, 5%, 10% levels, respectively.

By borrowing rate

Here, we use households' effective borrowing rates are a criterion for borrowing constraints. We define households as not borrowing constrained if borrowing rates are less than 1.5 times the average bank's loan rates. We define households as weakly borrowing constrained if their borrowing rates are higher than 1.5 times the average. If borrowing rates are higher than 2.0 times the average, we consider them 'strongly' borrowing constrained.

The regression results in [Table 3-16] are different from the results we obtained in other criteria. Income coefficients were estimated to be statistically insignificant, and more importantly, coefficients of debt were small and insignificant for 'potentially' borrowing constrained households. We think it is not appropriate to

apply borrowing rate related criteria in the analysis of households' consumption. The only statistically significant coefficient for this criterion was the number of family members.

[Table 3-16] Estimation results: borrowing rate

Dep. Variable: Consumption	$r_i^L \leq 1.5 \times r^B$	$r_i^L > 1.5 \times r^B$	$r_i^L > 2.0 \times r^B$
Income	0.141*** (0.040)	0.092** (0.038)	0.055 (0.034)
Interest rate	-0.123 (0.254)	-0.274 (0.377)	-0.338 (0.539)
Family size	0.070*** (0.024)	0.150*** (0.029)	0.152*** (0.037)
House price	-0.006 (0.006)	0.006 (0.012)	0.027 (0.020)
Debt level	0.009 (0.007)	0.000 (0.009)	0.001 (0.011)
Observations	3,483	1,650	871

Note: r_i^L refers to household i's effective borrowing rate and r^B refers to the average newly extended loans interest rate charged by depository institutions. This model is estimated by the two-stage system GMM method. ***, **, * denote statistical significance at 1%, 5%, 10% levels, respectively.

Borrowing constraints and income volatility changes

Here, we analyze the effects of increased income volatility on households' consumption behavior. As we estimated in [Table 3-11], we use the cross-term of $I\{Volatility\ Increase\}_i$ and other key variables, including income, house price and debt. We estimated all separate equations, but for simplicity, we report the coefficient of cross-term variables only, in order to ascertain whether households' changes in income volatility had effects on each key variable. Since our primary concern in this section is whether borrowing constrained households changed their consumption behavior in response to income volatility changes, we restrict our sample to households with potentially borrowing-constrained in terms of each criterion we used in this section.

[Table 3-17] reports that an increase in income volatility lowers borrowing constrained households' income coefficient. The coefficients were statistically significant in LTV and HDRI criteria, and not significant in net wealth and borrowing rates criteria. But all coefficients were estimated to be negative. This implies that faced with income volatility, borrowing constrained households smoothed their consumption, even under more volatile income changes. However, [Table 3-11] and [Table 3-12] show that the average households also had smaller income coefficient if they face increased income volatility. Thus, it is still not clear whether borrowing-constrained households 'more' lowered their income coefficient than the average households, in response of income volatility changes. But one thing that seems clear is that income coefficients tend to be lower if income volatility increases.

Next, it is not clear that enlarged income uncertainty increase affects households' wealth effects. One of our prior hypothesis was that increased human wealth uncertainty would lower wealth effects by precautionary saving motives. However, the regression results say the relationship is unclear. The effects of income volatility changes on debt level changes were also estimated to be not significant. See more detailed estimation results in [Appendix A6].

[Table 3-17] Estimation results with cross-term

Dep. Variable: Consumption	$LTV_i^B > 0.6$	$NW_i < 5000$	$HDRI_i > 100$	$r_i^L > 1.5 \times r^B$
Income $\times I_{Vol\_Inc}$	-1.231*** (0.428)	-0.142 (0.232)	-0.286** (0.120)	-0.081 (0.275)
House price $\times I_{Vol\_Inc}$	-0.411 (0.437)	-0.239 (0.311)	0.000 (0.257)	-0.108 (0.298)
Debt level $\times I_{Vol\_Inc}$	-0.118 (0.343)	-0.549* (0.310)	0.423*** (0.151)	-0.035 (0.370)
Observations	1,094	2,721	587	1,650

Note: Coefficient in each cell are estimated with every different specification. See the detailed estimation results in [Appendix A4]. This model is estimated by the two-stage system GMM method. ***, **, * denote statistical significance at 1%, 5%, 10% levels, respectively. Numbers in parenthesis are robust standard errors.

3.5. Heterogeneity across groups and consumption

In this section, we search for changes in consumption behaviors with the consideration of household heterogeneity

By age

We divide households into three age groups, and estimate the consumption equation separately. Young are households' head age less than 40, middle are between 40 and 55, and old households are household heads' age older than 55.

[Table 3-18] Estimation results: different age group

Dep. Variable: Consumption	Young ($age_i \leq 40$)	Middle ($40 < age_i \leq 55$)	Old ($age_i > 55$)
Income	0.171** (0.069)	0.189*** (0.071)	0.144*** (0.031)
Interest rate	0.065 (0.313)	-0.300 (0.212)	-0.083 (0.235)
Family size	0.131*** (0.033)	0.071*** (0.023)	0.144*** (0.019)
House price	-0.000 (0.007)	0.004 (0.006)	-0.014* (0.008)
Debt level	0.014* (0.008)	0.004 (0.005)	0.012** (0.005)
Observations	1,879	4,351	5,726

Note: This model is estimated by the two-stage system GMM method. ***, **, * denote statistical significance at 1%, 5%, 10% levels, respectively.

The coefficient of income was highest in the middle aged group, while old households had the lowest income coefficient. A one percent increase in income was associated with 0.189 percent increase in current consumption for middle aged households, but old households' consumption only increased 0.144 percent with the same rate of income growth. This is consistent with the life-cycle theory of consumption where old aged households have shorter periods for their income earning years, so their consumption is less affected by income changes. On the other hand, young households' income

coefficient was estimated to be lower than that for middle aged households. This implies that young workers face substantial uncertainty about their future earnings, making their consumption less responsive than that of middle aged households.

Young households' coefficient of debt levels was highest, while middle aged households had a smaller and insignificant coefficient. This indicates that young households' consumption is more related to their debt level changes. Old households also had a relatively large coefficient of debt levels, since their consumption is more affected by asset and liability conditions than their income.

By home ownership

Here, we divide households into three groups with home ownership criteria. As we reported in [Table 2-20], the divided household groups are households with no house at all, households with at least one house and households with at least two houses.

[Table 3-19] Estimation results: number of house holding

Dep. Variable: Consumption	Number of house holding		
	No house	At least one	At least two
Income	0.176*** (0.045)	0.200*** (0.054)	0.096*** (0.022)
Interest rate	-0.048 (0.228)	-0.195 (0.218)	-0.461* (0.270)
Family size	0.100*** (0.021)	0.097*** (0.021)	0.123*** (0.023)
House price	-0.014*** (0.005)	-0.003 (0.005)	0.085*** (0.021)
Debt level	0.008 (0.005)	0.003 (0.005)	0.009 (0.006)
Observations	4,143	4,424	3,389

Note: This model is estimated by the two-stage system GMM method. ***, **, * denote statistical significance at 1%, 5%, 10% levels, respectively.

Income coefficient for households with at least one house was highest, while the coefficient for households with at least two houses

were lowest. Income coefficient for households with no house was between households with at least one and two houses.

Note that this criterion is different from 'renters vs. owner-occupied.' Households with no house would be considered as 'net-short' of real estate assets, and households with more than two houses would be classified as 'net-long.' The coefficient of house price was estimated to be significantly positive for households with at least two houses. This indicates that as they are 'net-long' in real estate assets, increases in their real assets were strongly related with their current consumption. This is consistent with the results of Park (2019). For households with no house, the coefficient was estimated to be negative. We also further divided households into different age groups, but we could not find any significant difference.

By job industry change

In Chapter 2, we used household heads' job industry change as a measure of persistency of income volatility changes. If workers changed their job from safe to risky industry, the increased income volatility would be perceived as a permanent change.

[Table 3-20] Estimation results: job industry change

Dep. Variable: Consumption	Safe to risky industry	Risky to safe industry	No change
Income	0.170***	0.520***	0.132***
	(0.056)	(0.138)	(0.045)
Interest rate	-1.575**	-0.451	-0.170
	(0.680)	(0.865)	(0.200)
Family size	0.069	0.100	0.058***
	(0.045)	(0.076)	(0.021)
House price	0.007	-0.009	-0.004
	(0.021)	(0.021)	(0.005)
Debt level	-0.007	0.009	0.014***
	(0.022)	(0.018)	(0.005)
Observations	508	208	5,108

Note: This model is estimated by the two-stage system GMM method. ***, **, * denote statistical significance at 1%, 5%, 10% levels, respectively.

[Table 3-20] reports households who changed their job industry from risky to safe had the highest income coefficient. This result is intuitive, since as households would perceive their income uncertainty decreased permanently, precautionary saving motives would be lowered, so their current income exerted more effects on their consumption. However, due to the small sample size, the results are not free from robustness issue, and further analysis is needed.

Household heterogeneity and income volatility changes

Here, as we did in the last part of Section 3.4, we use the cross-terms between $I\{Volatility\ Increase\}_i$ and other variables, to see whether increased income volatility affected households' consumption behaviors.

It is found that faced with increased income volatility, income coefficients were lowered, which is similar to the result we saw in borrowing-constrained households. Income coefficient of young and net short in real estate assets were more affected by income volatility increases. However, it is difficult to say wealth effects and the effects of debt on consumption had significant changes when households face increased income volatility.

[Table 3-21] Estimation results with household heterogeneity

Dep. Variable: Consumption	Age young	Age middle	Age old	House Net short	House Net long
Income	-1.021***	-0.665***	-0.049	-0.486***	0.140
$\times I_{Vol\_Inc}$	(0.279)	(0.252)	(0.256)	(0.155)	(0.419)
House price	0.255	-0.212	0.548	-0.033	-0.027
$\times I_{Vol\_Inc}$	(0.249)	(0.149)	(0.450)	(0.238)	(0.417)
Debt level	-0.100	-0.178	0.202	-0.356***	0.118
$\times I_{Vol\_Inc}$	(0.134)	(0.115)	(0.272)	(0.120)	(0.396)
Observations	1,879	4,351	5,726	4,143	3,389

Note: Coefficient in each cell are estimated with every different specification. See the detailed estimation results in [Appendix A4]. This model is estimated by the two-stage system GMM method. ***, **, * denote statistical significance at 1%, 5%, 10% levels, respectively. Numbers in parenthesis are robust standard errors

3.6. Section summary

We briefly looked the consumption patterns with micro data of Korean households, obtained from Household Welfare Survey. The stylized consumption patterns were that household consumption growth was closely related to households' income growths. However, unlike other criteria, households with increased income volatility had lowest consumption growth. Considering their low debt growth rate and high debt-servicing burdens, households with increased income volatility had to expend their income not on consumption, but on debt-servicing.

Through the analysis of consumption equation with the consideration of borrowing constraints and household heterogeneity, we found following results. First, in the analysis of 'potentially borrowing-constrained' households' consumption patterns, it is not observed borrowing constrained households had bigger income coefficient. But we found that they had strong relationship between debt and consumption, implying their consumptions are more affected by debt level changes. This indicates the possibility that coincided with income volatility increase which accompanies deleveraging, borrowing constrained households' consumptions would be hindered not by the direct 'income effect', but the indirect 'deleveraging effect'.

Second, in the analysis of heterogeneous household groups, wealth effects are estimated to be positive for households with holding more than 2 houses. this implies the wealth effects vary with households' position of real estate assets. 'Net long' households did have positive wealth effects, while 'net-short' households had little relationship between real estate assets and consumptions.

Finally, coinciding with income volatility changes, it is observed that households' income coefficients were lowered. This reflects households' consumption smoothing in more volatile income changes. However, we could not find evidence that the effects of income volatility changes on borrowing-constrained households or heterogeneous households were meaningfully different.

4. Concluding Remarks

In this paper, we have used Korean households' micro level data to estimate the response of household leverage and consumption to income volatility changes. We found that changes in income volatility did matter for household leverage choices and consumption. The main findings were as follows:

First, an increase in households' income uncertainty was associated with households' deleveraging. In the aspect of risk management incentives of human wealth and 'tangible' wealth, this can be considered as risk-averse households adjusting their risk exposure stemming from 'tangible' wealth if they face increases in human wealth uncertainty. In particular, potentially borrowing-constrained households in terms of asset-related measures such as net wealth and DTA (Debt-to-Asset ratio), lowered their leverage ratio more rapidly in response to income volatility increases. At the same time, flow-related measures, such as DSR, had little explanatory power. This may reflect the financial institutions' prevalent practice that the dominant factor in loan approval is still collateral assets. As income volatility increases, borrowing-constrained households might face a 'forced' deleveraging needs, indicating they were no longer able to roll-over the existing debts or cannot raise additional debt. Even if households were not actually binding in borrowing constraint, they might save more in order to guarantee the minimum consumption levels in future periods, since increased income volatility would be associated with the probability increase of being borrowing-constrained in future periods. In terms of households' socio-economic variables, middle-aged households and household with 'net-short' of real estate assets had lowered leverage ratio more in response to income volatility changes. This is consistent with the standard life-cycle theory that old households are less affected by income shock, since they have shorter periods of earning time, while young and middle aged households are more affected by human wealth uncertainty. And as poor households are

more risk-averse, households with few real assets were more responsive to income uncertainty changes.

Second, faced with increased income volatility, households' income coefficients on consumption were lowered. This reflects households' consumption smoothing behaviors. In particular, consumption among households that were borrowing-constrained in terms of asset-related measures, middle aged households, and 'net-short' in real estate assets were more affected by an increase in income volatility. Coinciding with households' leverage choice change, highly indebted households' consumption would be more affected by income volatility changes.

[Table 4-1] Summary of the effects of income volatility increases

		Leverage	Consumption
Overall		Deleveraged	Income elasticity lowered
Borrowing constraints	High LTV	△	Income elasticity lowered more
	Low net wealth	Deleveraged more	△
	High HDRI	Deleveraged more	△
	High Borrowing rates	Deleveraged more	△
Household Heterogeneity	Age	Middle age deleveraged more	Middle and young age lowered more
	Home ownership	No home deleveraged more	No home lowered more
	Job change	STR deleveraged more (△)	△

Note: △ indicates that the relations (effects) were statically insignificant. 'STR' in job change criteria refers to 'from safe to risky industry' and faced increased income volatility.

We can find economic implications of this study for Korean households. First, from a microeconomic perspective, financial institutions may use the knowledge and experiences of households' leverage ratio changes in response to enlarged income volatility, and advise households to prepare for possible deleveraging needs. For financial institutions, it is important to manage loan assets as soundly as possible, so advising their customers to manage their leverage ratio choice preemptively to the future changes in income volatility will be helpful for banks' long-run profitability. Considering households' job industry, marital status and other important factors in income volatility, financial institutions may advise on households' dynamic optimal leverage choices. Also for the household side, such advice will be helpful since any abrupt needs for deleveraging may accompany disutility.

Second, from a macroeconomic perspective, combining households' leverage and consumption choices in response to income volatility changes, we find that there may exist two transmission channels of income volatility changes on consumptions. The first one is, by precautionary saving motives, households adjust their consumption less to the changes of income, when they face increased income volatility. The second transmission channel is through households' deleveraging. Faced with increase income volatility, households' net disposable income decreases as they deleverage their debts in response to increased income volatility, either 'forcedly' (borrowing-constrained) or spontaneously. This indicates the possibility that highly leveraged households' consumption will be vulnerable to income volatility changes. Therefore, an economy with huge household debts such as Korea, would be more vulnerable to the changes in household income uncertainty.

However, since our analysis heavily depends on SFLC, which is survey-based soft data, our results are not free from survey biases. For example, real estate prices in Chapter 3 may have survey bias if respondents do not have accurate knowledge of the exact market price of their real estate. Furthermore, the length of the time series we used in panel analysis was only six years. This makes it hard to

identify the structural changes in income volatility, which was the primary measure in our analysis. If the length of time series could be extended further, it would be possible to better identify the structural changes. We also did not consider households' liquidity conditions. Incorporating households' liquidity measures would help understand households' different responses. Finally, we only used a simple regression form to identify the effects of income volatility changes on households' leverage and consumption. Constructing a structural model would be needed to find more implications of the effects of income volatility changes on households' behavior.

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Appendices

A1. Various income measures and descriptive statistics

We considered various definitions of household income. The primary definition we adopt in this paper is households' current income. The second definition is current income minus private transfer income. The third one is the sum of labor, business and property income. The fourth one is households' labor and business income. The fifth definition is household labor income only. Finally, the sixth definition is household disposable income, which is defined as current income minus non-consumption expenditures, such as taxes and interest payments.

[Table A1-1] Number of households with zero or negative income

Year	y1	y2	y3	y4	y5	y6
2012	3	44	583	861	2,045	26
2013	5	34	591	869	1,974	41
2014	4	30	590	897	1,954	34
2015	8	30	670	963	2,006	25
2016	3	31	704	1,025	2,064	20
2017	4	33	752	1,088	2,133	27
Number of household with balanced panel	6,039	5,940	4,937	4,602	3,076	5,938

Note 1) y1 = current income
y2 = current income – private transfer income
y3 = labor income + business income + property income
y4 = labor income + business income
y5 = labor income
y6 = disposable income
2) The lowest row in the table is the number of households with positive income for 6 consecutive years

The simple descriptive statistics for various measures of income are reported in [Table A1-2]. By definition, current income is the highest, and labor income only is the smallest. It is easy to guess that

public and private transfer income is relatively small compared to labor and business income. There is negative disposable income, since some (in our sample, 172 households) households' non-consumption expenditures were larger than their current income.

[Table A1-2] Descriptive statistics of income

(unit: 10 Korean won)

		Mean	S.D.	Min	Max	Obs.
y1	Overall	4,562	4,333	0	102,400	N = 36,384
	Between		3,946	175	68,671	n = 6,064
	Within		1,789	0	51,068	T = 6
y2	Overall	4,478	4,376	0	102,400	N = 36,384
	Between		3,991	0	68,671	n = 6,064
	Within		1,793	0	50,985	T = 6
y3	Overall	4,191	4,443	0	102,400	N = 36,384
	Between		4,060	0	68,171	n = 6,064
	Within		1,804	0	48,925	T = 6
y4	Overall	3,964	4,203	0	102,400	N = 36,384
	Between		3,835	0	68,051	n = 6,064
	Within		1,721	0	48,730	T = 6
y5	Overall	2,800	3,496	0	73,900	N = 36,384
	Between		3,263	0	62,066	n = 6,064
	Within		1,254	0	27,467	T = 6
y6	Overall	3,753	3,523	-18,980	85,388	N = 36,384
	Between		3,122	-693	55,828	n = 6,064
	Within		1,633	-41,198	47,124	T = 6

A2. Sample selection bias and coefficient of ΔSD_i

[Table A2−1] Regression with varying leverage ratio threshold

	Baseline (total)		$LTV_i^N > 0.6$		$LTV_i^B > 0.6$	
	Coef.	Obs.	Coef.	Obs.	Coef.	Obs.
Total	−0.034**	6,064	−0.118	219	−0.082	535
$LR_i > 0.1$	−0.069***	2,587	−0.122	208	−0.107	495
$LR_i > 0.2$	−0.077**	1,887	−0.115	197	−0.081	467
$LR_i > 0.3$	−0.104**	1,321	−0.122	184	−0.083	415
$LR_i > 0.4$	−0.128**	894	−0.182*	160	−0.112	339
$LR_i > 0.5$	−0.174**	594	−0.187	130	−0.117	249
$LR_i > 0.6$	−0.207*	372	−0.209	83	−0.162	149
$LR_i > 0.7$	−0.286*	253	−0.263	54	−0.349	90
$LR_i > 0.8$	−0.322*	190	−0.348	32	−0.545	58
$LR_i > 0.9$	−0.338	156	−0.511	20	−0.867	35
$LR_i > 1.0$	−0.367	125	−0.938	11	−1.060	24

	$NW_i < 5000$		$HDRI_i > 100$		$r_i^L > 1.5 \times r^{Bank}$	
	Coef.	Obs.	Coef.	Obs.	Coef.	Obs.
Total	−0.085	1405	−0.252 **	257	−0.108***	888
$LR_i > 0.1$	−0.198*	552	−0.234**	232	−0.105**	598
$LR_i > 0.2$	−0.198*	493	−0.231**	221	−0.129**	426
$LR_i > 0.3$	−0.237*	423	−0.238**	211	−0.174**	307
$LR_i > 0.4$	−0.256*	377	−0.250**	200	−0.192**	222
$LR_i > 0.5$	−0.298*	315	−0.507**	165	−0.296**	162
$LR_i > 0.6$	−0.337*	253	−0.562**	143	−0.329*	115
$LR_i > 0.7$	−0.388*	207	−0.735**	121	−0.387	84
$LR_i > 0.8$	−0.410*	170	−0.725**	103	−0.473*	70
$LR_i > 0.9$	−0.675*	145	−0.775**	91	−0.500	57
$LR_i > 1.0$	−0.705	117	−0.772*	78	−0.353	49

Note: The ***, **, * denote the statistical significance at 1%, 5%, 10% level respectively.

A3. Asymmetric effects of income volatility changes

[Table A3−1] Asymmetric effects of income volatility: baseline

	$\Delta SD_i < \underline{SD}$	$\Delta SD_i < 0$	Total	$\Delta SD_i > 0$	$\Delta SD_i > \overline{SD}$
ΔSD_i	−0.035 (0.029)	−0.031 (0.021)	−0.034** (0.014)	−0.015 (0.025)	−0.022 (0.031)
Δy_i	−0.041 (0.027)	−0.028 (0.017)	−0.020* (0.011)	−0.010 (0.016)	−0.015 (0.020)
R^2	0.0017	0.0010	0.0010	0.0002	0.0004
Obs.	1,544	3,340	6,064	2,724	1,517

Note: $\underline{SD}$ and $\overline{SD}$ refer the lower and upper 25 percentile in ΔSD_i. ***, **, * mean statistical significance at 10%, 5%, 1% level respectively.

[Table A3−2] Asymmetric effects of income volatility: $\boldsymbol{LTV_i^N > 0.6}$

	$\Delta SD_i < \underline{SD}$	$\Delta SD_i < 0$	Total	$\Delta SD_i > 0$	$\Delta SD_i > \overline{SD}$
ΔSD_i	0.116 (0.254)	−0.000 (0.197)	−0.118 (0.079)	−0.136 (0.094)	−0.067 (0.084)
Δy_i	0.127 (0.154)	0.030 (0.116)	−0.018 (0.058)	−0.041 (0.061)	0.018 (0.057)
R^2	0.0154	0.0006	0.0121	0.0269	0.0522
Obs.	58	128	219	91	53

[Table A3−3] Asymmetric effects of income volatility: $\boldsymbol{LTV_i^B > 0.6}$

	$\Delta SD_i < \underline{SD}$	$\Delta SD_i < 0$	Total	$\Delta SD_i > 0$	$\Delta SD_i > \overline{SD}$
ΔSD_i	0.016 (0.109)	−0.021 (0.078)	−0.081 (0.053)	−0.054 (0.097)	−0.001 (0.130)
Δy_i	−0.002 (0.112)	−0.029 (0.073)	−0.005 (0.047)	0.031 (0.063)	0.079 (0.084)
R^2	0.0003	0.0005	0.0059	0.0063	0.0129
Obs.	144	313	535	222	126

[Table A3-4] Asymmetric effects of income volatility: $NW_i < 5000$

	$\Delta SD_i < \underline{SD}$	$\Delta SD_i < 0$	Total	$\Delta SD_i > 0$	$\Delta SD_i > \overline{SD}$
ΔSD_i	0.029 (0.145)	−0.058 (0.108)	−0.085 (0.059)	−0.048 (0.094)	−0.066 (0.116)
Δy_i	−0.097 (0.101)	−0.077 (0.072)	−0.065 (0.048)	−0.047 (0.066)	−0.071 (0.084)
R^2	0.0034	0.0016	0.0020	0.0009	0.0021
Obs.	392	749	1,405	656	367

[Table A3-5] Asymmetric effects of income volatility: HDRI > 100

	$\Delta SD_i < \underline{SD}$	$\Delta SD_i < 0$	Total	$\Delta SD_i > 0$	$\Delta SD_i > \overline{SD}$
ΔSD_i	−0.172 (0.136)	−0.222* (0.119)	−0.252** (0.111)	−0.395 (0.681)	0.265 (0.966)
Δy_i	−0.262 (0.226)	−0.371* (0.189)	−0.263* (0.148)	−0.144 (0.236)	−0.169 (0.294)
R^2	0.0212	0.0303	0.0211	0.0050	0.0092
Obs.	82	143	257	114	66

[Table A3-6] Asymmetric effects of income volatility: $r_i^L > 1.5$

	$\Delta SD_i < \underline{SD}$	$\Delta SD_i < 0$	Total	$\Delta SD_i > 0$	$\Delta SD_i > \overline{SD}$
ΔSD_i	−0.121** (0.054)	−0.095* (0.055)	−0.108*** (0.040)	−0.069 (0.073)	−0.053 (0.082)
Δy_i	−0.126* (0.069)	−0.118** (0.059)	−0.118*** (0.042)	−0.113* (0.063)	−0.116 (0.073)
R^2	0.0249	0.0102	0.0070	0.0082	0.0126
Obs.	229	491	888	397	208

A4. Income volatility of various job industry

SFLC classifies workers' job industries into 21 groups, including "Others". Each industry's income volatility is as follows:

[Table A4-1] Income volatility of job industry

Job industry	Income volatility	Observations
Other	0.532	12
Agriculture	0.367	1,998
Lodging	0.329	780
Retail	0.282	1,674
Real estate	0.279	234
Water supply	0.277	48
Mining	0.271	6
Construction	0.262	1,344
Art	0.256	132
Transportation	0.254	1,236
Association	0.250	696
Education	0.217	840
Maintenances	0.217	228
Manufacturing	0.210	3,276
Telecommunications	0.208	342
Social welfare	0.207	420
Scientific research	0.196	606
Finance	0.190	504
Public administration	0.180	1,044
Electricity and gas supply	0.143	84
International organizations	0.079	12

Note: industries are listed in descending order with income volatility. Income volatility is derived from the logged value of income after controlling households' major socioeconomic variables, such as age and number of family members.

A5. An example of the SFLC dataset's structural break

Since the 2018 survey, Statistics Korea began to use other administrative records from National Tax Office and Ministry of Health and Welfare to enhance the accuracy of the SFLC survey data. Although they began to modify the raw survey data with other administrative records, they retroactively modified the 2017 survey. According to the officer in charge of the SFLC in Statistics Korea, the authority has no plan to retroactively modify old surveys further. The exact variables of modification were household income, non-consumption expenditures, financial debts and assets, so on.

Here, we show an example of a household, having a structural break in 2017 with the old version of the survey and the new version. There are many households that stayed for the entire survey period. For simplicity, we show a household with household identification number "877200341". Their current income in the 2017 old version was 14,341 10k Korean won. However, after the modification, it changed to 17,893 10k won. Other related variables also had major changes in 2017. Thus, directly appending 2018 survey data to old 2012-2017 data would not be appropriate.

[Table A5-1] An example of the structural break of SFLC in 2017

(unit: 10k Korean won)

Year	Current income	Labor income	Disposable income
2012 (old)	10,080	9,800	7,712
2013 (old)	10,500	10,500	7,315
2014 (old)	11,000	11,000	8,045
2015 (old)	11,850	11,600	8,877
2016 (old)	15,569	15,300	12,115
2017 (old)	14,341	13,700	11,965
2017 (new)	17,893	17,355	15,043
2018 (new)	19,715	18,677	16,780

Note: The old version of the 2017 SFLC data were retrieved in Autumn, 2018. It is now not possible to access the old version of 2017 survey data publically. Statistics Office currently only provides the old version of 2012-2016 data and the new version of 2017 and 2018 data.

A6. Consumption equation estimation

[Table A6−1] Estimation results with narrow LTV > 0.6

Dep. Variable: Consumption	LTV > 0.6	(A)	(B)	(C)
Income	0.198*** 0.047)	0.162 (0.152)	0.187*** (0.062)	0.205*** (0.050)
Interest rate	−1.501** (0.645)	−1.483** (0.646)	−1.924** (0.764)	−1.636** (0.718)
Family size	0.053 (0.071)	0.055 (0.072)	0.101 (0.086)	0.073 (0.079)
House price	−0.032*** (0.011)	−0.032*** (0.011)	0.020 (0.051)	−0.040** (0.016)
Debt level	0.026** (0.010)	0.026** (0.010)	0.037** (0.016)	0.085 (0.083)
Income × I_{VOL_INC}		0.112 (0.445)		
House price × I_{VOL_INC}			−0.303 (0.288)	
Debt × I_{VOL_INC}				−0.188 (0.248)
Observations	522	522	522	522

[Table A6−2] Estimation results with broad LTV > 0.6

Dep. Variable: Consumption	LTV > 0.6	(A)	(B)	(C)
Income	0.107* (0.059)	0.767*** (0.218)	0.089* (0.049)	0.102* (0.061)
Interest rate	−0.363 (0.482)	−0.247 (0.631)	−0.718 (0.724)	−0.479 (0.583)
Family size	0.105** (0.045)	0.088* (0.050)	0.099** (0.046)	0.102** (0.047)
House price	−0.015 (0.010)	−0.020* (0.011)	0.057 (0.075)	−0.022 (0.021)
Debt level	0.031*** (0.010)	0.019* (0.011)	0.037** (0.016)	0.065 (0.103)
Income × I_{VOL_INC}		−1.231*** (0.428)		
House price × I_{VOL_INC}			−0.411 (0.437)	
Debt × I_{VOL_INC}				−0.118 (0.343)
Observations	1,094	1,094	1,094	1,094

[Table A6-3] Estimation results with net wealth < 50,000,000

Dep. Variable: Consumption	NW < 50,000,000	(A)	(B)	(C)
Income	0.270***	0.322***	0.279***	0.253***
	(0.078)	(0.114)	(0.081)	(0.082)
Interest rate	0.002	-0.013	0.006	-0.089
	(0.269)	(0.271)	(0.273)	(0.297)
Family size	0.124***	0.124***	0.134***	0.141***
	(0.030)	(0.026)	(0.034)	(0.033)
House price	-0.032***	-0.029***	0.030	-0.043***
	(0.008)	(0.009)	(0.084)	(0.012)
Debt level	0.018**	0.018**	0.015	0.166**
	(0.008)	(0.008)	(0.009)	(0.083)
Income $\times I_{VOL\_INC}$		-0.142		
		(0.232)		
House price $\times I_{VOL\_INC}$			-0.239	
			(0.311)	
Debt $\times I_{VOL\_INC}$				-0.549*
				(0.310)
Observations	2,721	2,721	2,721	2,721

[Table A6-4] Estimation results with HDRI > 100

Dep. Variable: Consumption	HDRI > 100	(A)	(B)	(C)
Income	0.071***	0.167***	0.072***	0.082***
	(0.022)	(0.063)	(0.025)	(0.015)
Interest rate	-0.337	0.020	-0.357	-0.698
	(0.635)	(0.661)	(0.766)	(0.635)
Family size	0.147***	0.135***	0.147***	0.125***
	(0.035)	(0.037)	(0.035)	(0.028)
House price	-0.013	-0.015	-0.014	-0.011
	(0.019)	(0.018)	(0.105)	(0.022)
Debt level	0.038*	0.024	0.036*	-0.106**
	(0.020)	(0.023)	(0.020)	(0.054)
Income $\times I_{VOL\_INC}$		-0.286**		
		(0.120)		
House price $\times I_{VOL\_INC}$			0.000	
			(0.257)	
Debt $\times I_{VOL\_INC}$				0.423***
				(0.151)
Observations	587	587	587	587

[Table A6-5] Estimation results with high borrowing rates

Dep. Variable: Consumption	$r_i^L > 1.5 \times r^B$	(A)	(B)	(C)
Income	0.092**	0.128	0.091**	0.091**
	(0.038)	(0.133)	(0.037)	(0.037)
Interest rate	-0.274	-0.320	-0.314	-0.284
	(0.377)	(0.407)	(0.394)	(0.390)
Family size	0.150***	0.147***	0.145	0.150***
	(0.029)	(0.031)	(0.031)	(0.033)
House price	0.006	0.006	0.041	0.006
	(0.012)	(0.012)	(0.094)	(0.016)
Debt level	0.000	0.000	0.001	0.012
	(0.009)	(0.009)	(0.009)	(0.096)
Income $\times I_{VOL\_INC}$		-0.081		
		(0.275)		
House price $\times I_{VOL\_INC}$			-0.108	
			(0.298)	
Debt $\times I_{VOL\_INC}$				-0.035
				(0.370)
Observations	1,650	1,650	1,650	1,650

[Table A6-6] Estimation results with high borrowing rates

Dep. Variable: Consumption	$r_i^L > 2.0 \times r^B$	(A)	(B)	(C)
Income	0.055	0.045	0.058*	0.055
	(0.034)	(0.127)	(0.030)	(0.033)
Interest rate	-0.338	-0.318	-0.556	-0.344
	(0.539)	(0.560)	(0.587)	(0.543)
Family size	0.152***	0.153***	0.141***	0.154***
	(0.037)	(0.039)	(0.041)	(0.038)
House price	0.027	0.027	0.206	0.031
	(0.020)	(0.020)	(0.126)	(0.029)
Debt level	0.001	0.001	0.009	0.007
	(0.011)	(0.011)	(0.015)	(0.049)
Income $\times I_{VOL\_INC}$		0.021		
		(0.248)		
House price $\times I_{VOL\_INC}$			-0.564	
			(0.400)	
Debt $\times I_{VOL\_INC}$				-0.029
				(0.260)
Observations	871	871	871	871

[Table A6-7] Estimation results with young age

Dep. Variable: Consumption	Age ≤ 40	(A)	(B)	(C)
Income	0.171**	0.842***	0.164***	0.173**
	(0.069)	(0.188)	(0.061)	(0.075)
Interest rate	0.065	-0.476	0.318	-0.084
	(0.313)	(0.346)	(0.368)	(0.403)
Family size	0.131***	0.064**	0.143***	0.129***
	(0.033)	(0.031)	(0.038)	(0.030)
House price	-0.000	-0.001	-0.067	0.000
	(0.976)	(0.006)	(0.062)	(0.007)
Debt level	0.014*	0.000	0.014*	0.040
	(0.008)	(0.007)	(0.008)	(0.037)
Income × I_{VOL_INC}		-1.012***		
		(0.279)		
House price × I_{VOL_INC}			0.255	
			(0.249)	
Debt × I_{VOL_INC}				-0.100
				(0.134)
Observations	1,879	1,879	1,879	1,879

[Table A6-8] Estimation results with old age

Dep. Variable: Consumption	Age > 55	(A)	(B)	(C)
Income	0.144***	0.169	0.109***	0.123***
	(0.031)	(0.134)	(0.041)	(0.042)
Interest rate	-0.083	-0.097	-0.036	-0.030
	(0.235)	(0.242)	(0.248)	(0.250)
Family size	0.144***	0.144***	0.140***	0.149***
	(0.019)	(0.019)	(0.020)	(0.020)
House price	-0.014*	-0.014	-0.142	-0.008
	(0.008)	(0.008)	(0.104)	(0.012)
Debt level	0.012**	0.012**	0.015**	-0.042
	(0.005)	(0.006)	(0.007)	(0.074)
Income × I_{VOL_INC}		-0.049		
		(0.256)		
House price × I_{VOL_INC}			0.548	
			(0.450)	
Debt × I_{VOL_INC}				0.202
				(0.272)
Observations	5,726	5,726	5,726	5,726

[Table A6-9] Estimation results with NHH = 0

Dep. Variable: Consumption	NHH = 0	(A)	(B)	(C)
Income	0.175***	0.461***	0.176***	0.175***
	(0.045)	(0.111)	(0.044)	(0.041)
Interest rate	-0.048	-0.422*	-0.061	-0.090
	(0.228)	(0.248)	(0.241)	(0.234)
Family size	0.100***	0.091***	0.101***	0.115***
	(0.021)	(0.022)	(0.023)	(0.023)
House price	-0.014***	-0.014***	-0.005	-0.020***
	(0.005)	(0.005)	(0.061)	(0.007)
Debt level	0.008	0.008	0.008	0.111***
	(0.005)	(0.005)	(0.005)	(0.036)
Income $\times I_{VOL\_INC}$		-0.486***		
		(0.155)		
House price $\times I_{VOL\_INC}$			-0.033	
			(0.238)	
Debt $\times I_{VOL\_INC}$				-0.356***
				(0.120)
Observations	4,143	4,143	4,143	4,143

[Table A6-10] Estimation results with NHH ≥ 2

Dep. Variable: Consumption	NHH ≥ 2	(A)	(B)	(C)
Income	0.096***	0.059	0.097***	0.090***
	(0.022)	(0.110)	(0.026)	(0.029)
Interest rate	-0.461*	-0.435	-0.476	-0.422
	(0.270)	(0.282)	(0.323)	(0.301)
Family size	0.123***	0.119***	0.123***	0.124***
	(0.023)	(0.026)	(0.023)	(0.024)
House price	0.085***	0.082***	0.095	0.081***
	(0.021)	(0.024)	(0.142)	(0.026)
Debt level	0.009	0.008	0.008	-0.019
	(0.006)	(0.007)	(0.007)	(0.094)
Income $\times I_{VOL\_INC}$		0.140		
		(0.419)		
House price $\times I_{VOL\_INC}$			-0.027	
			(0.417)	
Debt $\times I_{VOL\_INC}$				0.118
				(0.396)
Observations	3,389	3,389	3,389	3,389

[Table A6-11] Estimation results with STR

Dep. Variable: Consumption	Safe to risky	(A)	(B)	(C)
Income	0.170***	0.097	0.170***	0.183***
	(0.056)	(0.288)	(0.065)	(0.055)
Interest rate	-1.575**	-1.462**	-0.719	-1.739**
	(0.056)	(0.737)	(0.960)	(0.745)
Family size	0.069	0.071	0.049	0.069
	(0.045)	(0.044)	(0.075)	(0.044)
House price	0.007	0.009	-0.218	0.026
	(0.021)	(0.023)	(0.210)	(0.034)
Debt level	-0.007	-0.008	-0.024	0.040
	(0.022)	(0.023)	(0.026)	(0.090)
Income × I_{VOL_INC}		0.094		
		(0.375)		
House price × I_{VOL_INC}			0.401	
			(0.400)	
Debt × I_{VOL_INC}				-0.121
				(0.186)
Observations	508	508	508	508

[Table A6-12] Estimation results with RTS

Dep. Variable: Consumption	Risky to safe	(A)	(B)	(C)
Income	0.520***	0.661	0.418**	0.560***
	(0.138)	(0.417)	(0.183)	(0.187)
Interest rate	-0.451	-0.632	0.430	-0.490
	(0.865)	(0.917)	(1.359)	(0.969)
Family size	0.100	0.102	-0.025	0.115*
	(0.076)	(0.081)	(0.152)	(0.067)
House price	-0.009	-0.007	-0.082	-0.011
	(0.021)	(0.029)	(0.059)	(0.019)
Debt level	0.009	0.001	-0.012	-0.001
	(0.018)	(0.029)	(0.031)	(0.038)
Income × I_{VOL_INC}		-0.426		
		(1.532)		
House price × I_{VOL_INC}			0.671	
			(0.642)	
Debt × I_{VOL_INC}				0.077
				(0.270)
Observations	208	208	208	208

Abstract in Korean (국문 초록)

본 연구는 한국 가계의 미시 데이터를 이용하여 가계의 부채, 소득, 소비 간 관계를 분석하였다. 분석 데이터는 한국 통계청이 주관하여 작성하고 있는 가계금융복지조사의 2012년부터 2017년까지의 자료를 이용하였다. 본 연구는 가계의 소득 변동성 변화가 가계의 부채 조달 행태와 소비에 미치는 영향을 분석하였다는 점에서 기존 연구와 차별점을 가진다. 본 연구의 주요 분석 결과는 다음과 같다.

첫째로 우리는 소득 변동성 변화가 가계의 부채 비율(leverage ratio)에 미친 영향을 분석하였다. 소득 변동성이 확대된 가계는 그렇지 않았던 가계보다 부채 비율을 빠르게 축소한 것으로 나타났다. 보다 구체적으로 살펴보면 소득 변동성이 1 표준편차 증가한 경우 가계의 부채 비율은 1.3 ~ 1.5% 포인트 하락하였다. 소득 변동성 변화가 가계의 부채 비율에 미친 영향은 차입 제약과 가계의 연령 등 사회경제적 특성에 따라 다르게 나타났다. 예컨대 순자산이 적은 가계나 주택을 소유하지 않은 가계의 경우 소득 변동성 변화에 대해 부채 비율을 보다 민감하게 조정한 것으로 나타났다.

다음으로 우리는 가계의 소비 함수를 추정하고 소득 변동성 변화가 가계의 소비 행태에 미친 영향을 분석하였다. 평균적으로 소득 변동성의 큰 변화를 경험한 가계의 소비 탄력성은 그렇지 않은 가계보다 낮은 경향이 있었다. 이는 소득 변동성의 큰 변화를 경험한 가계는 당기의 소득 변화가 항구적 변화가 아닌 일시적 변화인 것으로 받아들인 것으로 해석할 수 있다. 한편, 소득 변동성의 변화가 소비에 미친 영향은 앞서 부채 비율의 변화에서의 결과와 유사하게 차입 제약과 가구별 특성에 따른 차이를 보였다.

이는 가계가 인적 자산과 금융/실물 순자산 리스크를 종합적으로 관리함에 따라 인적 자산 리스크 확대에 대해 부채 비율 축소를 통한 금융/실물 순자산 관련 리스크 축소로 대응한 것을 시사한다. 이러한 결과는 금융기관이 고객의 자산 포트폴리오에 대한 조언뿐만 아니라 최적 부채 비율에 대한 조언도 가능할 수 있음을 시사한다. 또한 가계의 소득 변동성 변화가 소득 효과를 통해 소비에 직접적 영향을 미치는 경로 외에도 부채 비율 축소 과정에서 부채 상환 부담이 늘어남에 따른 순처분가능소득 감소 경로를 통해서도 가계 소비에 영향을 미칠 수 있음을 시사한다.