Demand for Risky Assets under Labor Income Uncertainty: Panel Analysis

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Abstract

In proper risk aversion theory developed by Kimball(1993), investors are less willing to take one risk in the presence of another independent risk. Based on the theoretical implication, this study using Korea Household Panel Survey (KHPS) investigates the impact of independent income risk on the demand for risky assets. A Tobit model is estimated and the main findings are as follows:

Firstly, Korean households decrease the demand for risky assets when income risk is higher. They also increase the demand for risky assets as their wealth level increases. These findings are consistent with the von Neumann-Morgenstern utility function of standard risk aversion, that is, decreasing absolute risk aversion and decreasing absolute prudence. Secondly, younger households have relatively stronger preference for risky assets than older households. Thirdly, the estimation results show that households with higher portions of risky assets in their portfolios are more sensitive to income risk than those with lower portions. This implies that Korean households may change their risky asset demand in a nonlinear pattern. Finally, Korean self-employed households hold assets not only directly but through their business. As a result, the impact of income risk on the demand for risky assets is overestimated.

Whether the findings of the present paper may be broadly supported by other kinds of survey data is left for future studies.

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I. Introduction

In typical portfolio choice theory, the composition of assets depends on expected returns and asset risk. In such a theoretical rule, if investors' preferences are identical individual investors would choose identical portfolio compositions. However, investors in the real world compose their portfolios extremely differently from each other, and wealthy investors even pursue portfolio compositions different from the portfolios predicted in a simple model, as King and Leape (1998) point out. This implies that investors choose their portfolios with consideration of various factors besides expected returns and the risks of assets, and much research has been done in search of these factors. Heaton and Lucas (1997) argue that higher uncertainty about human capital weakens the preferences of investors for risky assets, while Bodie et al.(1992) say that younger investors who have comparative advantages in capabilities for hedging income risk, thanks to their flexibility in supplying labor, tend more strongly to hold risky asset than the aged. Foldes (2000) suggests that an uncertain time horizon affects the portfolio choice. Meanwhile, Rosen and Wu (2003) link health risk with portfolio choice.

These studies could be said to be analyzing whether investors' decisions on holding risky assets are affected by other background risks as well as the risks of those assets. The theory about the relationship between background risk and portfolios was first initiated by Dreze and Modigliani (1972), who show using a 2-period model that, if labor income risk cannot be perfectly hedged, optimized consumer choice and portfolio choice cannot be separated from each other. In addition, Kimball (1993), who broadens the concept of proper risk aversion made by Pratt and Zeckhauser (1987), develops a generalized theoretical model that makes possible an analysis of the interaction between background risk and other types of risks. In this model, if the utility function is standard risk averse, background risk constrains the holding of risky assets by investors.

Based upon this theoretical development, many studies have lately found evidence that labor income risk hampers the demand for risky assets. Gusio et al. (1996) prove in an analysis using a household incomes survey in Italy that labor income risk decreases the demand for risky assets. Heaton and Lucas (2000) find in an analysis for the self-employed that investors with high business risk are likely to hold lower ratios of risky assets. Meanwhile, Elmendorf and Kimball (2000) focus their attention on the risk-mitigating function of the income tax system. They prove that, assuming a utility function with characteristics by which absolute risk aversion and absolute prudence decrease, a reduction in the income tax rate would exacerbate income uncertainty, lowering the demand for risky assets.

In this study, I conduct an empirical analysis of the effects that income risk have on the portfolio compositions of households in Korea, by using the Korea Household Panel Survey (KHPS) conducted by Daewoo Research Institute. While there have been many foreign studies of background risk and portfolio choice, few sophisticated analyses have been made domestically, and the few analyses done here relied just on some working-level reports. In this regard, this study makes a critical contribution to this analysis.

Although I use a method similar to the empirical analysis conducted by Gusio et al. (1996), I have made two important improvements in this study. First is the effective control for measurement error. Almost all micro-data are exposed to serious measurement error, and in some cases effective control for measurement error even dictates the success or failure of studies. While the existing literature uses static micro-data, this study uses the averages of panel data over a 4-year period, making itself relatively immune from measurement error. I also estimate a final model using income risk estimated by instrumental variables in order to minimize the effect of measurement error that is not offset in the averaging process. By such double control for measurement error, I expect to gain consistent MLE estimates from a Tobit model.

While Gusio et al. (1996) use only income dispersion data estimated from future income forecasts stated directly by respondents, I additionally use in this paper the income variance as a proxy variable to estimate a model. Among the problems confronted in empirical analyses related to income risk, one is that there exist no perfectly agreed income risk estimates. Consumption variance is estimated from the data that materialized in the past. In contrast, directly reported data have more advantages in that they are the direct forecasts of future income. However, some respondents might have misunderstood the questions. Notably, as income risk is the concept of permanent income while surveys simply question the income prospects for the next year, income splitting estimated from the surveys could be overestimated. Likewise, each of the methods that measure income risk has its own advantages, and as a consequence it is necessary to compare the outcomes that use multiple methods of measuring income risk.

This study analyzes the likelihood of a non-linear shift in portfolio composition in response to income risk. When fixed costs account for a significant part of transaction costs, investors would refrain from responding to income risk in order to avoid high average transaction costs if their weights of risky assets in total portfolio composition are low. However, as the ratio of risky assets increases, investors could respond more sensitively to income risk. This study verifies the above through estimation of a Tobit model by varying the levels of censoring of the ratio of risky assets, and comparing the corresponding outcomes.

This empirical analysis covers the effects of demographic factors (i.e. age or gender) and other economic variables (i.e income or occupation) on portfolio composition, and the outcomes have diverse theoretical and practical implications. For instance, conventional life-cycle theory is focused on the sizes of investors' asset holdings in accordance with their ages. However, this study provides better understanding of life-time asset accumulation by economic entities, by offering critical information to fund managers in this field on shifts in portfolio composition in accordance with entities' ages. Fund managers usually recommend relatively safe funds to the elderly. If the uncertainty over labor income grows among the aged due to their retirement or healthcare costs, and they consequently, become more risk-averse, such behavior could be justified.

The outcomes of this study also have important implications in terms of macroeconomic issues. Changes in stock market returns are one macroeconomic issue. Most empirical analyses show weak correlations between total income and stock returns. However, Benzoni et al. (2005) demonstrate that this correlation gets stronger in the longer-term. Because the volatility of labor income generally increases during an economic slowdown (Storesletten et al. (2004)), if investors decrease their demand for risky assets in response to income risk, and the price of risky assets subsequently declines, this could be suggested as one explanation for the long-term correlation between labor income and return on assets.

The change in demand for risky assets related to income risk might offer some explanation for the equity premium puzzle suggested by Mehra and Prescott (1985). That is, investors confronted with income risk could have more aversion to risky assets than predicted in a typical asset price model, and if so stock returns should reach levels sufficient to compensate for asset risk. Lastly, the analytical methods in this study could be broadened to perform comparisons between countries, from which important empirical results and implications of the differences in risky asset compositions can be gained.

This paper is organized as follows. Chapter Ⅱ introduces the previous literature on labor income risk and portfolio choice, focusing largely on the characteristics of the utility function. The estimation model in this chapter includes an income risk variable and a wealth variable as explanatory variables, making possible the verification of the relationship between income risk and demand for risky assets and the characteristics of standard risk aversion of the utility function by estimating the coefficients of these variables. Chapter Ⅲ provides elementary statistics on Korean households in the KHPS and looks over the current status of their asset holdings. Chapter Ⅳ suggests the estimation results of the Tobit model, chapter Ⅴ finally summarizes the main outcomes.

II. Theoretical Discussion and Estimation Model[1)]

Kimball (1993) defines the concept of standard risk aversion by generalizing the 2-period model of Pratt and Zeckhauser (1987). That is, if a trend of risk-aversion gets stronger with the addition of independent risk, the von Neumann-Morgenstern utility function comes to have characteristics of standard risk-aversion. And if the utility function has the characteristics of an absolute risk-aversion coefficient and an absolute prudence coefficient, the necessary and sufficient conditions for standard risk aversion are satisfied.

Assume that an investor has a von Neumann-Morganstern utility function. Also postulate that the utility function is a concave function, and the marginal utility function a convex function. That is, it is assumed that this investor has decreasing absolute risk-aversion and absolute prudence coefficients. Under this assumption, the following relationships hold between the random variables with an average of zero, $\tilde{x}$ and $\tilde{y}$, and the underlying assets w:

$$u(w) \geqq E[u(w+\tilde{x})] \tag{1}$$

and

$$u'(w) \leqq E[u'(w+\tilde{y})] \tag{2}$$

Equations (1) and (2) imply that the investor is risk-averse and prudent.

Kimball (1993) shows that, if a utility function satisfies the conditions above and $\tilde{x}$ and $\tilde{y}$ are random variables independent of each other, the equations (1) and (2) become:

1) The derivation of the theoretical model in this chapter follows the proof of Kimball (1993).

$$E[u(w+\tilde{x}+\tilde{y})]-u(w+\tilde{x}) \leqq E[u(w+\tilde{y})]-u(w) \tag{3}$$

and for this case the utility function is defined as standard risk- averse. The equation (3) implies that if risk $\tilde{x}$ threatens the investor, he will be less likely to take additional risk $\tilde{y}$ independent from $\tilde{x}$ than he will be if risk $\tilde{x}$ doesn't exist.

Facing such additional risk, the behavior of the investor who is standard risk-averse provides critical insight for his choice of portfolio under the existence of labor income risk. The optimized investment condition for the investor with underlying assets w can be expressed by a marginal condition as equation (4):

$$E[\alpha^{*}\tilde{z}u'(w+\alpha^{*}\tilde{z})]=0 \tag{4}$$

where α^{*} represents the optimized portfolio and $\tilde{z}$ denotes the returns on risky assets. Now assume that equation (5) is derived by applying $\tilde{x}$, the additional labor income risk that is independent from portfolio $\alpha^{*}\tilde{z}$:

$$E[\alpha^{*}\tilde{z}u'(w+\alpha^{*}\tilde{z}+\tilde{x})] \leqq 0 \tag{5}$$

Then, as the utility function is concave, the addition of income risk leads to the decrease in the optimized investment level α^{*}. Therefore, the theoretical ground for the relationship between demand for risky assets and income risk comes down to the proof of equation (5).

As the feature of absolute prudence is that the utility function decreases, implying that marginal utility is a convex function, $xy>0$ equations (6) and (7) hold for the certain two variables x and y, with $xy>0$

$$-u''(w+y) \geqq -u''(w) \tag{6}$$

$$-u''(w+x+y) \geqq -u''(w+x) \tag{7}$$

And as a consequence of (6) and (7), equation (8) is derived:

$$-u''(w+x+y)-(-u''(w+y)) \geqq -u''(w+x)-(-u''(w)) \tag{8}$$

Such a relationship also holds for the strong monotonic conversion function by the log function. That is;

$$\ln(-u''(w+x+y)) - \ln(-u''(w+y)) \geqq \ln(-u''(w+x)) - \ln(-u''(w)) \tag{9}$$

If the logarithm is eliminated here, then:

$$u''(w+x+y) \leqq \frac{u''(w+x)u''(w+y)}{u''(w)} \tag{10}$$

If we multiply both sides by α^*z, after setting $y = \alpha^*z$

$$\alpha^*zu''(w+x+\alpha^*z) \leqq \alpha^*z\frac{u''(w+\alpha^*z)}{u''(w)}u''(w+x) \tag{11}$$

If both sides are then integrated over a given interval $[0.\chi]$, we get:

$$\alpha^*z\int_0^x u''(w+\chi+\alpha^*z)d\chi \leqq \frac{u''(w+\alpha^*z)}{u''(w)}\int_0^x u''(w+\chi)d\chi \tag{12}$$

Since the integration over the second derivative of the utility function is identical with the marginal utility function, the domains of integration are identical with equations (13) and (14), respectively:

$$\int_0^x u''(w+\chi)d\chi = u'(w+x) - u'(w) \tag{13}$$

$$\int_0^x u''(w+\chi+\alpha^*z)d\chi = u'(w+x+\alpha^*z) - u'(w+\alpha^*z) \tag{14}$$

As a consequence,

$$\alpha^*z[u'(w+x+\alpha^*z) - u'(w+\alpha^*z)] \leqq \alpha^*z\frac{u''(w+\alpha^*z)}{u''(w)}[u'(w+x) - u'(w)] \tag{15}$$

Since the relationship of equation (15) also holds for all possible values of x and α^*z, if sx and α^*z are substituted for by $\tilde{x}$ and $\tilde{z}$, the mutually independent random variables, and mathematical expectation are taken of both sides, then:

$$E[\alpha^*\tilde{z}u'(w+\tilde{x}+\alpha^*z)] - E[\alpha^*\tilde{z}u'(w+\alpha^*\tilde{z})] \leqq$$

$$E\left[\alpha^*\tilde{z}\frac{u''(w+\alpha^*\tilde{z})}{u''(w)}\right][E(u'(w+\tilde{x})) - u'(w)] \leqq 0 \qquad (16)$$

The second term in the left side of equation (16) becomes zero by the equation of optimized portfolio condition (4), and the second term in the right side of equation (16) has a non-negative signs. The decrease in risk-aversion also assures the following relationship:

$$E\left[\alpha^*\tilde{z}\frac{u''(w+\alpha^*\tilde{z})}{u''(w)}\right] \leqq \left[\alpha^*\tilde{z}\frac{u'(w+\alpha^*\tilde{z})}{u'(w)}\right] = 0 \qquad (17)$$

Therefore, the whole right side of equation (16) has a negative value and proves equation (5).

Intuitively, investors are interested in the total risks that will burden them, and consequently, even when the two risks are statistically independent, the existence of one risk will discourage investors from taking the other. That is, risks free from each other are led to being in substitute relationship. Such a conclusion as to the behavior against risk applies not just to the relationship between labor income risk and demand for risky assets, but also to all independent risk. For instance, as Rosen and Wu (2003) suggest a weak (with high health risk) person is less likely to hold risky assets than a healthy (with low health risk) person.

Absolute prudence that diminishes in the process of deriving the above equation has been shown to be a necessary condition of standard risk aversion. This implies that behaviors of investors against independent risks comply with the precautionary savings motive. Kimball (1990) argues that a consumer faced with uncertainty about his/her labor income is likely to smoothen his/her consumption by increasing precautionary savings. However, the means of saving include investment in risky as well as non-risky assets, and investors choose their portfolio compositions in consideration of labor income risk, in other words income uncertainty, as well as the risk accompanied by risky asset holdings. Therefore, other conditions being equal, higher uncertainty as to labor income leads to higher risk-aversion.

The above described theory about the holding of risky assets under the existence of labor income risk can be tested by estimating a model of portfolio choice between safe and risky assets as follows (18):.

$$RR_{jt} = \beta_0 + \beta_1 E_{t-1}(YG_{jt}^2) + \beta_2 w_{jt} + \delta Z_{jt} + \epsilon_{jt} \qquad (18)$$

where j is a unit of investing entities and investment is assumed to be made based upon a household unit in model estimation. Following Gusio, et al. (1996), I use RR_{jt}, a ratio of risky assets to total financial assets, as a variable representing the demand for risky assets, that is, portfolio choice. Labor income risk is generally represented by labor income uncertainty, that is, income labor variance, which is denoted by the $E_{t-1}(YG_{jt}^2)$[2)] conditional mathematical expectation of the squared labor income variation rate and Z_{jt} represents the vector of control variables that affect the demand for risky assets.

If equation (18) is averaged across by time, the following estimation model is derived:

$$\overline{RR}_j = \beta_0 + \beta_1 \overline{YG}_j^2 + \beta_2 \overline{w}_j + \delta \overline{Z}_j + \epsilon_j \qquad (19)$$

where each variable implies sample average $\overline{X}_j = (1/T)\Sigma_{t=1}^{T} X_{jt}$. Under the existence of income risk, the theory of demand for risky assets can be verified by estimating β_1 and β_2. If the increase in income risk results in the restraint of demand for risky assets as predicted in the theory, the estimated β_1 will have a negative value. Not only that, but since standard risk aversion requires decreasing absolute risk-averse coefficients and absolute prudence coefficients as necessary conditions, β_2 should have a positive value. However, this estimated positive value can not be translated into a direct proof for the utility function of absolute risk aversion. For example, as Gusio et al. (1996) point out, even in the case where the transaction costs accompanying the holding of risky assets and the costs of information acquisition are fixed, β_2 would have a positive value. However, a positive β_2 together with a negative β_1 could be interpreted as proofs for the standard risk-aversive utility function.

2) It is more generally accepted that income risk is represented by the conditional variance of the income variation rate. However, time series data for estimating conditional variance are insufficient, since the KHPS data in the empirical analysis covers only five years. However, the conditional variance $V_{t-1}(\cdot)$ is:

$$V_{t-1}(YG_{jt}) = E_{t-1}(YG_{jt}^2) - [E_{t-1}(YG_{jt})]^2.$$

If log-income is a random walk, then $E_{t-1}(YG_{jt}) = 0$, which makes the conditional variance coincide with the mathematical expectation of the squared income variation rate.

III. Korea Household Panel Survey and Current Status of Asset Holding by Sample Households

1. Korea Household Panel Survey

I use the KHPS (Korea Household Panel Survey released by the Daewoo Research Institute in the estimation of equation (19). The KHPS was conducted annually from 1993 to 1998 and offers data on the economic activities (i.e. income, consumption and current status of asset holdings of Korean households) as well as demographic data on household members during that period. I exclude the 1998 survey, however, in order to prevent possible impacts of the Asian financial crisis. The first KHPS survey was initiated based on 4,547 households, while the subsequently surveyed ones until 1997 were all based on 2,571 only 56.3% of the initial 1993 number. In an empirical analysis of this study, I select households by applying several criteria for minimizing measurement error. First, households with no income reports are excluded, since it is highly likely that measurement error could occur for their other items. I also exclude households whose total consumption expenditures or some of whose main items of consumption expenditures[3] are zero. Lastly, households earning more than 1 billion won are also excluded, as they are considered outliers. After the process of selection for the control of measurement errors, I use 1,903 households in the final analysis, among which, the shares of households holding financial assets and risky assets are 96.3% (1,832) and 24.9% (474), respectively.

This study focuses on the determinants of financial assets. In this regard, I exclude real assets such as real estate from the range of financial assets, even though they play a role as means of investment.[4] Next I also exclude insurance, because it has the purpose of assurance rather than investment and its asset value is hard to assess. Therefore, I include only deposits, stocks and bonds in financial assets. Deposits include savings and demand deposits, and bonds are composed of government and corporate bonds.

Defining the scope of risky assets, requires more caution. There is no

3) The households that recorded 0s in their basic consumption expenditure items (foods, housing, clothes and shoes, recreation and entertainment) and those whose expenditures on food alone were zero, are excluded the from the sample.

4) Housing is notably one of the major objects of investment in Korea. However, as the KHPS information on market prices of houses held is very inaccurate, and the holding of houses is included as a type of dummy in the empirical analysis model, housing is excluded here from the scope of assets.

disagreement on the fact that stocks and corporate bonds are risky assets. Government bonds are on the contrary practically risk-free assets, from the perspective of risk of default on principal repayment. However, considering the fluctuation in their returns, government bonds could ultimately be risky assets as well. Even in the case where inflation is considered, it is hard to say that deposits that assures fixed rates are safe assets. This study follows Gusio et al. (1996) to include government bonds as well as stocks and corporate bonds in the scope of risky assets. Meanwhile, as the empirical analysis in this study uses annual data, it would be appropriate to exclude government bonds with less than 1–year maturity. The KHPS does not provide any information on the holding of government bonds by specific maturity, but this will not be a big concern as government bonds with less than 1–year maturity are not issued in Korea.[5)]

Just as other micro-data do, the KHPS also has a problem of measurement errors. Notably, financial assets, consumption expenditures and income data, the main variables in our empirical analysis could have serious measurement errors. The data related to financial assets such as deposits are relatively accurate, but it is not easy for respondents to know the accurate market values of their stocks and bonds. That is why many respondents provide the purchase prices or face values of stocks and bonds, rather than their market values. Not only that, but some respondents say they do not know the values of their holdings. For these household samples, the KHPS has them specify the amounts of their asset holdings, in a certain section of the data. Such measurement errors will have much less effect, however, as the empirical analysis in this study uses the ratio of the risky asset holdings to financial assets overall. Even in the extreme case of underestimation or overestimation by which total financial assets and risky assets are judged to be almost equal, this would never affect the ratio of risky assets.

In general, it is hard to collect the data on consumption expenditure in the process of compiling household micro-data. For collection of accurate consumption-expenditure data, the sample households should maintain their household accounts, and their consumption expenditure data should be collected for each item, based upon these accounts.[6)] However, the KHPS data would be relatively inaccurate, as it is compiled by categorizing consumption expenditure into several main items. The data could also be inconsistent as the Daewoo Research

5) Among the Monetary Stabilization Bonds issued by the Bank of Korea, some discount bonds are issued as short-term bonds. However, these bonds are in practice all owned by institutions.

6) Surveys like the City Household Survey released by Statistics Korea and the Consumer Expenditure Survey in the U.S. taken for the purpose of collecting data on consumption and expenditure, use this method.

Institute changed its survey items after KHPS initiation in 1993. Despite these problems, the measurement error is expected to ease somewhat, as the empirical analysis uses the 4–year average of the consumption-expenditure variation.

Measurement errors occur also in the income data. However, thanks to the relative accuracy of the income data, these errors are significantly offset by deriving averages just as with the consumption expenditure data. In addition, these errors seem controlled within a statistically allowable range, as I use income variation estimated by instrumental variables. The estimation methods are described in detail in Chapter Ⅳ.

Lastly, all nominal variables have been converted into real variables by the CPI.

2. Household composition, and current status of asset holdings of households in Korea

<Table 1> exhibits the sample distribution in accordance with the characteristics of the heads of the households from the KHPS. Firstly, the age distribution shows the form of a bell, with one peak at the age range between 36 and 40. At most age ranges, 90% of households have male heads, a fact which seems to stem from the definition of head of household made based on resident registration in the KHPS.

Table 1 Demographic composition of households

Age Cohort	Distribution (%)	Male[1)] (%)	Married[2)] (%)	Members (persons)	Earners (persons)
below 31	4.5	94.2	89.5	4.1	1.4
31-35	18.6	99.2	96.6	4.7	1.3
36-40	21.0	99.3	97.3	5.0	1.3
41-45	14.7	96.4	92.9	5.2	1.4
46-50	9.6	94.0	87.4	5.4	1.6
51-55	9.9	93.7	88.4	5.4	1.9
56-60	8.1	88.3	83.1	4.9	1.8
61-65	6.3	87.4	83.2	4.1	1.5
above 66	7.3	79.0	67.4	3.6	1.2
Total	100.0	94.4	90.1	4.7	1.5

Notes: 1) Head of household is male for more than 2 out of 4 sample years
2) Head of household is married for more than 2 out of 4 sample years.

Table 2 **Economic conditions of households**

(thousand won)

Age Cohort	Self-owned (%)	Total income	Total assets	Risky assets	Asset ratio to income(%)
below 31	26.7	2939.6	1519.1	504.0	51.7
31-35	41.5	3183.8	1440.6	333.9	45.2
36-40	51.5	3609.6	1643.1	386.3	45.5
41-45	66.1	3431.6	1801.3	437.5	52.5
46-50	73.8	3326.1	1514.1	154.0	45.5
51-55	77.8	3416.5	1638.2	355.5	48.0
56-60	80.5	3251.2	1222.1	53.1	37.6
61-65	82.4	2449.5	1645.9	89.7	67.2
above 65	89.1	1670.7	822.6	206.6	49.2
Total/mean	62.4	3031.0	1471.9	280.1	48.6

<Table 2> summarizes the economic conditions of sample households. First, the share of households owning their own houses is low at an early stage, when the head of household enters the labor market, then steadily increases with age to ultimately reach 89.1%. While total income becomes maximized at the ages between 36 and 40, the maximized amount of financial asset holdings appears at the ages of 41 to 45. This is interpreted as generally consistent with the income and wealth accumulation trends forecast by the lifetime income hypothesis. Meanwhile, households in Korea hold 48.6% of their total incomes in financial assets while among all age groups, the households at the ages between 41 and 45 hold the highest ratios of financial assets to incomes.

Regarding the purposes of this study, the most critical thing is the tendency toward holding of risky assets, and <Figure 1> to <Figure 4> show the descriptive statistics of the ratios of risky asset holdings by age and occupation. <Figure 1> shows that the ratio of risky assets to total financial assets remains low across the board. By age, the ratio of risky assets holdings to total assets remains 7.8% at the ages between 31 and 35, records its highest level of 8.6% between 36 and 40 and then declines sharply to 6.7% between 41 and 45. Even the share of households owning risky assets shows similar movements in line with age, with 31.5% of total households between the ages of 36 and 40 are holding after which the share declines.

<Figure 1> indicates that younger or middle-aged households are relatively more likely to own risky assets than the aged. <Figure 2> exhibits the income

Figure 1 Risky asset holding of age cohorts

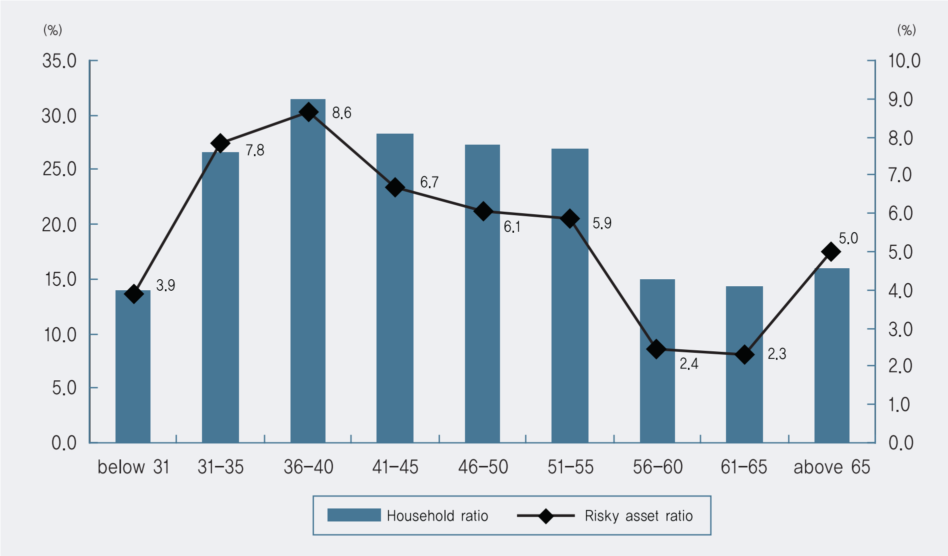
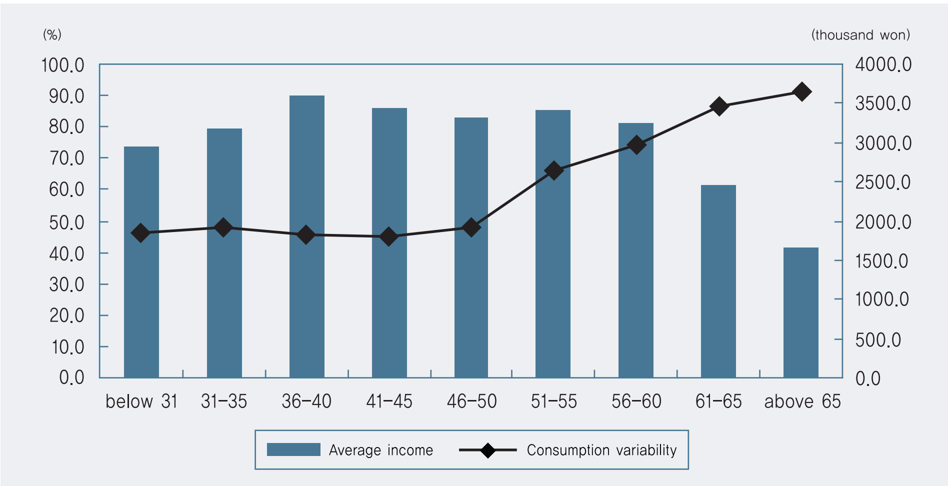


Figure 2 Average incomes and consumption of age cohorts



risk by age, represented as the variation in consumption expenditure, one way of measuring labor income risk in an empirical analysis, implying that the tendency to hold risky assets could be related to labor income risk. Although fund managers believe that labor income and the tendency toward holding risky assets have a certain correlation, that belief seems practically groundless looking at <Figure 1> and <Figure 2>. That is, average income reaches its peak at the ages between 36 and 40, but then fluctuates only slightly through the age of 56 to 60. It, therefore, seems insufficient to clarify the aversion to risky asset holding by

Figure 3 **Risky asset holding of occupational cohorts**

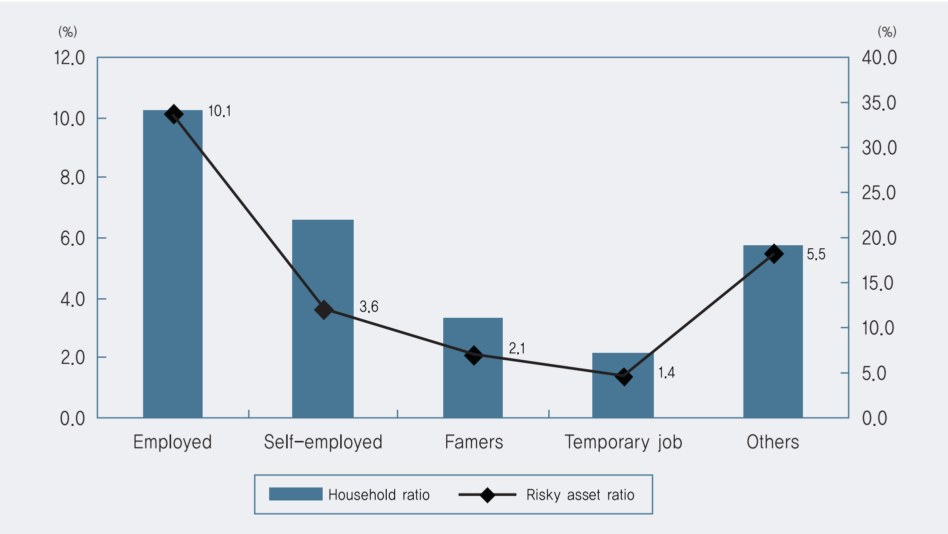
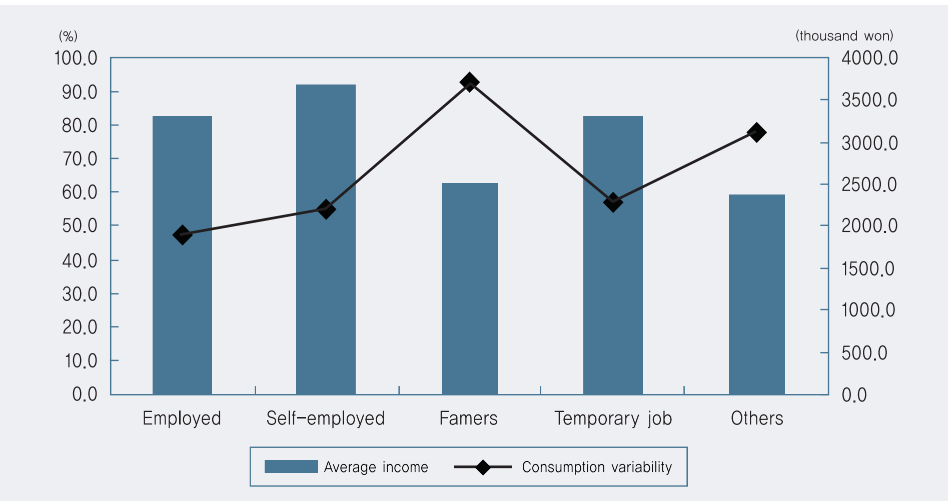


Figure 4 **Average incomes and consumption of occupational cohorts**



the aged with the income gap only. On the other hand, the variation in consumption expenditures increases drastically after the ages between 46 and 50, implying that the aversion to risky assets by the aged could be related to income risk.

The relationship between the tendency to hold risky assets and income risk can also be observed from the risky asset-holding by occupation trends in <Figure 3> and <Figure 4>, which show that salaried workers tend to hold the highest ratio of risky assets. Just as with the case of asset holdings broken down by age, the relationship between risky asset holding and income level also seems uncertain. That is, households with heads who are self-employed earn the highest incomes. However, the ratio of their risky asset-holdings accounts for less than half of the ratios of asset holdings overall and their asset compositions of the households whose heads are salary workers.

IV. Empirical Analysis

1. Measurement of Income Risk

In the estimated equation (19), income variation means the variation of permanent income. The problem, however, is that there is no agreed upon statistical method that can distinguish between permanent and temporary income. In this regard, this study strives to concentrate on the accuracy of the outcomes, using several methods to measure income risk.

The methods of measuring income risk used in the existing literature can be sub-categorized into three. The first is to use income variation estimated directly from the income data. However, as pointed out, this method cannot distinguish between temporary and permanent incomes. Moreover, the time series data from the KHPS cover five years only, making it practically impossible to distinguish exactly between the permanent and the temporary income parts. Representative studies which estimate income risk using the income data from the KHPS are Lee (1999) and Shin and Joo (2002). The former uses the original data while the latter separates the permanent income pulse and the temporary income pulse using the method suggested by Carroll and Samwick (1997). However. as both studies fail to find the income uncertainty and target wealth relationship predicted in the theory, their observed income data are unreliable as a means of measuring income risk. I therefore exclude the methods of using income data directly.

The second method of income risk measurement uses the consumption expenditure variations presented by Dynan (1993). Given that consumption changes only when permanent income varies, consumption volatility can be the most reliable estimate of income risk under the conditions that the permanent income hypothesis does not hold and that there is no constraint on liquidity. However, as mentioned earlier, the micro-data of household consumption expenditure have disadvantages in being exposed to appreciable measurement errors. When such error occurs, it is impossible to gain estimates consistent with those from a conventional estimation method, as $\overline{YG}_j^2$ and residual ϵ_j become correlated in the estimated model (19). In order to overcome this problem in the empirical analysis, I estimate the consumption and expenditure variation using instrumental variables.

Consumption expenditure is defined as total consumption expenditure on non-durable-goods and services, but I exclude educational and medical expenses as they are barely related to income uncertainty.[7] And Consumption of durable goods is also excluded, as it goes against the time separability of the utility function.[8]

The methods described above are not free from the criticism that they estimate the income risk from already materialized data, and consequently some studies estimate income risk from the future income data which consumers predict by themselves. Among foreign studies, Guiso et al. (1992, 1996) and Kennickell and Lusardi (2004) are the representative ones and domestically there are Lee (1999) and Choi (2000), which use the Consumer Sentiment Survey released by the Samsung Economic Research Institute. These studies use the distributed data on the income estimated from the forecasts which consumers reported themselves about their next year incomes or economic conditions.

In this study, I estimate income variance by the method in Lee (1999). The KHPS asks about the improvement of economic conditions compared to the previous year and the prospects for economic conditions in the following year with answers given based on a 5–interval scale. Assume that the assessment of improvement in economic conditions in year t is the income variation ΔY_t and

7) Attanasio and Weber (1995) exclude expenditures on housing service in addition to educational and medical expenses.

8) The PSID (Panel Study of Income Dynamics) benchmarked by the KHPS, collects only the data on consumption expenditure on foods, and as a consequence, studies using the PSID utilize the expenditure on foods as a surrogate variable. Such a way could be justified if the expenditure on foods is made independently from other expenditures. However, many studies offer evidence of a high correlation among consumption expenditure items. In addition, the PSID has a critical flaw in that consumption expenditure on foods accounts for an extremely negligible portion of total expenditure. I therefore use the total expenditure on non-durable goods in this study.

ΔY_t^e is the improvement in economic couditions of year t forecast in year $t-1$. Then the gap between real income variation and forecast income variation, that is, prediction error E_t^Y, is defined as follows:

$$E_t^Y = \Delta Y_t^e - \Delta Y_t \tag{21}$$

From (21), income variance is then calculated as follows:

$$V_Y = \frac{1}{4}\sum_{t=94}^{97}(E_t^Y - \overline{E_t^Y})^2 \tag{22}$$

$$\text{with } \overline{E_t^Y} = \frac{1}{4}\sum_{t=94}^{97}E_t^Y$$

However, it is hard to say that respondents forecast their next years' incomes based upon their current permanent incomes, and as a result, the variance could be over-evaluated due to changes in temporary income. And as the survey comprises a 5–level interval scale, significant error could occur. In order to control for these errors, I estimate income risk by once again conducting regression analysis of income variance for the instrumental variables.

2. Outcomes from Tobit Model Estimation

The demand for risky assets is determined based upon two stages: decision-making on whether to hold risky assets and the decision-making on asset distribution between risky and non-risky assets, that is, portfolio composition. When households make these two-step decisions, not all hold risky assets while not all own non-risky assets. This causes a sample selection bias, and it is therefore impossible to gain consistent estimates using the conventional least squares method. To resolve this problem, I estimate a Tobit model using MLE (Maximum Likelihood Estimation) in the empirical analysis. The Log Maximum Likelihood function is defined as follows:

$$\begin{aligned}\ln L = &- \sum_{RR_j>0}\frac{1}{2}\left[\ln(2\pi) + \ln\sigma^2 + \frac{(\overline{RR}_j - \beta' X_j)^2}{\sigma^2}\right] \\ &+ \sum_{\overline{RR}_j=0}\ln\left[1 - \Phi\left(\frac{\beta' X_j}{\sigma}\right)\right]\end{aligned} \tag{23}$$

where X_j is the vector of the explanatory variables.

As mentioned above, I use the income risk estimated with instrumental variables in the final empirical analysis; the outcomes are presented in <Table 3>. I select instrumental variables that are immune from measurement errors and at the same time correlated with income volatility under the permanent income concept. According to the result of income risk estimation using consumption expenditure variability, R^2 was 0.041, indicating that the instrumental variables clarify only a small part of consumption expenditure variability. This result is similar to that of Dynan (1993), in which an U.S. consumer expenditure survey is used. Age and Age^2 are for reflecting the effects of changes in preference for assets depending upon the ages of the heads of the sample households, and are included as forms of quadratic polynomials in accordance with the empirical

Table 3 **Estimation of income uncertainty**

	nstrument 1		nstrument 2	
ariables	Consumption variability	ncome variance	Consumption variability	ncome variance
Constant	0.032 (0.902)	0.367 (0.183)	0.746 (0.000)	−0.074 (0.000)
Age	1.727 (0.102)	1.208 (0.284)	–	–
Age^2	−0.087 (0.404)	−0.141 (0.206)	–	–
ccupation	−0.043 (0.221)	−0.081 (0.033)	−0.080 (0.022)	−0.074 (0.046)
Earners	−0.067 (0.030)	0.083 (0.013)	−0.039 (0.192)	0.089 (0.005)
Education	−0.041 (0.015)	0.006 (0.704)	−0.083 (0.000)	0.018 (0.238)
nitial wealth	−0.019 (0.304)	−0.006 (0.750)	−0.013 (0.481)	−0.007 (0.726)
–statistics	13.671 (0.000)	2.338 (0.030)	13.619 (0.000)	2.800 (0.025)
R^2	0.041	0.007	0.028	0.006
Durbin–atson	1.886	1.889	1.880	1.885

Note: p-values are in parentheses.

analysis results. Age dummy variables are also included in the final estimated equation and for more accurate comparison of the effect by age, I present the results of the income risk estimation, in which the age dummy variables are excluded, in the second panel of table.

The estimations using the two estimation methods show similar results, with

Table 4 **Demand for risky assets (instrument 1, censored at 0)**

	Risky assets stocks corporate and government bonds		Risky assets stocks	
ariables	Consumption variability	ncome variance	Consumption variability	ncome variance
Constant	−0.662 (0.001)	−0.061 (0.755)	−0.805 (0.000)	−0.150 (0.494)
Age	1.866 (0.027)	1.670 (0.051)	2.342 (0.013)	2.115 (0.028)
Age^2	−0.085 (0.296)	−0.214 (0.014)	−0.118 (0.197)	−0.258 (0.008)
Male	−0.051 (0.500)	−0.037 (0.629)	−0.056 (0.509)	−0.047 (0.585)
Married	0.098 (0.086)	0.120 (0.038)	0.125 (0.052)	0.153 (0.020)
Divorced	−0.005 (0.965)	−0.016 (0.886)	0.027 (0.816)	0.017 (0.888)
ousehold sie	0.018 (0.075)	0.038 (0.000)	0.012 (0.259)	0.036 (0.001)
Self-owned	0.093 (0.000)	0.084 (0.001)	0.099 (0.000)	0.090 (0.001)
Average income	0.004 (0.592)	0.027 (0.000)	0.002 (0.820)	0.027 (0.000)
Total financial assets	0.010 (0.000)	0.011 (0.000)	0.011 (0.000)	0.011 (0.000)
ncome uncertainty	−1.445 (0.000)	−1.302 (0.000)	−1.590 (0.000)	−1.426 (0.000)
$\chi^2(10)$	366.31 (0.000)	341.87 (0.000)	337.87 (0.000)	313.05 (0.000)

Notes: 1) p-values are in parentheses.
2) The coefficients of age and age^2 are multiplied by 100 and 1,000, respectively, and the coefficients of average income and total financial assets are multiplied by 1,000.

the exception of only small changes in the sizes of the estimates and their levels of significance. The most obvious difference is the effect of educational level, which seems not to affect income risk in the estimated equation that uses income variance. Although R^2 was merely 0.007 the F-statistics reject the pooled null hypothesis.

<Table 4> shows the final results using income risk estimated from <Table 3>. It also includes the outcomes when only stocks are regarded as risky assets, in addition to the ones when stocks + corporate bonds + government bonds are risky assets. The results of estimation using the two methods show high similarities with each other. The estimated coefficients of financial asset holdings have positive values and are statistically significant. This outcome is interpreted to coincide with the fact that the absolute risk-aversion and absolute prudence coefficients decrease against wealth where the utility function increases. The results of model estimation demonstrate that households owning their own houses are likely to hold higher ratios of risky assets. Economic entities own their houses for the purposes of savings or investment in addition to their residence. If their houses were just for residence, there would be no theoretical grounds for house owning itself to affect the holding of risky assets. However, the empirical analysis shows that relatively large numbers of households in Korea own their houses for savings and investment purposes. In this case, the scope of wealth can be broadened to include non-current assets, to which the theory of a relationship between wealth and risky asset holdings can be applied.

The coefficients from estimating average income are positive values for all cases, as expected earlier. However, except when using income variance, they are not statistically significant. Just as implied by the descriptive analysis in Chapter Ⅱ, therefore, average income has uncertain effects on the holding of risky assets. Given that average income has a in high correlation with wealth, such a result is quite unexpected.

The effects of income uncertainty on the demand for risky assets, the top of priority of this study, are statistically significant for all cases consistent with the finding of Gusio et al. (1996). However, the absolute values of the coefficients from the estimation results are very high, and this stems from the differences in the two estimation methods. Korean investors thus appear to be sensitive to income risk in their decision-making on portfolio choice, that is, the holding of risky assets. This becomes the proof for the utility function, which has the characteristics of simultaneous decreases in absolute risk aversion and absolute prudence, as well as explaining the fact that the coefficients of all financial asset variables are estimated to have positive values. This could also be interpreted as indirect evidence that the precautionary savings motive is a critical element in Korean households' decision-making on savings.

The results of estimation using age effects coincide with the age effect, which is a concave function in all measuring methods. Notably, the coefficients from estimation using income variance are all statistically significant. <Figure 5> displays the estimation of the trends of risky asset holding by age (instrumental variable 1), in which the demand for risky assets increases with age to its maximum level at age 40, and decreases sharply after that. This is a result very similar to the trends of the ratio of risky asset holdings presented in <Figure 1>.

There are two contrasting pieces of evidence with respect to the effects of age on the holding of risky assets. Bodie et al. (1992) shows that the younger generation, which can supply its labor more flexibly, is more likely to hold risky assets. High health risk could also be one of the reasons the aged are averse to risky assets, and although the theoretical model in this study is focused on labor income risk, it can also be applied to other background risks. Rosen and Wu (2003) found evidence that unhealthy households hold relatively less risky assets, and considered this to be the cause of the tendency of the younger generation to hold risky assets.

The contrasting view is that the younger generation tend to hold less risky assets, as they could be under liquidity constraints. And King and Leape (1987) claim that the younger generations prefer less risky assets because investors only gradually attain information on financial markets during their lifetimes. Guiso et al. (1996) supports this arguments by having found evidence that investors at the age of 60 are most likely to hold risky assets. <Figure 5> presents the contradictory results that Korean households tend to own less risky assets after they enter their 40s. This is interpreted as due to the behavior of fund managers who recommend relatively low-risk portfolio compositions to the aged.

For a closer look at the effects of age on the estimation results, <Table 5> shows the results using income risk estimated by instrumental variable 2 that excludes the age dummy. Compared to the estimation results using instrumental variable 1, the absolute values of Age and Age^2 are low and statistically insignificant. In addition, the effects of income risk on the holding of risky assets are less statistically significant. These results imply that aging has conflicting impacts, in that it leads to a decrease in demand for risky assets while at the same time increasing the demand for risky assets by reducing income risk. According to the outcomes using instrumental variable 2, these conflicting effects offset each other, leading the absolute values of income and income risk effects to be downwardly concentrated in the final estimation results. For more accurate estimation of age effects, therefore, age should be included in the final estimation equation as well as the equation estimating the instrumental variables.

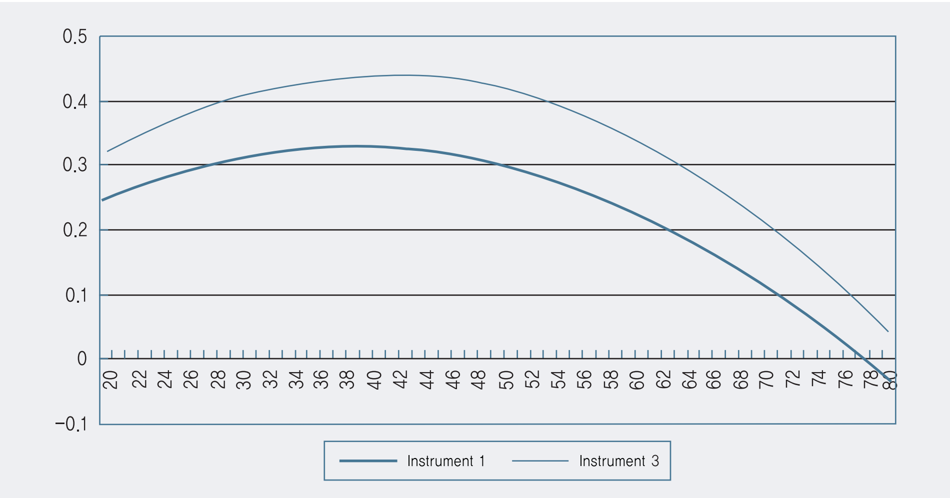
The right panel in <Table 5> shows the estimation results that include the effects of educational level. When education level is included in the equation for estimation of income risk and for final estimation, it could generate multi-collinearity just like in the case when age is included.

To prevent this problem, I exclude educational level from the estimation equation for income risk (instrument 3) and include it only in the final estimation equation.[9)]

Gusio, et al. (1996) analyzes that such educational effects comply with the strong tendency of the aged to hold risky assets. On the other hand, the educational levels of the aged are lower than those of the younger generation in Korea, and so these effects should be interpreted as consistent with the strong tendency of investors over 40 to hold risky assets. <Figure 5> includes the age effects of the estimation results using instrumental variable 3. They show movements similar with the case of instrumental variable 1, complying with such an interpretation.

The estimation model, which includes the variables controlling for household

Figure 5 **Age effects on demand for risky assets**



9) The results of estimating the equation for income risk using instrumental variable 3 shows small gaps with the cases using instrumental variable 1 from <Table 3>.

composition, shows interesting results concerning the likelihood of holding risky assets. If the head of household is married, the holding risky assets is highly likely, and households having more family members tend to increase their risky assets by a significant level of 5% to 10%. However, looking over the gender dummy variables, the households having female heads tend strongly to own

Table 5 **Demand for risky assets (instrument 2 and 3)**

	nstrument 2		nstrument 3	
ariables	Consumption variability	ncome variance	Consumption variability	ncome variance
Constant	−0.065 (0.730)	0.026 (0.907)	−1.010 (0.000)	−0.414 (0.043)
Age	−0.312 (0.689)	−0.069 (0.931)	1.423 (0.095)	1.660 (0.049)
Age^2	0.036 (0.654)	−0.026 (0.745)	−0.037 (0.646)	−0.178 (0.038)
Male	−0.062 (0.413)	−0.032 (0.681)	−0.058 (0.440)	−0.059 (0.432)
Married	0.066 (0.243)	0.129 (0.026)	0.074 (0.197)	0.055 (0.332)
Divorced	−0.024 (0.819)	−0.015 (0.889)	−0.021 (0.848)	−0.045 (0.666)
ousehold sie	0.027 (0.005)	0.034 (0.001)	0.023 (0.017)	0.043 (0.000)
Self−owned	0.085 (0.000)	0.091 (0.000)	0.088 (0.000)	0.076 (0.002)
Average income	0.003 (0.621)	0.026 (0.000)	0.002 (0.784)	0.014 (0.051)
Total financial assets	0.010 (0.000)	0.011 (0.000)	0.010 (0.000)	0.010 (0.000)
ncome uncertainty	−1.086 (0.000)	−0.892 (0.000)	−1.044 (0.000)	−1.162 (0.000)
Education	−	−	0.086 (0.000)	0.077 (0.000)
$\chi^2(10)$	393.38 (0.000)	321.99 (0.000)	384.97 (0.000)	391.64 (0.000)

Note: p-values are in parentheses.

risky assets, which seems a surprising result, but this is unreliable in that the estimates are statistically inaccurate.

The likelihood of risky asset holding as a function of occupation attracts much interest from a theoretical as well as a practical viewpoint. In the trends of holding risky assets by occupation in <Figure 2>, salaried workers are likely to hold the highest ratio of risky assets. However, there is no theoretical ground for a direct effect of occupation on decision-making as to the holding of risky assets, theory suggests only an indirect influence on the decision-making, through income risk. The coefficients of the occupation dummy variable in the estimation of instrumental variable in <Table 3> have negative values[10] with significances of 5% or 10%. This implies that the incomes of salaried workers are relatively stable and, as a consequence, the workers are more likely to hold risky assets.

Meanwhile, there could be some gaps between stock and bond transactions in terms of information acquisition or transaction costs, and if this is the case it should be easy to find differences between stock holding and income risk. The right panel in <Table 4> shows the results of estimation using only stocks as risky assets, with outcomes similar to the case using the conventional definition of risky assets. It is therefore safe to say that, in holding stocks, Korean households do not make decisions different from those that they make related to their bond holding.

3. Additional Results for Households Portfolio Choice

Regarding the change in the tendency to hold risky assets against income risk, one interesting point is that investors' responses could differ in accordance with how high their shares of risky assets among total assets are. That is, investors could respond asymmetrically to income risk in accordance with their shares of risky assets. A conventional portfolio choice theory that assumes a perfect market without any friction such as transaction costs predicts linear responses. In reality, however, transaction costs do occur, and investors could change their optimized behaviors. If these transaction costs are appreciable, and fixed costs account for a significant portion of them, then investors transacting small amounts of financial assets will restrain their risky asset transactions even if their income risk grows in order to avoid high average costs. Generally the transactors with higher shares of risky assets are more likely to engage in massive scales of transactions,

10) I impose the values of 1 on salaried workers and 0 on those in other occupations.

and consequently respond more sensitively to the same income risk.

To observe the asymmetrical risky asset holding behavior, I estimate a model in which the ratio of risky assets is censored at 20% in <Table 6>. Compared to <Table 3>, the coefficients of the income uncertainty variables are estimated to be two to three times higher in absolute value terms, indicating that households with high ratios of risky assets are relatively more sensitive to income risk. However, the effects of income level are strongly rejected, in contrast to the case in <Table 3>, implying that investors with high ratios of risky assets do not reflect income level in decision-making on their holding of risky assets.

Meanwhile, self-employed households are likely to own financial assets for their business operations as well as just for the purpose of investment. Gusio et al. (1996) point out that the returns of financial assets for investment alone and those of financial assets held for business purposes could have a positive relationship, in which case the effects of labor income risk on risky asset holding could be overestimated. <Table 7> exhibits the comparison of estimation results from the samples excluding the self-employed, with the estimated effects of income risk 1.5 to 2 times lower than for the full sample[11)], supporting the possibility stated above. The effects of average income also change, with statistically significant positive effects on the demand for risky assets. The likelihood of risky asset holding by the self-employed becomes more obvious in the case of the sample censored at 0.2, implying that households engaging in their self-employed businesses hold their financial assets for the purposes of businesses operations as well as investment.

11) The estimates exhibit high gaps relative to those of Gusio et. al.(1996), a fact which seems to stem from numbers of the self-employed in Korea compared to Italy.

Table 6 **Demand for risky assets (censored at 0.2)**

	Risky assets stocks corporate and government bonds		Risky assets stocks	
ariables	Consumption variability	ncome variance	Consumption variability	ncome variance
Constant	−1.528 (0.004)	0.183 (0.737)	−1.361 (0.011)	0.300 (0.581)
Age	3.793 (0.112)	3.389 (0.153)	2.829 (0.233)	2.706 (0.252)
Age^2	−0.128 (0.579)	−0.450 (0.061)	−0.051 (0.824)	−0.379 (0.114)
Male	−0.223 (0.317)	−0.220 (0.333)	−0.228 (0.305)	−0.228 (0.314)
Married	0.348 (0.054)	0.419 (0.028)	0.337 (0.062)	0.405 (0.034)
Divorced	0.203 (0.450)	0.164 (0.546)	0.209 (0.435)	0.176 (0.515)
ousehold sie	0.003 (0.909)	0.063 (0.024)	0.008 (0.777)	0.066 (0.018)
Self-owned	0.234 (0.001)	0.206 (0.003)	0.236 (0.001)	0.206 (0.003)
Average income	−0.016 (0.421)	0.041 (0.028)	−0.015 (0.438)	0.039 (0.038)
Total financial assets	0.0161 (0.000)	0.017 (0.000)	0.016 (0.000)	0.017 (0.000)
ncome uncertainty	−3.576 (0.000)	−3.595 (0.000)	−3.345 (0.000)	−3.546 (0.000)
$\chi^2(10)$	204.50 (0.000)	188.78 (0.000)	196.79 (0.000)	186.85 (0.000)

Note: p-values are in parentheses.

Table 7 Demand for risky assets (self-employed excluded)

ariables	Censored at 0		Censored at 0.2	
	Consumption variability	ncome variance	Consumption variability	ncome variance
Constant	−0.321 (0.161)	−0.043 (0.856)	−0.740 (0.174)	−0.237 (0.676)
Ages	0.275 (0.784)	−0.320 (0.748)	0.028 (0.990)	−1.638 (0.485)
Age^2	0.018 (0.848)	−0.031 (0.756)	0.076 (0.745)	0.035 (0.883)
Male	−0.101 (0.252)	−0.076 (0.389)	−0.294 (0.189)	−0.250 (0.264)
Married	0.108 (0.107)	0.145 (0.033)	0.369 (0.048)	0.430 (0.025)
Divorced	−0.116 (0.432)	−0.088 (0.550)	−0.058 (0.854)	−0.009 (0.978)
ousehold sie	0.016 (0.178)	0.031 (0.013)	0.012 (0.675)	0.038 (0.191)
Self−owned	0.117 (0.000)	0.108 (0.001)	0.221 (0.004)	0.208 (0.006)
Average income	0.019 (0.044)	0.041 (0.000)	0.022 (0.310)	0.059 (0.004)
Total financial assets	0.011 (0.000)	0.012 (0.000)	0.017 (0.000)	0.017 (0.000)
ncome uncertainty	−1.095 (0.000)	−0.631 (0.001)	−2.120 (0.000)	−0.962 (0.037)
$\chi^2(10)$	282.11 (0.000)	267.53 (0.000)	165.65 (0.000)	152.02 (0.000)

Note: p-values are in parentheses.

V. Conclusion

The standard risk-aversion theory suggested by Kimball (1993) shows that, even if two types of risk are statistically independent from each other, the one exacerbates the risk-aversion against the other. Based on this theoretical result, I tested whether labor income risk constrains the tendency of Korean households to hold risky assets using the data of the KHPS. For accurate results, I used the two income risk proxy variables of consumption expenditure variability, and income variance, estimated from the surveyed respondents’ forecasts. In order to control for measurement errors. I also used income risk estimated by instrumental variables in the final estimation equation. The results estimated from the Tobit model are summarized as follows:

First, the effects of income risk were statistically significant for all cases regardless of the type of income risk proxy variable. In addition, the demand for risky assets rose in accordance with the increase of wealth, which seems to be a result consistent with the characteristics of the utility function, in which absolute risk aversion and absolute prudence decrease against wealth. The empirical analysis results thus comply with standard risk aversion theory, strongly supporting this theory.

Second, the age effects form a concave function regardless of the method of measuring income risk. The results using income variance show that the generation around 40 years of age is more likely to hold risky assets than the younger generations or the elderly. Household’ demographic factors also affect the likelihood of holding risky assets. Households whose heads are married or which have more members tend to hold relatively higher ratios of risky assets than those with unmarried heads or less members. However, neither head of household gender nor divorce had effects on the holding of risky assets.

Third, the estimation results from censoring the ratio of risky assets at 0.2 show that households with high ratios of risky assets were relatively more sensitive to income risk, implying that their responses to income risk are non-linear.

Lastly, I tested the possibility that the estimation results could be distorted by self-employed households holding financial assets for business operation purposes as well as for investment, and derived results supporting this possibility. Regarding the question of whether the results in this study would be supported more broadly by other types of panel data, I would like to leave that for research in the future.

<References>

[Korean]

Kim, Si-won “Are Korean Consumers Cautious?”, Economic Analysis Vol.13 No.3, 2007, pp.157-194.

________, “Consumer Heterogeneity and Asse Price Model: Empirical Anlysis from the US. Consumer Expenditure Survey” International Economic Study , Vol.11 No.2, 2005. pp. 73-96.

Lee, Min-won, “Panel Analysis of Korean Precautionary Savings,” International Economic Studies Vol.5 No.1 1999, pp.65-89.

Shin, Kwan-ho Joo won, “The Effects of Income Uncertainty on Wealth Accumulation and Consumption,” Economic Analysis Vol.8 No.1, Bank of Korea, 2002, pp. 100-134.

Choi. Hee-kap, “Empirical Analysis of Consumption and Expenditure under Uncertainty” International Economic Studies , Vol.9 No.1, 2003, pp. 187-206.

[English]

Attanasio, Orazio P., and Gulielmo Weber, “Is Consumption Growth Consistent with Inter-termporal Optimization? Evidence from the Consumer Expenditure Survey,” *Journal of Political Economy* 103:, 1995, pp. 1121-57.

Bensoni, Lucas, Pierre Collin-Dufresne, and Robert S. Goldstein, “Portfolio Choice over the Life-Cycle in the Presence of ‘Trickle Down’ Labor Income,” NBER Working Paper 11247, 2005.

Brandt, Michael W., “Estimating Portfolio and Consumption Choice: A Conditional Euler Equation Approach,” *Journal of Finance*, 54(5), 1999, pp. 1609-1645.

Bodie, Z., R.C. Merton and W.F. Samuelson, “Labor Supply Flexibility and Portfolio Choice in a Life Cycle Model,” *Journal of Economic Dynamics and Control* 16, 1992, pp. 427-449.

Canner, N., N. G. Mankiw and D. N. Weil, “An Asset Allocation Puzzle,” *American Economic Review* 87(1), 1997, pp. 181-191.

Carroll, C. D., and A. A. Samwick, “The Nature of Precautionary Wealth,” *Journal of Monetary Economics* 40, 1997, pp. 41-71.

Constantinides, G. M. and D. Duffie, “Asset Pricing with Heterogeneous Consumers,” *Journal of Political Economy* 104(2), 1996, pp. 219-240.

Dynan, Karen E., "How Prudent Are Consumers" *Journal of Political Economy* 101(2), 1993, pp. 1104-1113.

Dreze, Jacques H. and Modigliani, Franco, "Consumption under Uncertainty," *Journal of Economic Theory* 5(3), 1972, pp. 308-335.

Eeckhoudt, Louis, Christian Gollier, and Harris Schlesinger, "Changes in Background Risk and Risk Taking Behavior," *Econometrica* 64(3), Notes and Comments, 1996, pp. 683-689.

Elmendorf, Douglas W. and Miles S. Kimball, "Taxation of Labor Income and The Demand for Risky Assets," *International Economic Review* 41(3), 2000, pp. 801-832.

Foldes, Lucien, "Valuation and Martingale Properties of Shadow Prices: An Exposition," *Journal of Economic Dynamics and Control* 24(11-12), 2000, pp. 1641-1701.

Gusio, Luigi, T. Jappelli, and D. Terlizzese, "Earnings Uncertainty and Precautionary Saving," *Journal of Monetary Economics* 30(2), 1992, pp. 307-338.

____________, "Income Risk, Borrowing Constraints, and Portfolio Choice," *American Economic Review*, vol. 86, no. 1, 1996, pp. 159-172.

Heaton, John and Deborah Lucas, "Savings Behavior and Portfolio Choice: Evidence from the Tax Data" Working Paper, Northwestern University," 1997.

____________, "Portfolio Choice and Asset Prices: The Importance of Entrepreneurial Risk," *Journal of Finance* 55(3), 2000, pp. 1163-1198.

Kennickell, Arther and A. Lusardi, "Disentangling the Importance of the Precautionary Saving Motive," NBER Working Paper 10888, 2004.

Kimball, Miles S., "Precautionary Saving in the Small and in the Large," *Econometrica*, 58, 1990(a), pp. 53-73.

____________, "Precautionary Saving and the Marginal Propensity to Consume," NBER Working Paper No. 3403, 1990(b).

____________, "Standard Risk Aversion," *Econometrica*, 61(3), pp. 589-611, 1993.

King, Mervyn A. and Jonathan I. Leape, "Wealth and Portfolio Composition: Theory and Evidence," *Journal of Public Economics* 69(2), 1998, pp. 155-193.

____________, "Asset Accumulation, Information, and the Life Cycle," NBER Working Paper 2392, 1987. *Econometrica* 55, 1987 pp. 143-154.

Rosen, Harvey S. and Stephen Wu, "Portfolio Choice and Health Status," NBER Working Paper 9453, 2003.

Storesletten, K., Telmer,AND A. Yaron, “Cyclical Dynamics in Idiosyncratic Labor-market Risk,” *Journal of Political Economy* 112, 2004, pp. 695-717.

Viceira, Luis M., “Optimal Portfolio Choice and Long-Horizon Investors with Nontradable Labor Income,” NBER Working Paper 7409, 1999.

Vissing-Jorgensen, Annette, “Toward an Explanation of Household Portfolio Choice Heterogeneity: Nonfinancial Income and Participation Cost Structures,” NBER Working Paper 8884, 2002.