Portfolio Choice with a Correlated Background Risk: Theory and Evidence*

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Abstract

We extend the static portfolio choice problem with a small background risk to the case of small partially correlated background risks. We show that respecting the theories under which risk substitution appears, except for the independence of background risk, it is perfectly rational for the individual to increase his optimal exposure to portfolio risk when risks are partially negatively correlated. Then, we test empirically the hypothesis of risk substitutability using INSEE data on French households. We find that households respond by increasing their stockholdings in response to the increase in future earnings uncertainty. This conclusion is in contradiction with results obtained in other countries.

So, in light of these results, our model provides an explanation to account for the lack of empirical consensus on cross-country tests of risk substitution theory that encompasses and criticises all of them.

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1 Introduction

There has been growing interest on the implications of incomplete markets for both theoretical and empirical questions. Especially, many puzzles in the economics and finance literatures have motivated the development and application of the theory on portfolio choice with background risk with successful results.

More precisely, the development of portfolio choice theory with incomplete markets has forced researchers to take into account the statistical properties of the uninsurable component of individuals' income risk in explaining the demand for risky assets. Because it is beyond the individual's control, this income risk has been termed 'exogenous' or 'background' risk. Considering different classes of risks, Pratt and Zeckhauser (1987) with '*properness*', Kimball (1993) with '*standardness*' and Gollier and Pratt (1996) with '*vulnerability*', establish conditions on individuals preferences for substitutability between endogenous and exogenous risks. In these contexts, an investor will reduce his demand for risky assets if the risk on his income increases.

There are very recent empirical papers which study the impact of income uncertainty and precautionary motives on the structure of households' portfolio. But these papers do not lead to the same conclusions. On Italian data, households facing uninsurable risk and future liquidity constraints will reduce their share of risky assets (Guiso *et al.*, 1996) and increase coverage against the risks that can be avoided (Guiso and Jappelli, 1998). Vissing-Jorgensen (2002) also finds evidence that background risk reduces stock market participation in the United States. Hochguertel (1998) results for the Netherlands are inconclusive and those of Alessie *et al.* (2000) for the same country did not find a significant effect of income uncertainty on the demand for risky assets. But Arrondel and Masson (1996) obtained a different result with French data: if households are more exposed to risk (proxied by occupation sectors), they invest a greater proportion of their wealth in risky assets.[1]

These inconclusive empirical results forced us to carefully look at the hypotheses under which theoretical models predicted risk substitution. Precisely, all the theoretical results were conditional on the independence between the two risks (capital and income), implying no correlation. However,

[1] Arrondel and Masson (2002) obtain a similar conclusion with data of "Patrimoine 97" Insee survey used in this paper. More precisely, households whose head works in the private sector invest *ceteris paribus* more often in risky assets than households who work in the public sector, even when they have known unemployment episodes.

recent but yet preliminary and incomplete research on this correlation shows that this hypothesis needs not be true.

In this paper we present an extension of the static portfolio model with undiversifiable income risk to take account of a non zero correlation. We identify conditions on the correlation under which the investor will rationally respond by increasing his demand for risky assets to increased income uncertainty. As well, less stringent conditions under which risk substitution may obtain can be found conditional on the correlation. So, previous models are a particular case of our hypothesis. Then, we tested the hypothesis of risk substitution using recent data concerning risky investment behaviour in France. We found that French households respond by increasing their stock holdings in response to the increase in future earnings uncertainty. This conclusion being in contradiction with findings in other countries, could be explained by spatial differences in the correlation between risks as our first part theoretical extension suggests.

The paper is organized as follows: in section 2, we provide the theoretical framework of portfolio choice under incomplete markets and present our extension of the model with a correlated background risk. We also lay down the main hypothesis to be tested. Section 3 presents salient data features and describes the measure of risk aversion and the households' subjective perception of income risk measure. The empirical analysis uses the 1997 INSEE Survey on Wealth ("Patrimoine 97") which combines data on financial assets with information on individual income risk assessments for a sample of 10,207 French households. In section 4, we examine portfolio choice to estimate the impact of changes in background risk on portfolio demands .Section 5 concludes.

2 Theory

Not enough attention has been paid to the statistical properties of background risk both at the theoretical and empirical levels, particularly to the statistical relationship between background risk and excess financial return risk. However, from an empirical point of view, there are some exceptions.[2]

Heaton and Lucas (2000) perform a cross-sectional analysis of the subjective correlation between these two risks. When non-diversifiable income risk

[2] For a list of different measures of the correlation between labor incomes and stock returns, see Haliassos (2002).

is decomposed in different categories (wage, proprietary and housing) each of them has a different statistical correlation to financial returns risk: on average, wage income and returns to housing are negatively correlated with stock returns, whereas proprietary income is positively correlated.[3]

Davis and Willen (2000) perform an empirical study of the correlation in the vein of Heaton and Lucas (2000) but using a different decomposition criterion. They identify occupation-level components of individual income innovations, motivated by the results of Cocco *et al.* (2001) who found that the correlation between labor income innovations and equity return innovations rises with education. Their main conclusions coincide with those of the previous work: cross-sectional heterogeneity helps to explain observed heterogeneity in portfolio choice and the statistical properties of income innovations with respect to financial return innovations are conditional on these heterogeneities.

Botazzi *et al.* (1996) study the correlation of fluctuations between human capital innovations and innovations on the return of assets for a cross-section of OECD countries. For instantaneous correlations, they find that wages and profits move in opposite directions for most OECD countries. However they do not find a robust sign for correlations between human and financial capital innovations.

Motivated by these results, we extend the static model of portfolio choice to include a small partially correlated background risk. We are able to show that in the case of negative correlation between the labour income shocks and the excess financial return shocks, introducing an additive background risk to the standard portfolio choice problem would increase the proportion of stocks held by households even if we allow for risk substitution on the unhedgeable component of the background risk. Intuitively, the negative correlation can be interpreted as an uncontrollable implicit liability in risky assets that individuals tend to compensate by directly modifying their portfolio risk exposure in the sense of increasing it. Thus, we allow for risk substitution on the independent component of the background risk, but the hedging effect from the correlated component can dominate the substitution effect.

[3] But the subjective measure of the correlation depends on individuals' characteristics (see Heaton and Lucas, 2000).

2.1 Portfolio Choice Models

In this section we review the standard static optimal portfolio composition approximation model for small risks and its extension to the presence of an independent small background risk. Then we review the theoretical conditions on the class of preferences or in the class of background risks considered, under which we observe substitution between risks. We extend the results of this literature to the case of a partially dependent small background risk. Finally we discuss how the sign and magnitude of the correlation conditions the theoretical predictions of the literature of risk substitution.

2.1.1 Complete Markets

Consider the problem[4] of an agent that considers how to invest his current wealth w_0 when there are only two assets available : a risky asset promising to deliver tomorrow a random return $\widetilde{r}$ and a riskless asset promising the delivery of a sure return r. The individual objective function is a continuous differentiable representation of his preferences that admit an expected utility form over final wealth w_f. Denoting by α the amount of initial wealth that is invested in the risky asset, by $\widetilde{z} \equiv \widetilde{r} - r$ the excess return of the risky asset over the riskless asset, and by $w \equiv w_0(1+r)$ the final wealth had he invested all his current wealth w_0 in the riskless asset, we can write the solution α^* to the individual optimization problem as :

$$\alpha^* \in \arg\max_{\alpha} Eu(w + \alpha\widetilde{z}) \tag{1}$$

Define as $V(\alpha^*) = Eu(w + \alpha^*\widetilde{z})$ the value function of the agent evaluated at its optimal portfolio choice. Following Gollier (2001) and under the assumptions :

(i) The excess return risk $\widetilde{z}$ is small and alternates in sign,
(ii) $u(.)$ is differentiable,
(iii) $E\widetilde{z} > 0$,
(iv) $\lim_{\alpha \to +\infty} V'(\alpha) < 0$ ([5]), and

[4] Throughout the paper we will borrow the standard notation that is used in the theory of choice under uncertainty. An excellent recent book by Gollier (2001) from which we borrow notation, surveys and clarifies old and recent developments on the theory of choice under uncertainty and its applications.

[5] Which is equivalent to requiring $\frac{\lim_{t \to -\infty} u'(t)}{\lim_{t \to +\infty} u'(t)} > \frac{\int_0 zdF(z)}{\int_0 zdF(z)}$, or alternatively that either

(v) The Taylor expansion is taken around $k = 0$ using the parametrization $\widetilde{z} = kE\widetilde{z} + \widetilde{\varepsilon} : E\widetilde{z} > 0$ and $E\widetilde{\varepsilon} = 0$,

we can approximate the solution of the standard portfolio problem in the following way :

$$0 < \alpha^* \simeq \frac{E\widetilde{z}}{\sigma_z^2 A_u(w)} < +\infty$$

So that the individual invests a positively bounded amount of his total wealth in the risky asset which is larger the larger the excess return it promises, and smaller the higher the risk aversion or the higher the variance of it.[6]

2.1.2 Incomplete Markets

In this section we present the extension of the basic portfolio choice model to the presence of an uninsurable component of individual income called 'background risk'.[7]

If we consider that the individual second period income is non-diversifiable (labor market second period income, proprietary income, or illiquid housing investments), independent of excess financial return risk and we denote it by $\widetilde{y}$ then the standard portfolio problem described above can be rewritten as :

$$\widehat{\alpha} \in \arg\max_{\alpha} Eu(w + \alpha\widetilde{z} + \widetilde{y}) \tag{2}$$

As previously we can define the value function of the agent as $W(\widehat{\alpha}) = Eu(w+\widehat{\alpha}\widetilde{z}+\widetilde{y})$ when evaluated at his optimal choice $\widehat{\alpha}$. Under the (adequately modified) assumptions that we used for the standard portfolio choice model, we can approximate for small background and endogenous risks, the solution to the previous problem as follows :

$$0 < \widehat{\alpha} \simeq -\frac{E\widetilde{z}E\{u'[w + \widetilde{y}]\}}{E\{\widetilde{\varepsilon}^2 u''[w + \widetilde{y}]\}} < +\infty$$

Which deserves some remarks :

$\lim_{t \to -\infty} u'(t) = +\infty$ or $\lim_{t \to +\infty} u'(t) = 0$ or boundedness above or below of the domain of the utility function.

[6] This optimal risky assets demand is similar to those of Arrow (1965) for a static framework and Merton (1971) for a multiperiod model under specific assumptions (additively separable utility function across periods and lognormality of asset prices).

[7] The effect of uninsurable and unavoidable earnings risk on consumption and portfolio choice was first studied by Drèze and Modigliani (1972).

(i) The denominator of this expression can be rewritten in the following way :

$$E\{\widetilde{\varepsilon}^2 u''[w+\widetilde{y}]\} = E\{\widetilde{\varepsilon}^2\}Eu''[w+\widetilde{y}] + cov[\widetilde{\varepsilon}^2, u''] : \widetilde{\varepsilon}^2 = (\widetilde{z} - E\widetilde{z})^2$$

So that $E\{\widetilde{\varepsilon}^2\} = E\left\{(\widetilde{z} - E\widetilde{z})^2\right\} = \sigma_z^2$.

Since we can show[8] that if $cov[\widetilde{\varepsilon}^2, u''] = 0$, we find an analogous expression to the approximate solution of the standard portfolio problem [1] where we will replace the index of absolute risk aversion $A_u(w)$ for the felicity function $u(.)$, by an index of absolute risk aversion $A_v(w)$ for the felicity function $v(s) = Eu(s+\widetilde{y})$, as defined by Kihlstrom *et al.* (1981)[9] :

$$\widehat{\alpha} \simeq \frac{E\widetilde{z}}{\sigma_z^2 A_v(w)}$$

So that the portfolio problem with background risk will be analogous to the standard portfolio problem except for the change in preferences. Questions on the magnitude or direction of the optimal portfolio composition change when a small background risk is introduced can be explained by differences in the absolute risk aversion parameter when the underlying utility function changes from $u(.)$ to $v(.)$.[10]

(ii) Observe that if we do not restrict the two risks to be statistically independent, it can happen that $W'(\widehat{\alpha})|_{\widehat{\alpha}=0} \geq 0$ and thus $\widehat{\alpha} \geq 0$ even if $E\widetilde{z} < 0$. This is because now :

$$sign\, W'(\widehat{\alpha})|_{\widehat{\alpha}=0} = sign\{E\widetilde{z} + \frac{cov[\widetilde{z}, u']}{Eu'}\}$$

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[8] Observe that $cov[f(\widetilde{\varepsilon}), g(\widetilde{y})] = E[f(\widetilde{\varepsilon})g(\widetilde{y})] - E[f(\widetilde{\varepsilon})]E[g(\widetilde{y})]$ where $f(s) = s^2, g(t) = u''(w+t)$. From the independence between $\widetilde{\varepsilon}$ and $\widetilde{y}$ we will have that $E[f(\widetilde{\varepsilon})g(\widetilde{y})] = E[f(\widetilde{\varepsilon})]E[g(\widetilde{y})]$ if :

(i) $f : (\mathbb{E}_\varepsilon, \Xi_\varepsilon) \to \mathbb{R}_+$ borel measurable and bounded, since $\forall \varepsilon \in \mathbb{E}_\varepsilon, f(\varepsilon) \geq 0$ and $Max\{f(\underline{\varepsilon}), f(\overline{\varepsilon})\} < +\infty$.

(ii) $g : (\mathbb{E}_y, \Xi_y) \to \mathbb{R}_-$ borel measurable and bounded. Thus considering $-g(t) = -u''(w+t) > 0, \forall t$ in a compact support bounds below the fuction $-u''(w+t)$. It is bounded above as well if we impose $\lim_{t\to+\infty} -u'(t) = 0$, which is a necessary condition to obtain an interior solution to the portfolio problem.

(iii) We assume that both $\widetilde{\varepsilon}$ and $\widetilde{y}$ are defined on the same probability space $(\Omega, A, \mathbb{P})$.

These three conditions are sufficient to guarantee the independence between (Borel measurable) real functions of independent real random variables.

[9] It must be noted that the assumptions under which this approximation is true are the same as for the standard portfolio problem, where we replace $u(.)$ by the indirect utility function $v(.)$ of Kihlstrom *et al.* (1981).

[10] It is an application of the theorem of Arrow (1965) and Pratt (1964).

Since given that $u''(.) < 0$, the $cov[\widetilde{z}, u'] > 0$ is equivalent to $cov[\widetilde{z}, \widetilde{y}] < 0$.

Meaning that if both risks are negatively correlated, it is rational for a risk averse individual to invest in the risky asset even if it generates a negative expected excess return, since the reason why he will invest in it is the partial insurance it provides against the exogenous risk. And conversely if $cov[\widetilde{z}, u'] > 0$: it can be perfectly rational for the agent not to invest in the risky asset even if it delivers a considerable positive expected excess return over the risk-free asset. The reason now is that investing in the risky asset increases considerably the global risk the individual suffers, through the positive covariance between the two risks. Not to invest is a way of reducing the global risk up to the level the individual wishes to be exposed optimally. It is obvious to say from the expression above that if $cov[\widetilde{z}, u'] = 0$, then for the individual to be rational to invest in the risky asset even in the presence of background risk, the excess return must be positive just as in the standard portfolio problem. Thus,

(iii) Replacing function $v(.)$ by function $u(.)$ in the standard portfolio problem, we obtain parallel conditions at the boundary, necessary to the existence of an interior solution for the portfolio problem with a small background risk.

Pratt and Zeckhauser (1987) were the first to capture the common wisdom intuition that individuals should react by reducing their risky investments whenever their income became riskier, and termed it '*risk substitutability*'. Risk substitutability seeks conditions on the class of background risks $\widetilde{y}$ and/or on the class of preferences $u(.)$, under which the optimal investment in risky assets when final wealth is partly non-diversifiable, $\widehat{\alpha}$, is smaller than what the agent would optimally invest were this non-diversifiable component absent, α^* :

$$\alpha^* \in \arg\max_{\alpha} Eu(w + \alpha\widetilde{z}) > \widehat{\alpha} \in \arg\max_{\alpha} Eu(w + \alpha\widetilde{z} + \widetilde{y})$$

According to our approximations of the optimal solutions in each of the two cases, we observe that it would be sufficient for $\alpha^* > \widehat{\alpha}$ to have $A_v(w) > A_u(w)$, for a small independent background risk $\widetilde{y}$. For background risks not necessarily small, given the global concavity of the problem, the condition for risk substitutability imposes a non-positive sign on the FOC of problem [2] when evaluated at the optimal solution of problem [1]:

$$W'(\alpha^*) \equiv E_{z,y}\{\widetilde{z}u'[w + \alpha^*\widetilde{z} + \widetilde{y}]\} \leq 0$$

Depending on the class of independent background risks under consideration, the different authors needed to impose different restrictions on individuals' preferences for risk substitution behaviour to be observed.

Pratt and Zeckhauser (1987) established that introducing an independent background risk in the class of *undesirable risks*[11], requires preferences to be '*proper*' in order to observe that the individual rationally reacts so as to substitute the increased exposure to the exogenous risk by reducing his exposure to the endogenous risk, i.e. decreasing his risky portfolio demand.

Kimball (1993) stated that if the felicity function of the individual satisfies the decreasing absolute risk aversion (DARA) and decreasing absolute prudence (DAP)[12] restrictions, introducing an independent *loss-aggravating background risk*[13] $\widetilde{y}$ to the standard portfolio problem (1) should decrease the individual optimal holdings of the risky asset. Preferences satisfying the DARA and DAP restrictions are termed '*standard'* by Kimball[14]. This result is also true in a multi-period portfolio choice model.[15]

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[11]A risk $\widetilde{y}$ is undesirable at initial wealth w if and only if $Eu(w+\widetilde{y}) \leq u(w)$. This can be restated in terms of the risk premium $\rho : E\widetilde{y} \leq \rho$. This set of risks are also known as expected-utility-decreasing risks. Intuitively, the agent is willing to pay more than their expected value to take a decision as if he were in a certain environment (according to a certain objective function).

[12]Kimball (1990) proposes to measure absolute prudence by the ratio $p = -u'''/u''$. Positive prudence implies precautionary saving and indicates the strength of precautionary motive: if people have decreasing prudence, precautionary saving declines as individual wealth rises. Intuitively, an individual behaves according to decreasing absolute prudence if, as he becomes richer, he is willing to pay a decreasing amount to make his optimal decision in the absence of uncertainty prevail under uncertainty.

[13]A risk $\widetilde{y}$ is loss-aggravating when starting from initial wealth w if and only if it satisfies $Eu'(w+\widetilde{y}) \geq u'(w)$. Observe that this is equivalent to $E\widetilde{y} \leq \Psi : \Psi$ is the precautionary premium as defined by Kimball (1990). The set of risks that satisfy this property for preferences $u(.)$ and initial wealth w are called expected-marginal-utility-increasing risks. In intuitive terms, they are risks that make the agent willing to pay a smaller amount than its expected value in order to keep as optimal the decision prevailing before the risk introduced. Finally observe that if preferences are DARA, every undesirable risk is loss-aggravating.

[14]Kimball (1993) introduces also the concept of *temperance* (measured by the ratio $t = -u''''/u'''$) which describes a desire to reduce total exposure to risk. Under the condition of "standardness", temperance is greater than prudence which is also greater than absolute risk aversion under DARA ($t > p > A$).

[15]Some recent theoretical papers examine the joint consumption-portfolio choice problem in the presence of background risk. Using a two-period model, Elmendorf et Kimball (2000) analyze the effect of uninsured labor income risk on the joint saving/portfolio

Finally Gollier and Pratt (1996)[16] consider the most restrictive class of independent background risks (*unfair risks*[17]) and obtain the least restrictive class of preferences under which the individual behaviour displays risk substitutability. Gollier and Pratt show that preferences must satisfy the condition of 'risk vulnerability'.[18]

Then observing that if preferences are DARA, every undesirable risk is loss-aggravating, Gollier and Pratt (1996) summarize the relationship between the preference class restrictions as:

$$\text{Standardness} \Rightarrow \text{Properness} \Rightarrow \text{Risk vulnerability} \Rightarrow \text{DARA}$$

2.2 A Correlated Small Background Risk

In this section we extend the basic portfolio problem to allow for a small partially correlated background risk, borrowing from Elmendorf and Kim-

composition decision. Under "standarness", increase in background risk reduces demand for risky securities. Increase in saving is observed at the same time under more stricter conditions on preferences (under CRRA for example).

Koo (1995), extending Merton's (1971) multi-period consumption-portfolio choice model to labor income uncertainty and liquidity constraints, shows numerically that if economic agents have constant relative risk aversion (CRRA), an increase in the variance of permanent income shocks leads to a reduction in both optimal allocation to stocks and the consumption-labor income ratio.

More recently, Viceira (1999) considers a similar multi-period model for which he derives an approximate analytical solution. He finds "that an mean-preserving increase in the variance of labor income growth reduces the investor's willingness to hold the risky asset and increases her willingness to save" (if investor's preference are described by CRRA instantaneous utility function and that labor income risk is independent of stock market risk). Moreover, he shows that consumer primarily reacts by extending precautionary saving and secondarily by reducing his risky portfolio (see also Campbell and Viceira, 2002, and Letendre and Smith, 2001).

[16] These two authors made two major contributions in this paper beyond its own original scientific contribution. First, they synthesized and clarified the relation between previous papers on restrictions on preferences that captured the intuitively appealing notion of 'risk substitutability'. Second, they generalized them in the sense of extending their results to the more intuitive class of unfair risks, evidentiating the trade-off between restricting the class of preferences and restricting the class of background risks.

[17] A risk $\widetilde{y}$ is unfair if and only if $E\widetilde{y} \leq 0$. This can be restated in terms of the risk premium $\rho : E\widetilde{y} \leq 0 \leq \rho$. Observe that undesirable risks have no *a priori* restriction on the sign of their expectation, and thus include unfair risks as a particular class.

[18] Preferences are 'risk vulnerable' if absolute risk aversion, A, is decreasing and convex. This is equivalent to $p > 2A$.

ball (2000) its stylized specification. The crucial point is that the sign and magnitude of the correlation may exacerbate or counterbalance the optimal portfolio response to the introduction of a background risk, even under the assumptions on preferences or risks that guarantee risk substitutability (except independence). Intuitively, if we suppose that there is a negative correlation between the endogenous and the exogenous risk, introducing it in the agent's program would generate an additional motive for holding the endogenous risk: insurance against the adverse realizations of the exogenous risk.

2.2.1 A Partially Correlated Small Background Risk.

We want to study the individual static portfolio decision problem when the two risks are statistically correlated. To do this we adopt the methodology of Elmendorf and Kimball (2000) to the simpler problem defined above although $\widetilde{y} = \overline{y} + \widetilde{\epsilon} + \beta\widetilde{z} = \widetilde{h} + \beta\widetilde{z}$. So that allowing for $\beta \neq 0$ we allow for a non-zero correlation between a part of the undiversifiable labour income risk $\widetilde{y} - \widetilde{h}$ and the endogenous financial excess return risk $\widetilde{z}$. The program (2) of the agent is modified accordingly, to become:

$$\widehat{\theta} \in \arg\max_{\theta} Eu[w + \theta\widetilde{z} + \widetilde{h}]$$

So that the optimal portfolio composition that satisfies the FOC which is necessary and sufficient will be:

$$\widehat{\theta} = \widehat{\alpha} + \beta$$

We are going to derive approximations of the solution for small correlations β and risks $\widetilde{z}, \widetilde{h}$ by using a first order Taylor expansion on the FOC. We will use the indirect utility function of Kihlstrom *et al.* (1981) over the independent component $\widetilde{h}$ of background risk $\widetilde{y}$ to rewrite program (2) as :

$$\widehat{\theta} \in \arg\max_{\theta} Ev[w + \theta\widetilde{z}] \tag{3}$$

So that the FOC evaluated at the optimum α^* of program (1) becomes of an indeterminate sign:

$$E_z\{\widetilde{z}v'[w + \alpha^*\widetilde{z} + \beta\widetilde{z}]\} \lesseqgtr 0$$

Proposition 1 *: If we introduce a small partially correlated background risk into the standard portfolio problem, the optimal portfolio composition response depends, under the standard assumptions for risk substitutability, on the sign and magnitude of the small correlation between risks*[19].

Proof. Consider the FOC of the agent's problem (3) and take a first order Taylor expansion on the marginal indirect utility:

$$v'[w + \alpha z + \beta z] = v'[w + \alpha z] + (\beta z)\, v''[w + \alpha z] + o(\beta z), \forall z$$

Where $o(\beta z)$ is a quantity that represents higher order terms of βz that will tend to zero faster than βz as $\beta z \to 0$. This approximation is then valid for both β and z small. We obtain the following expression after premultiplying by z both sides of the approximation, taking expectations and evaluating the FOC approximation at the optimum of the standard portfolio problem (1):

$$\begin{aligned} E_z\{\widetilde{z}v'[w + \alpha^*\widetilde{z} + \beta\widetilde{z}]\} &\approx E_z\{\widetilde{z}v'[w + \alpha^*\widetilde{z}]\} + \beta E_z\{[\widetilde{z}]^2\, v''[w + \alpha^*\widetilde{z}]\} \\ &\approx E_{z,h}\{\widetilde{z}u'[w + \alpha^*\widetilde{z} + \widetilde{h}]\} + \beta E_{z,h}\{[\widetilde{z}]^2\, u''[w + \alpha^*\widetilde{z} + \widetilde{h}]\} \end{aligned}$$

Where the approximate equality follows from substituting the indirect utility $v(.)$ by its direct utility representation $u(.)$. Then the first term on the RHS corresponds to the effect of introducing an independent background risk on the optimal portfolio composition of the standard portfolio problem under the assumption of independence between the endogenous and the exogenous risk. But now, there is a second term the sign of which depends on the sign of the correlation β :

$$\begin{aligned} \beta &< 0 \Longrightarrow E_z\{\widetilde{z}v'[w + \alpha^*\widetilde{z} + \beta\widetilde{z}]\} \lesseqgtr 0 \Longrightarrow \widehat{\theta} \lesseqgtr \alpha^* \\ \beta &\geq 0 \Longrightarrow E_z\{\widetilde{z}v'[w + \alpha^*\widetilde{z} + \beta\widetilde{z}]\} \leq 0 \Longrightarrow \widehat{\theta} \leq \alpha^* \end{aligned} \tag{4}$$

■

The importance of this proposition is to show that even if we impose conditions on preferences and on the independent component of background risks to observe risk substitution, we might not observe it if the correlation

[19] Te reader is referred to the appendix for a more intuitive and extensive interpretation of the results of this proposition. There, the effect of introducing a completely correlated risk is developed to grasp the intuition of the methodology.

with the dependent component of the background risk is negative and sufficiently large. On the contrary, if both risks are positively correlated it is possible that we observe risk substitution under less stringent conditions on preferences or the class of background risks considered. Observe also that if the correlation is null, there is no correlated component of the background risk and the standard restrictions on preferences and background risks predict when risk substitution is to be obtained. Finally observe that the proposition does not deal with a proper 'increase in risk'[20]. Instead we have adopted the more comfortable assumption of introducing an additive background risk as it is standard in this type of literature.

2.2.2 A partially Negatively Correlated Background Risk.

Since we are interested in observing conditions under which individual agents rationally react to the introduction of partially non-diversifiable income risk by tilting up the fraction of initial wealth invested in stocks, we will just consider the case of negative correlation in this section. As the approximate solution (4) shows, in the case of positive correlation risk substitution is aggravated.

Proposition 2 *: A decreasing absolute risk averse individual will tend to increase his optimal exposure to financial risks when a partially negatively correlated risk is introduced additively into his optimization program, provided the undiversifiable uncorrelated part of the exogenous risk is loss-aggravating.*

Proof. The FOC of 2 is : $E_{z,h}\{\widetilde{z}u'[w+\widehat{\theta}\widetilde{z}+\widetilde{h}]\} = 0 \Longleftrightarrow E_z\{\widetilde{z}v'[w+\widehat{\theta}\widetilde{z}]\} = 0$ by definition of the indirect utility function $v(x) = E_h u[x + \widetilde{h}]$, and by the independence between $\widetilde{z}$ and $\widetilde{h}$. The FOC of 1 is : $E_z u'[w + \alpha^* \widetilde{z}] = 0$. Subtracting both expressions : $E_z \left(\widetilde{z}\{v'[w + \widehat{\theta}\widetilde{z}] - u'[w + \alpha^* \widetilde{z}]\} \right) = 0$. If for any possible realization of the random variable z we have that $v'[w + \widehat{\theta}z] - u'[w + \alpha^* z] = 0$, the necessary and sufficient condition will be satisfied. If $\widetilde{h}$ is loss-aggravating we have that $E_h u'[w + \widetilde{h}] \geq u'[w]$ or equivalently that $v'[w] \geq u'[w]$. Thus for the sufficient condition to be true, we need that

[20] A step towards this direction has been undertaken by Eeckhoudt *et al.* (1996) which is an analysis that extends the previous literature to consider affiliated risks, a form of positive dependence.

$w+\widehat{\theta}z \geq w+\alpha^{*}z, \forall z$ or equivalently that $\widehat{\theta} \geq \alpha^{*}$. Now since $\widehat{\theta} \equiv \widehat{\alpha}+\beta : \beta < 0$ we have that $\widehat{\alpha} \equiv \widehat{\theta} - \beta > \alpha^{*}$

The intuition can be grasped in figure 1.

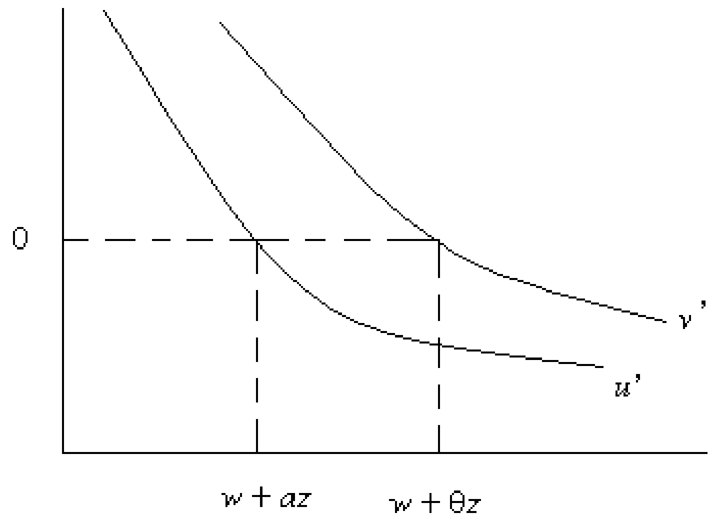

Figure 1: Intuition of the proof of Proposition 2

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The main implication of this proposition is precisely to place ourselves in the class of loss-aggravating risks to show that even if we would impose conditions for preferences to be '*standard*' in Kimball's (1993) framework, it would be possible that agents rationally increase their portfolio demands if labor income risk is partially negatively correlated to risky assets excess return.

The following proposition extends the results of the first proposition on the effects of introducing a partially negatively correlated labor income risk (background risk) to the class of loss aggravating risks in which initial wealth is random.

Proposition 3 *We can extend the previous proposition to the background risk $\widetilde{y}$ being in the class defined as :*

$$Eu'(w + \alpha^*\widetilde{z} + \widetilde{y}) \geq Eu'(w + \alpha^*\widetilde{z}) \tag{5}$$

And the conclusion now will be that $\alpha^* < \alpha^* - \beta \leq \widehat{\alpha} : \beta < 0$. Thus the optimal portfolio composition $\widehat{\alpha}$ in the presence of the partially negatively correlated background risk $\widetilde{y}$ will be higher than in the absence of any exogenous risk, and still bigger than the increase that would correspond to fully hedge the part of labor income risk that can be diversified using the financial markets.

Proof. The FOC of (2) is : $E_{z,h}\{\widetilde{z}u'[w+\widehat{\theta}\widetilde{z}+\widetilde{h}]\} = 0 \Longleftrightarrow E_z\{\widetilde{z}v'[w+\widehat{\theta}\widetilde{z}]\} = 0$ by definition of the indirect utility function $v(x) = E_h u[x + \widetilde{h}]$, and by the independence between $\widetilde{z}$ and $\widetilde{h}$. The FOC of (1) is : $E_z u'[w + \alpha^*\widetilde{z}] = 0$. Subtracting both expressions : $E_z\left(\widetilde{z}\{v'[w + \widehat{\theta}\widetilde{z}] - u'[w + \alpha^*\widetilde{z}]\}\right) = 0$. If for any possible realization of the random variable z we have that

$$v'[w + \widehat{\theta}z] - u'[w + \alpha^* z] = 0 \tag{6}$$

the necessary and sufficient condition will be satisfied. If $\widetilde{y}$ is in the class of loss-aggravating risks satisfying (5) we have that $Ev'(w+\theta^*\widetilde{z}) \geq Eu'(w+\alpha^*\widetilde{z})$ using the definition of the indirect utility function, with $\theta^* \equiv \alpha^* + \beta : \beta < 0$. A sufficient condition guaranteeing that $\widetilde{y}$ is in the class (5) is, taking the following definitions $\widetilde{\omega} \equiv w + \alpha^*\widetilde{z}, \widetilde{\varepsilon} \equiv \beta\widetilde{z}$,

$$\forall\omega, \varepsilon : v'(\omega + \varepsilon) \geq u'(\omega)$$

And particularly it must be true that :

$$\forall\omega : v'(\omega + \min\varepsilon) \geq u'(\omega)$$

Noting that we adopt the convention of sign $\min\varepsilon < 0$ so that $\widetilde{\varepsilon} \equiv \beta\widetilde{z}$ implies that if $\beta < 0$ then $\min\varepsilon \equiv \min[\beta z] = \beta[\max z] < 0$. Conversely, if $\beta > 0$ then $\min\varepsilon \equiv \min[\beta z] = \beta[\min z] < 0$ given that $\widetilde{z}$ is a random variable that

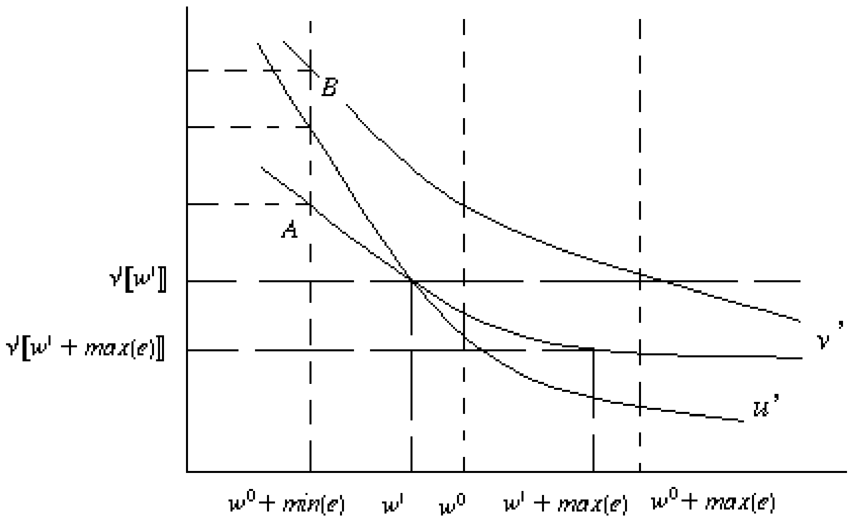

Figure 2: Intuition of the proof of Proposition 3

must alternate in sign for the portfolio problem to have a bounded solution. This observation will be used below.

As depicted in figure 2, and using the fact that $v''(.), u''(.) < 0$ by risk aversion, two situations are possible at any particular ω_0:

Situation A is not possible since if $u'(\omega_0 + \min\varepsilon) > v'(\omega_0 + \min\varepsilon) \geq u'(\omega_0)$ then there must exist a $\omega_1 < \omega_0 : v'(\omega_1) = u'(\omega_1)$ implying that $v'(\omega_1 + \max\varepsilon) < u'(\omega_1)$ by $v''(.) < 0$. A contradiction. Then only situation B is possible imposing that:

$$v'(\omega_0 + \min\varepsilon) \geq u'(\omega_0 + \min\varepsilon), \forall\omega_0, \varepsilon \tag{7}$$

Now we will use condition [6] conveniently rewritten in terms of ω, ε as follows for all possible values of z:

$$v'[w + \widehat{\alpha}z + \beta z + \alpha^* z - \alpha^* z] \equiv v'[\omega + \varepsilon + (\widehat{\alpha} - \alpha^*)z] = u'[\omega]$$

and plugging the last equality in the condition [7] :

$$v'(\omega_0 + \min\varepsilon) \geq v'\left[\omega_0 + [\min\varepsilon] + [\min\varepsilon] + (\widehat{\alpha} - \alpha^*)\frac{1}{\beta}[\min\varepsilon]\right]$$

By risk aversion, i.e. $v''(.) < 0$, the previous inequality implies that :

$$[\min\varepsilon] + (\widehat{\alpha} - \alpha^*)\frac{1}{\beta}[\min\varepsilon] = \frac{1}{\beta}[\min\varepsilon][\beta + (\widehat{\alpha} - \alpha^*)] = [\max z](\widehat{\theta} - \alpha^*) \geq 0$$

or that $\widehat{\theta} - \alpha^* \geq 0$ since $\max z > 0$ by convention. Therefore $\widehat{\alpha} \geq \alpha^* - \beta > \alpha^*$ for $\beta < 0$. ■

We have showed that respecting the theories under which risk substitution appears, except for the independence of background risk, it is perfectly rational for the individual to increase his optimal exposure to portfolio risk when risks are partially negatively correlated. This increase can temper the intuitive risk substitution effect depending on the sign and magnitude of the correlation. Furthermore, interpreting this finding from the point of view of empirical predictions on the response of optimal investment in risky assets to the introduction of an additive background risk, we can conclude that the sign of the correlation must be taken into account to predict the direction of the response. Without controlling for it, the empirical evidence cannot pretend to be conclusive on risk substitutability.

3 The Data and the Risk Variables

We mostly rely here on the "Patrimoine 97" household survey and on a specific part of the questionnaire devoted to the risk variable (either exposure or attitudes).

3.1 The "Patrimoine 97" French Household Survey

A nationally representative sample of more than 10,000 households was drawn and a comprehensive interview survey of their wealth was conducted by the INSEE. It is an abridged version of the questionnaire from the earlier survey on "Financial Assets 1992". In particular it provides:

- detailed information on the socio-economic and demographic situation of the household (education, occupational group, marital status, information concerning the children...), as well as on the biographical and professional evolutions of each spouse (youth, career, unemployment or other interruptions of professional activity) ;

- detailed data on household's income, on the amount and the composition of its wealth (including liabilities and professional assets) ;

- brief information on the inter-generational transfers received and bequeathed (financial helping out, gifts and inheritance) and more generally on the "history of its wealth".

More specifically, a part of the questionnaire tries to give us a general idea of individuals' degree of exposure and aversion to risk, as subjectively perceived and assessed by them. It consists of a recto-verso questionnaire which was distributed to the interviewees at the end of the first interview. This page submitted to the whole sample of 10,207 households must be filled in individually by the interviewee and his/her spouse (if applicable) and returned by post to INSEE. Only 4,633 individuals answered to this questionnaire (corresponding to 2,954 households).

The content is slightly different for employed persons than for unemployed or non working persons. More specifically, it asks the former to assess their short and long-term risks of unemployment, as well as the likely change in their future income over the next 5 years. In addition, a simple two-stage lottery game enables us to divide the individuals into four groups according to their degree of relative risk aversion following the methodology of Barsky *et al.* (1997).

Table 1 looks at the ownership of various forms of stocks as well as at the amounts invested in 1997. The fraction of households with direct stockholding is about 15 percent. More precisely, around 12 percent of households have listed shares, 1.4 percent have non-listed shares and 3.1 percent own employers' shares. The proportion of households with indirect stockholding -mainly through mutual funds- is around 13.5 percent. It follows that the upper bound of (direct or indirect) stockownership in France is estimated to be around 23 percent of the population. The average amount invested in (direct) stocks is about 3,800 euros (25,000 euros among direct stockholders) and households invest on average 6,700 euros in stocks or in mutual funds (29,000 euros among owners).

A descriptive analysis (Arrondel and Masson, 2002) shows that stockholding exhibits a humped-shaped pattern according to age, with a peak of 28 percent in the 50-59 age bracket and increases very sharply with the level of (financial) wealth, concerning 85 percent of the households in the top centile. Stockholders are better educated, more often self-employed or employees in the private sector. Moreover, the frequency of stockownership is higher for male-headed or two income recipient households, and also when parents themselves own(ed) stocks.

Table 2 reports descriptive statistics for the whole sample of 10,207 households and for the sample of 2,954 respondents. There are only small differences between the two samples: the respondents seem to be older and more educated; they are more often white-collar workers and single and have less children; they are a little more wealthy (+ 6.7 percent for net wealth, +8.8% for financial wealth) and earn a little more money at work (+ 2.6 percent). A Logit model which estimates the differences between the two samples confirms these descriptive effects of wealth, social status, education and household composition.

These differences in socio-economic characteristics explain why the sample of respondents own more often risky assets: the probability of owning risky assets is higher among the respondents than in the total sample (+5.5 percentage points for direct stockholding and +7 percentage points for direct or indirect stockholding). But the average proportion of financial wealth invested in risky assets is similar.[21]

[21] But, for the moment, we used the sample of respondents without taking into account this selection bias.

3.2 Measuring Relative Risk Aversion

To obtain a measure of risk aversion, we asked individuals about their willingness to gamble on lifetime income (see the appendix) according to the methodology of Barsky *et al.* (1997). The "game" resides in determining sequentially whether the interviewee would accept to give up his present income and to accept other contracts, in the form of lotteries: he has one chance in two to double his income, and one chance in two for it to be reduced by one third (contract A), by one half (contract B), and by one fifth (contract C). This allows us to obtain a range measure of relative risk aversion under the assumption that preferences are strictly risk averse and utility is of the CRRA type. The degree of relative risk aversion is less than 1 if the individual successively accepts contracts A and B ; between 1 and 2 if he accepts A but refuses B ; between 2 and 3.76 if he refuses A but accepts C ; and finally more than 3.76 if he refuses both A and C. Among the 4,633 respondents to the questionnaire, 3,483 individuals participated in the lottery.

Table 2 gives the fraction of all respondents who fall into the four risk aversion groups. The first line gives the frequencies among the whole sample of respondents. The second line displays the frequencies among fifty-year-old or more individuals. These results could be compared to those of Barsky *et al.* (1997) and those of Kapteyn and Teppa (2002) among the same age group (second and third line). As for the U.S. (76%) and the Netherlands (79.8%), most of the French respondents (85.4 percent) are in the category of high relative risk aversion (they refuse contract A). The main difference between France and the two other countries resides in the distribution between those who accept or refuse the contract C. In France, 57 percent of individuals who rejected contract A refuse contract C and 43 percent accepted this contract. However in the U.S. only 15 percent accept contract C and only 17 per cent do so in the Netherlands. Moreover, in France, only 6 percent accept contract B whereas in the U.S., as in the Netherlands, the acceptance rate is more than twice this rate (12.8 percent in US and 11.2 in Netherlands). In the U.S. and in the Netherlands there are more individuals with low relative risk aversion (inferior to 1).

How does risk aversion change with consumer's attributes? So, we have regressed the measure of relative risk aversion (by an ordered Probit model) on observable characteristics that can proxy for differences in tastes (Arrondel *et al.*, 2002). Few explanatory variables are statistically significant to explain risk aversion. You become more risk averse when you are older; a woman[22]; when your parents had financial difficulties during your youth; when parents do not hold risky assets; and when people are educated. Finally and like in Barsky *et al.* (1997), we find that risk tolerance decreases with income until the middle of the distribution, and then increases[23].

We examine also the extent to which measured risk aversion predicts risky behavior (Arrondel *et al.,* 2002): propensity to take risk in financial decisions, participation in horse-betting type of games (horses race bets, national lotteries, slot machines, casino) and choice of occupational status (self-employed). We find that the risk aversion measure predicts all these risky behaviors, even after controlling for the economic and demographic variables: less risk averse individuals are those who are more willing to take risk in financial decisions, or to participate in national lotteries. Rather, doing racetrack bets or playing with a slot machine are related to intermediate risk averse individuals. Being self-employed (non farmer) is also influenced by CRRA: individuals who choose contract A are more often self-employed than the others.

3.3 The Self-Reported Measure of Future Income Risk

To construct a proxy for the subjective variance of households' income (see the appendix), the methodology we followed is inspired in the survey carried out by the Bank of Italy, " Survey of Household Income and Wealth " (SHIW), for 1989 (Guiso *et al.*, 1992). It asks households to distribute 100 points between different scenarios regarding the evolution of income - We assume that the household income variance can be proxied by the respondent's estimated variance or, when there were two respondents in the household, by the head of the household variance evaluation[24]. So doing we obtain a measure of income uncertainty for 2,334 households. The average expected growth of future income is around 1.5%[25].

[22]This gender-specific risk behaviour is also obtained by Barsky *et al.* (1997) but not by Kaptein and Teppa (2002).

[23]The relationship between CRRA and wealth is ambiguous because the causality should be the inverse (a more prudent consumer should save more). In Arrondel (2002), estimation of wealth equations shows no relation between asset holdings and CRRA.

[24]Assume that five years ahead expected real income is $y_{t+5} = y_t(1+\bar{x})$, the formula of the expected variance of household income is $var(y_{t+5}) \equiv \sigma_y^2 = \sigma_x^2 y_t^2$, where y_t is current real income, $\bar{x}$ is the expected growth rate of real income and σ_x^2 its variance.

[25]French time series on income give a mean growth of 1.8% over the period 1990-1996.

Table 3 displays the frequency distribution of the ratio between the subjective standard deviation and current income (σ/y). Two measures of risk are calculated depending of the value hold for upper and lower bounds (respectively 35 and 50%). More than forty percent of those surveyed hold point expectations about five year ahead expected real income. For almost half of them (46 percent) the standard error is between 0 and 10 percent (resp. 40%). Only 5 percent (resp. 8 percent) display a measure of uncertainty exceeding 15 percent. For the whole sample, the mean of the standard error of income shocks is about 4.3 percent (resp. 4.9) of the level of real income. The subjective income variance reported by French households is strikingly low when compared with the value usually assumed in the literature on precautionary saving, reporting a value of the standard error of income shocks between 10 and 20 percent of the earnings' level (for example 15 percent for next year expected earnings in the U.S. as reported in Deaton (1992). In the SHIW survey on 1989 Italian data, Guiso *et al.* (1992) obtain also a very low earnings variance for next year expected income; the standard error of earnings' shocks being evaluated at 1.15 percent of current real earnings' level. These authors put forward several reasons to explain the gap between the different measures: the nature of the data (self reported measure of earnings uncertainty and standard error of earnings uncertainty obtained from panel data); the possibility that Americans face more earnings uncertainty than Italians; overestimation of the true "uncertainty" in econometric regressions or measurement error in cross section data.

A Tobit regression[26] of (σ/y) on the sample characteristics shows that less risk averse households tend to report a higher variance. This result confirms that attitude towards risk affects job choice, with more risk averse households choosing safer occupations. We show that self-employed (except farmers) anticipate a higher income risk for the next five years. In other respects, it confirms that old households report a lower variance than young households corroborating that income profiles show decreasing risk along the life cycle. Households whose head is currently unemployed anticipate a higher risk on their future income like those who had or have health problems.

[26] The results of these regressions can be obtained from the authors upon request.

4 Empirical Analysis of Portfolio Choice

In this section, we use data from survey "Patrimoine 1997" to study the impact of background risk and borrowing constraints on the demand for risky assets in France. The current analysis compares closely to that of Guiso *et al.* (1996) mainly in two respects: we assess income uncertainty from subjective information and we dispose of a similar measure of borrowing constraints.

4.1 Econometric Specifications

We posit the following relation for the share of risky assets in financial wealth:

$$\frac{A}{F} = g(\sigma^2, cl, \gamma, X) + e \tag{8}$$

where $A \geq 0$ is the demand for risky assets and F is total financial wealth. cl is the probability of being liquidity constrained in the future (see the appendix), σ^2 is the subjective earnings variance, γ is coefficient of relative risk aversion and X is a vector of variables which influence the demand for risky investments. e is an error term. In specification (8) income risk is assumed to be exogenous as in recent models of portfolio choice.

The set of explanatory variables X has been chosen according to the theoretical models. In portfolio choice models where capital markets are imperfect (transaction costs, holding costs, imperfect information) portfolios are incomplete (King and Leape, 1998). So portfolio choice depends on household's income and wealth (to finance transaction and information costs) and on the stock of financial information (proxied by age, education, parents' wealth composition). We take into account other sources of future exogenous risk, especially on family (we control only by marital status and number of children at home or away from home). Finally, we introduce the nature of (present or past) professional activity (employee vs. self-employed).

The effect of age included in X is polysemous (Arrondel and Masson, 1996). Bodie *et al.* (1992) show that the young enjoy greater labor flexibility than the old and may therefore be more likely to hold risky assets; Gollier and Zeckhauser (1997) show that young households take on relatively more portfolio risk than older households if (and only if) absolute risk tolerance is convex; King and Leape (1987) stress that financial information is acquired slowly along individual's life, a fact that can explain why the young hold a less diversified portfolio than the old: the young are more likely to be liquidity constrained and so less willing to take risk when choosing their portfolio.

A simple OLS regression of (8) leads to inconsistent estimates due to the fact that a significant proportion of households does not own risky assets. In the same way, OLS regressions of (8) on the restricted sample of investors who hold risky assets is subject to selection bias (Heckman, 1976). So, I model the demand for risky assets as a two-stage decision process (King and Leape, 1998) where the first step is a Probit model to account for the probability of ownership and the second step consists in estimating conditional demand of risky assets (by introducing the opposite of Mill's ratio in the set of regressors to correct selectivity bias). In other words, households choose first whether or not to hold risky assets, then they decide how to allocate total financial wealth between safe and risky securities. As there are only two categories of assets used in regressions, it is also possible to handle the selection bias by estimating a simple Tobit model on the share of risky assets where the lower limit is zero. However, Tobit estimation constrains to depend on the same set of variables, the determinants of whether to hold risky assets or not and if so how much.

In the two-stages procedure, we use different sets of explanatory variables to explain the discrete and the continuous choice. We assume that information costs explain essentially the decision to hold or not risky assets (Arrondel and Masson, 1990). Therefore we introduce education and the presence of risky assets in parents' wealth only in the Probit model[27]. Moreover, this hypothesis guarantees that the opposite of Mill's ratio is not co-linear with other explanatory variables of conditional demand.[28]

Tables 5 (a and b) and 6 (a and b) display results issued of the two econometric techniques. Column 1 and 2 of the tables show results of two-step estimation; column 3 displays results of Tobit estimation.

[27] Moreover, gains or loose in stock exchange investments have been introduced only in the demand equation.

[28] For more details about estimation of household portfolio models, see Miniaci and Weber (2001).

4.2 Demand for Risky Assets in France

4.2.1 Direct stockholding

Demand for risky assets, A, is firstly proxied by direct stockholding investments. Columns 1 and 2 of Table 5a report two-step estimation results (discrete and continuous choice) using this definition of risky assets. The age variables indicate that the probability of risky assets ownership is the lowest for young households and increases through the life cycle to reach a maximum at the age of 46: increases in probability of owning risky assets could be explained by information costs but the reduction in risky investments after 46 is more complex to interpret[29].

The effect of financial and total net wealth in the Probit model (and the effect of inheritance) is positive and is consistent with the presence of fixed transaction costs and a DARA utility function. An increase in the amount of financial net wealth from the 10th percentile (around 1,000 euros) to the 90th percentile (around 100,000 euros) increases the probability of being a stockholder by 17.1 percentage points, when holding the other variables in the regression constant at their means. The stock of information inherited from parents proxied by the ownership of the same assets in parents' wealth increases also the probability of risky assets ownership (see also the positive effect of the head of household's education, significant at 10%). Households whose parents owned stocks are about 10.6 percentage points more likely to hold stocks directly, again keeping the other regression variables constant at their means. Self-employed own less equities than other households. Single persons (except divorced), married couples or unmarried couples for less than 5 years invest more often in risky assets than other types of households.

The effect of individual measures of risk aversion has the expected sign in Probit but coefficients only distinguish great risk averters (CRRA$\geqq$ 3.76) from other risk averse households[30]. Households who are classified in the group of high risk averters were, *ceteris paribus,* about 6.7 percentage points less likely to hold stocks directly (relatively to the group of low risk averters). The coefficient of the proxy for liquidity constraints is negative in the Probit equation: households who anticipate to be liquidity constrained in the future

[29] Arrondel and Masson (1990) suggest that the decrease in the probability of owning risky assets could be interpreted by deferred consumption needs (a life cycle motivation): to consume their wealth during retirement, old households prefer to hold liquid investments.

[30] However, the negative relation between risk aversion and demand for risky assets is better estimated in the Tobit regression (column 3) than in the Probit regression.

invest less in risky assets. Moving a household from the 10th to the 90th percentile of probability to be deterred from applying for credit in the future decreases the probability of being a stockholder by 7.6 percentage points, keeping the all other regressors fixed at their means.

Concerning human resources, we first note a positive mean-effect of non financial income on the probability of stock market participation. Moving a household from the 10th to the 90th percentile of labor income increases the probability of being a stockholder by 9.4 percentage points, keeping the all other regressors fixed at their means.

The coefficient of the expected variance of income[31] in the Probit equation is negative and significantly different from zero: households whose future income is less risky are also those who invest less in risky assets. In other words, income risk and endogenous risk do not appear to be substitutes. Households who have no risk on their labor income were, *ceteris paribus*, about 3.6 percentage points less likely to hold stocks directly than households who are in the highest risky income decile.

There are few variables which are statistically significant in the conditional asset demand equation (column 2): large Stock Exchange gains in the past increase the amount invested in equities; entrust of financial advisors for managing portfolio increases the share of stocks in financial wealth. So, it appears that conditional demands for stocks are mainly explained by the variables which proxy price fluctuations on the capital market. We find a negative effect of income risk on conditional demands for risky assets but the coefficient is not significantly different from 0.[32]

To compare our results with Guiso *et al.* (1996) conclusions favoring the substitutability hypothesis (the coefficient of the expected variance of income is significantly negative), we run a Tobit model on the share of risky assets in financial wealth (column 3): the coefficient of income variance is always positive but it is only significant at 13% level.

Because retired people have no risk on their non financial income, we

[31] The value of subjective income variance introduced in the regressions corresponds to a upper and a lower bound of 50% for the evolution of income. However, the results obtained are qualitatively the same with other future values.

[32] These results, combined with the previous ones concerning stock market participation seem to confirm, at least in part, the model of King and Leape (1998), where transaction costs are one of the main explanatory factors of portfolio incompleteness. In this model, assets demands, conditional upon ownership, depend mainly on technical characteristics of assets and on individuals' degree of risk aversion.

perform the same regression as the previous ones but only on the sample of households with an active head (Table 5b). The non financial income volatility effect is always negative on the probability of stock participation. It is negative in the Tobit model for the share invested in stocks. Active households who have no risk on their labor income were, *ceteris paribus*, about 5.2 percentage points less likely to hold stocks directly than active households who are in the highest risky income decile.

4.2.2 Robustness and miscellaneous results

Since only a small fraction of households report positive amounts of risky assets, we have also explored the sensitivity of the results to a broader definition of risky assets: direct or indirect stockholding (Table 6a for total sample, Table 6b for an active head of household). For most variables, the estimates are similar to those obtained with the narrow definition. Notably, the coefficient of income variance in the discrete choice hypothesis is always positive and statistically significant[33]; in the continuous choice, this coefficient is not significantly different from 0. In Tobit regressions, the coefficient is positive and significantly different from 0.

However, the previous estimates can be misleading (Lusardi, 1997). Some of the zero values in the self-reported measure of earnings variance may be artificial and may constitute a non negligible component of measurement error. Additionally, there could be an endogeneity bias, since more risk averse households might have chosen simultaneously safer jobs and less risky

[33] Households who have no risk on their labor income were, *ceteris paribus*, about 6 percentage points less likely to hold stocks directly and indirectly than households who are in the highest risky income decile. A similar calculus on the sample of active households leads to an increase of 7 percentage points.

portfolios[34]. In these cases, the coefficient of earnings variance is biased[35].

We rigorously tested endogeneity by estimating an instrumental variables model in which the first stage regression predicts income risk using an OLS model, and the main equation predicts the probability of stock ownership using a linear probability model, or the share of stock in financial wealth using an OLS model. At the level of the household's head, the instruments are the subjective probability of unemployment, the existence of previous health problems and a dummy for becoming independent; at the level of parents, they are proxies for resources, social status and portfolio composition. The results of specification tests concerning this econometric procedure are reported in Table 7.

We tested whether income risk is endogenous by including in the main equations both actual income risk and the error term from the first stage regression (see Robin, 2000). In the case of the probability of stockholding, the null hypothesis of exogeneity was not rejected. Therefore, the single equation models is preferred as long as the instruments are valid. The instruments are jointly statistically significant in the first regression (partial F-statistics were 2.045). Moreover, we did not reject the null hypothesis that the instruments can be excluded from the main equations. For the conditional risky assets demands, the conclusions are the same. In consequence, we can consider that the positive effect of income risk on risky assets portfolio is empirically

[34] Drèze and Modigliani (1966) claimed that individuals choose endogenously their job also as a function of their risk preferences, given that they addressed a lifetime decision theoretic model. Since the choice of a job is endogenous and future wages are uncertain, we can interpret job choice as the investment in a risky asset, the return on which are future uncertain wages. Eeckhoudt and Gollier (2002) have recently studied this problem. If $u(.)$ shows DARA, DAP and P>2A then a household who chooses simultaneously his job and portfolio will be less exposed to portfolio risk than a household whose job is exogenous. The intuition of this result is clear: for the individual characterized by these preferences, both income and portfolio risks are substitutes in the sense that a risk averse individual who chooses simultaneously his portfolio risk and his occupation depending on his attitude towards risk will behave more conservatively than he otherwise would, had been his labour income completely diversifiable.

[35] For instance, Friedman (1957, p. 74-75) found some self-employed save less than other occupations. More recently, Skinner (1988) finds that the saving rate of the self-employed and sales workers (those generally thought to receive riskier incomes) are less than the others. As he did not control with a measure of risk aversion, he points out that "there may be problems... in differences of attitudes towards risk among occupations". Guiso and Paiella (2000) show a negative correlation between their empirical measure of risk aversion and the probability of being self -employed.

robust.[36]

5 Conclusion

In this work we have tried to clarify the empirical lack of consensus on the cross-country different attempts to test risk substitution by means of an extension of the static portfolio choice model with a partially correlated small background risk. We argued that a non-zero correlation, even if small, can counterbalance the theoretical prediction of risk substitution behaviour. For the case of a negative correlation, we have shown that it might be perfectly rational to increase individual exposure to financial risk in response to increased earnings uncertainty. Risk substitution is always present but the 'hedging effect' dominates the risk substitution effect. Conversely, if the correlation is positive, risk substitution can be derived under less restrictive assumptions.

In any case, the purpose of the theoretical part was to show that the empirical analysis performed subsequently for the case of France is not at odds with results available for other countries (substitutability in Italy and US., no correlation in Netherlands), once aggregate correlations are considered and not necessarily controlled for. So, the strikingly different conclusions can be reconciled. Not being available an empirically satisfactory measure of aggregate correlation between the empirical measures for earnings and excess financial return risks, definite conclusions on the empirical relevance of risk substitution theory should be postponed until then.[37]

However, other possible explanations can account for the empirically detected effect, like the role of labor supply flexibility, the endogeneity of job choice, the strength of the welfare state benefits etc.

[36] If we consider that portfolio choice is made simultaneously to consumption choice, wealth has to be consider also as an endogenous variable in the model. We have verified that taking account of the endogeneity of this variable do not invalidate the positive relation between risky assets demand and income risk.

[37] The paper of Vissing-Jorgensen (2002) is a good example of an empirical study which introduces simultaneously in the regressions income risk and a measure of correlation of nonfinancial income with the stock market. She uses PSID data and financial markets return data, to conclude that correlations are not empirically significant to explain non-participation nor conditional portfolio demands in the US.

Appendix

Intuition of Proposition 1.

To better grasp the intuition, we will proceed in two steps. In the first we will assume that the background risk is perfectly correlated with the endogenous risk, and we will interpret the optimal portfolio response to its introduction. The second step corresponds to the proof of Proposition 1. The interpretation of the results in that proposition is made in accordance with the results of step one.

Consider the truncated problem that obtains when the uncorrelated risk component $\widetilde{h}$ is absent. This preliminary step can be interpreted as imposing an exogenous restriction on the amount of total wealth that must be invested/shorted in the financial market providing an excess return over the riskless asset of $\beta\widetilde{z}$. Then the individual will adjust his initial risky position in the absence of this constraint, to counterbalance the effect of this restriction. The program would be:

$$\overline{\theta} \in \arg\max_{\theta} Eu[w + \theta\widetilde{z}]$$

The first order necessary and sufficient condition becomes :

$$E_z\{\widetilde{z}u'[w + \overline{\theta}\widetilde{z}]\} = E_z\{\widetilde{z}u'[w + \overline{\alpha}\widetilde{z} + \beta\widetilde{z}]\} = 0 \tag{9}$$

If it is evaluated at the solution of [1] we can observe that by continuity of $u(.)$, the sign of the expression is related with the sign of the correlation β :

$$signE_z\{\widetilde{z}u'[w + \alpha^*\widetilde{z} + \beta\widetilde{z}]\} = -(sign\beta)$$

To see why, observe that for a small correlation β and/or a small risk $\widetilde{z}$, we can approximate the marginal utility component in [9] as :

$$u'[w + \alpha^* z + \beta z] \approx u'[w + \alpha^* z] + (\beta z)\, u''[w + \alpha^* z], \forall z$$

Premultiplying by z on both sides and taking expectations, we can observe that the first term on the RHS coincides with the optimality condition of problem [1], so that it is null. The second term on the RHS coincides with the SOC of [1] times the correlation factor, and by concavity of $u(.)$ will always be negative if the correlation is positive, and conversely :

$$E_z\{\widetilde{z}u'[w + \alpha^*\widetilde{z} + \beta\widetilde{z}]\} \approx \beta E_z\{[\widetilde{z}]^2\, u''[w + \alpha^*\widetilde{z}]\}$$

So that we can conclude that :

$$\beta < 0 \Longrightarrow E_z\{\widetilde{z}u'[w+\alpha^*\widetilde{z}+\beta\widetilde{z}]\} > 0 \Longrightarrow \widehat{\alpha} > \alpha^*$$
$$\beta \geq 0 \Longrightarrow E_z\{\widetilde{z}u'[w+\alpha^*\widetilde{z}+\beta\widetilde{z}]\} \leq 0 \Longrightarrow \widehat{\alpha} \leq \alpha^*$$

This shows that just considering the correlated part of background risk $\widetilde{y}$ there will be a direct effect on the optimal portfolio composition α^* that will depend on the sign of the correlation. Intuitively, this component corresponds to a 'hedging effect' if the correlation is negative, or to a 'portfolio composition constraint' if the correlation is positive.

The Measure of Relative Risk Aversion

Suppose that you have a job which guarantees for life your household's current income R. Other companies offer you various contracts which have one chance out of two (50%) to provide you with a higher income and one chance out of two (50%) to provide you with a lower income.

Are you prepared to accept *Contract A* which has 50% chances to double your income R and 50% chances that your income will be reduced by one third?

For those who answer YES : the *Contract A* is no longer available. You are offered *Contract B* instead which has 50% chances to double your income R and 50% chances that it will be reduced by one half. Are you prepared to accept?

For those who answer NO : you have refused *Contract A*. You are offered *Contract C.* which has 50% chances to double your income R and 50% chances that it will be reduced by 20%. Are you prepared to accept?

The Measure of Earnings Uncertainty

Within the next 5 years, your total household revenue (the rise in prices excluded) :

-... will have increased by more than 25%

-... will have increased by 10 to 25%

-... will have increased by less than 10%

-... will be constant

-... will have decreased by less than 10%

-... will have decreased by 10 to 25%

-... will have decreased by more than 25%

-... will have marked ups and downs (indicate the minimum and maximum annual income)

You dispose of 100 points to be distributed among the 8 categories, according to the degree to which you agree or you disagree with the relative statement.

The Probability of Being Liquidity Constrained

In the "Patrimoine 97" survey, households are asked two questions aimed at measuring their ability to get access to the credit market. These questions are similar to that of the SHIW Italian survey (Guiso *et al.* 1996). We classify consumers as being liquidity constrained if they respond positively to at least one of the two following questions. The first indicates whether a consumer is a "discouraging borrower", the second whether he is a "turned down applicant":

- Did you renounce to finance expenditures on durable goods (main residence, cars ...) or did you renounce to restore your home because you expected that bank or other financial intermediaries will refuse the loan or the mortgage?

- Did you renounce to finance expenditures on durable goods (main residence, cars ...) or did you renounce to restore your home because bank or other financial intermediaries refused the loan or the mortgage?

There are 11.7% of households who are liquidity constrained in the total sample and 9.8% in the sample of respondents at the recto-verso questionnaire.

First we estimate the probability of being liquidity-constrained by controlling for individuals' characteristics. Then we use the predicted measure as a proxy for the existence of future borrowing constraints in asset-demand equations. The instruments for the borrowing constraints are the following: global income, age, a dummy for retirement, occupation dummies, education, household's composition, parents' social status and wealth, dummies for unemployment (present and past), dummies for health problems (severe or minor), and dummies for professional status and regional localization.

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Table 1
Data on Direct and Indirect Stockholding

	Detail on survey questions		
	Ownership (%)	**Amount (in FF)**	**Amount (in Euro)**
Direct Stockholding			
Stocks	*15,0*	*25 044*	*3 818*
Listed stocks	11,9	20 252	3 087
Unlisted stocks	1,4	3 857	588
Employers' stocks	3,1	934	142
Indirect stockholding		-	
Mutual funds (excluding money market funds) and other managed accounts	13,5	18 900	2 881

Source. Patrimoine 97 INSEE survey

Table 2 : Sample characteristics

Average household's characteristics	**Respondents**	**Total sample**
Total net wealth (mean in French francs)	749 000	701 500
Financial wealth (mean in French francs)	245 000	220 000
Household income (mean in French francs)	156 750	152 800
Number holding risky assets (%) (direct stockholding)	20,5	15,0
Number holding risky assets (%) (direct or indirect stockholding)	30,0	23,1
Proportion of risky assets in financial wealth (mean)	0,19	0,21
Proportion of risky assets in financial wealth (mean)	0,27	0,28
Age of head (%)		
least than 30 years old	11,5	11,8
30-40 years old	17,3	19,1
40-50 years old	18,8	20,3
50-60 years old	16,1	15,9
60-70 years old	15,3	13,4
more than 70 years old	21,1	19,5
Social status of head (%)		
Farmer	4,6	5,1
Self employed (small production unit)	7,0	8,3
Self employed (big production unit)	0,2	0,4
Liberal profession	1,1	1,1
Executive	13,8	11,8
High qualified employee	21,8	18,8
Low qualified employee	20,0	19,4
High qualified workers	18,6	20,9
Low qualified workers	9,9	11,6
Inactive	2,8	2,7
Diploma of head (%)		
No diploma	16,7	20,8
Primary level	33,4	33,7
Secondary level	14,7	14,5
Baccalaureate	14,2	13,0
Graduate studies	12,7	11,3
Postgraduate studies	8,3	6,7
Household composition (%)		
Single	32,6	30,0
Couple without child	28,7	26,0
Couple with one child	12,0	13,3
Couple with two children	11,6	13,2
Couple with three children or more	5,3	6,9
Single with children	5,9	6,4
Other cases	3,8	4,2
Town resident (%)	56,1	59,5
Number of constrained households (%)	11,7	9,8
Relative risk aversion (CRRA)(3)(4)		
3.76=<CRRA	41,3	
2=<CRRA<3.76	40,2	
1=<CRRA<2	11,9	
CRRA<1	6,5	
Coefficient of variation of earnings(4)(5)	4.32-4.94	
Number of households	2 954	10 207

Source : "Patrimoine 97" survey

(1) Direct stockholding : household hold equities directly.

(2) Direct or indirect stockholding : household hold equities directly or trough mutual funds.

(3) The measure of risk aversion is described in the appendix.

(4) For risk aversion and income variance, we assume that the variables of household can be proxied by the value estimated by the respondent or, when there were two respondents in the household, the value evaluated by the head of the household (see the appendix).

(5) For the first value of income variance, we assume that the upper and the lower bound are 35%. For the second, we assume that the upper and the lower bound are 50%.

Table 3 : Risk aversion in France, in Netherlands and in U.S.A.

	Rejection of Contract A		**Acceptance of Contract A**	
	Rejection of contract **C**	Acceptance of contract **C**	Rejection of contract **B**	Acceptance of contract **B**
	3.76=<g	**2=<g<3.76**	**1=<g<2**	**g<1**
France (total sample)	43,1	39,4	11,2	6,3
France (>=50 years old)	48,6	36,8	8,7	5,9
Netherlands (>= 50 years old)	66,3	13,5	9,0	11,2
U.S.A. (>= 50 years old)	64,6	11,6	10,9	12,8

Source : "Patrimoine 97" survey, Health and Retirement Survey (cf. Barsky & al. 1997), CentERpanel (cf. Kapteyn and Teppa, 2002)

Table 4 : Frequency Distribution of the Ratio of the Subjective Standard Deviation of Future Income to Current Earnings (S/y)

σ / y (%)	Frequency 1	Frequency 2
0	41,0	41,0
0-2.5	6,1	6,1
2.5-5.0	13,4	12,7
4.0-7.5	17,0	14,9
7.5-10.0	9,7	5,9
10.0-15	7,6	11,7
more than 15	5,1	7,8
Mean : 4.32-4.94	100,0	100,0

Source : "Patrimoine 97" survey

(1) The lower and the upper bound are equal to 35%.

(2) The lower and the upper bound are equal to 50%.

Table 5a

The demand for risky assets (direct stockholding)*

Variables	**(1) Probit estimates** Est. (s.e.)	**(2) Demand equation**[(1)] Est. (s.e.)	**(3) Tobit estimates**[(1)] Est. (s.e.)
Financial wealth (10E-7)	9,863 (1,138)	3,773 (2,548)	1,969 (0,271)
Financial wealth squared (10E-14)	-5,750 (0,900)	-2,702 (1,742)	-1,117 (0,221)
Total net wealth (10E-7)	0,977 (0,600)	-0,647 (1,213)	0,263 (0,164)
Total net wealth squared (10E-14)	-0,645 (0,489)	0,777 (0,782)	-0,176 (0,121)
Income (log.)	0,214 (0,076)	-0,098 (0,172)	0,050 (0,021)
Income risk (standard error of future income*10E-5)	0,501 (0,251)	-0,425 (0,491)	0,105 (0,069)
Self-employed	-0,284 (0,112)	-0,279 (0,233)	-0,063 (0,031)
Age(10E-1)	0,519 (0,169)	-0,190 (0,369)	0,132 (0,048)
Age squared(10E-2)	-0,056 (0,016)	0,021 (0,035)	-0,014 (0,004)
Inheritance and gift received	0,206 (0,070)	-0,104 (0,170)	0,050 (0,020)
Inter vivos transfers	-0,046 (0,087)	0,239 (0,192)	0,002 (0,025)
Diploma			
Primary level	0,104 (0,124)		0,007 (0,035)
Secondary level	0,152 (0,142)		0,039 (0,040)
Baccalaureate	0,156 (0,142)		0,036 (0,040)
Graduate studies	0,178 (0,152)		0,042 (0,043)
Postgraduate studies	0,284 (0,159)		0,060 (0,044)
Marital Status			
Married	-0,162 (0,123)	-0,281 (0,263)	-0,045 (0,035)
Unmarried couple (>=5 years)	-0,645 (0,213)	-0,650 (0,546)	-0,178 (0,061)
Unmarried couple (<5 years)	-0,246 (0,189)	0,065 (0,445)	-0,053 (0,054)
Widowed	0,064 (0,160)	-0,347 (0,333)	-0,001 (0,045)
Divorced	-0,484 (0,181)	-0,380 (0,461)	-0,137 (0,052)
Number of children at home	-0,027 (0,042)	0,168 (0,092)	-0,001 (0,012)
Number of children away from home	0,058 (0,031)	0,051 (0,074)	0,016 (0,009)
Proxy for liquidity constraints	-1,440 (0,604)	-0,643 (1,643)	-0,443 (0,172)
Urban resident	0,142 (0,069)	0,281 (0,161)	0,044 (0,020)
Parents own risky assets	0,371 (0,092)		0,089 (0,025)
Constant relative risk aversion (CRRA)			
No answer	0,259 (0,105)	0,365 (0,235)	0,068 (0,030)
2=<CRRA<3.76	0,218 (0,078)	0,305 (0,176)	0,066 (0,022)
1=<CRRA<2	0,163 (0,115)	0,348 (0,244)	0,058 (0,032)
CRRA<1	0,264 (0,146)	0,219 (0,311)	0,077 (0,042)
Gains at Stock exchange		1,527 (0,407)	
Loose at Stock Exchange		-0,720 (0,593)	
Portfolio management			
Manage portfolio individually		0,518 (0,180)	
Follow their financial advisor		0,412 (0,186)	
Financial advisor manager		1,058 (0,235)	
No indication about managing		0,824 (0,277)	
Constant	-5,100 (0,898)	-1,924 (2,673)	-1,289 (0,253)
Inverse of Mill's ratio		0,601 (0,431)	
Khi2(54) or Pseudo R2	416,52		0,238
Number of observations	2 383	515	2 383

Source : "Patrimoine 97" survey

(1) The dependant variable in demand equation (2) is the logistic transformation of the share (p) of risky assets in financial wealth: log p / (1-p). In Tobit estimation (3), the dependant variable is the share of risky assets in financial wealth.

(2) The income risk variable is calculated with lower and upper bounds of 50% for future income evolution.

* Household's characteristics refer to the head except for income risk and relative risk aversion. For these two variables, we assume that the variable of household can be proxied by the value estimated by the respondent or, when there were two respondents in the household, the value evaluated by the head of the household. Reference groups are : no diploma, single, CRRA>=3.76, no specific management.

Table 5b

The demand for risky assets among active households (direct stockholding)*

Variables	**(1) Probit estimates** Est. (s.e.)	**(2) Demand equation[(1)]** Est. (s.e.)	**(3) Tobit estimates[(1)]** Est. (s.e.)
Financial wealth (10E-7)	11,062 (1,519)	6,433 (3,697)	2,302 (0,388)
Financial wealth squared (10E-14)	-6,030 (1,067)	-3,732 (2,171)	-1,142 (0,268)
Total net wealth (10E-7)	0,209 (0,704)	-0,805 (1,590)	0,083 (0,204)
Total net wealth squared (10E-14)	-0,317 (0,525)	0,573 (0,945)	-0,129 (0,138)
Income (log.)	0,191 (0,092)	-0,139 (0,222)	0,044 (0,026)
Income risk (standard error of future income*10E-5)	0,695 (0,275)	-0,311 (0,612)	0,168 (0,080)
Self-employed	-0,333 (0,138)	-0,398 (0,313)	-0,083 (0,040)
Age(10E-1)	0,820 (0,271)	0,031 (0,732)	0,202 (0,080)
Age squared(10E-2)	-0,086 (0,030)	0,001 (0,082)	-0,021 (0,009)
Inheritance and gift received	0,189 (0,084)	-0,054 (0,219)	0,046 (0,025)
Inter vivos transfers	-0,241 (0,122)	0,414 (0,301)	-0,041 (0,036)
Diploma			
Primary level	0,226 (0,185)		0,024 (0,055)
Secondary level	0,257 (0,194)		0,059 (0,057)
Baccalaureate	0,322 (0,199)		0,053 (0,059)
Graduate studies	0,360 (0,202)		0,072 (0,059)
Postgraduate studies	0,487 (0,209)		0,096 (0,061)
Marital Status			
Married	-0,122 (0,138)	-0,434 (0,320)	-0,041 (0,041)
Unmarried couple (>=5 years)	-0,575 (0,229)	-0,938 (0,628)	-0,162 (0,068)
Unmarried couple (<5 years)	-0,233 (0,195)	-0,009 (0,487)	-0,052 (0,058)
Widowed	0,171 (0,232)	-0,812 (0,529)	0,024 (0,070)
Divorced	-0,531 (0,206)	-1,080 (0,582)	-0,164 (0,062)
Number of children at home	-0,050 (0,047)	0,239 (0,109)	-0,004 (0,014)
Number of children away from home	0,096 (0,053)	0,044 (0,135)	0,025 (0,016)
Proxy for liquidity constraints	-1,234 (0,660)	-2,166 (1,873)	-0,410 (0,197)
Urban resident	0,128 (0,082)	0,303 (0,205)	0,034 (0,025)
Parents own risky assets	0,408 (0,106)		0,104 (0,031)
Constant relative risk aversion (CRRA)			
No answer	0,183 (0,138)	0,248 (0,328)	0,042 (0,042)
2=<CRRA<3.76	0,154 (0,093)	0,354 (0,223)	0,055 (0,028)
1=<CRRA<2	0,105 (0,132)	0,173 (0,301)	0,031 (0,039)
CRRA<1	0,133 (0,174)	0,035 (0,396)	0,022 (0,052)
Gains at Stock exchange		1,218 (0,632)	
Loose at Stock Exchange		-1,153 (0,802)	
Portfolio management			
Manage portfolio individually		0,645 (0,223)	
Follow their financial advisor		0,653 (0,244)	
Financial advisor manager		1,165 (0,310)	
No indication about managing		0,808 (0,300)	
Constant	-5,590 (1,072)	-2,603 (3,426)	-1,395 (0,312)
Inverse of Mill's ratio		1,150 (0,515)	
Khi2(54) or Pseudo R2	272,37		0,209
Number of observations	1 690	347	1 690

Source : "Patrimoine 97" survey

(1) The dependant variable in demand equation (2) is the logistic transformation of the share (p) of risky assets in financial wealth: log p / (1-p). In Tobit estimation (3), the dependant variable is the share of risky assets in financial wealth.

(2) The income risk variable is calculated with lower and upper bounds of 50% for future income evolution.

* Household's characteristics refer to the head except for income risk and relative risk aversion. For these two variables, we assume that the variable of household can be proxied by the value estimated by the respondent or, when there were two respondents in the household, the value evaluated by the head of the household. Reference groups are : no diploma, single, CRRA>=3.76, no specific management.

Table 6a

The demand for risky assets (direct or indirect stockholding)*

Variables	**(1) Probit estimates** Est. (s.e.)	**(2) Demand equation**[(1)] Est. (s.e.)	**(3) Tobit estimates**[(1)] Est. (s.e.)
Financial wealth (10E-7)	11,898 (1,205)	2,393 (2,203)	2,205 (0,302)
Financial wealth squared (10E-14)	-6,552 (0,901)	-2,089 (1,580)	-1,275 (0,251)
Total net wealth (10E-7)	1,459 (0,579)	-0,276 (1,090)	0,377 (0,178)
Total net wealth squared (10E-14)	-1,104 (0,463)	0,774 (0,764)	-0,249 (0,136)
Income (log.)	0,240 (0,069)	-0,108 (0,156)	0,063 (0,022)
Income risk (standard error of future income*10E-5)	0,694 (0,247)	-0,015 (0,444)	0,168 (0,075)
Self-employed	-0,382 (0,107)	-0,552 (0,212)	-0,097 (0,034)
Age(10E-1)	0,381 (0,153)	0,160 (0,324)	0,149 (0,049)
Age squared(10E-2)	-0,045 (0,014)	-0,013 (0,031)	-0,016 (0,005)
Inheritance and gift received	0,213 (0,066)	-0,147 (0,147)	0,059 (0,021)
Inter vivos transfers	0,106 (0,081)	-0,140 (0,175)	0,026 (0,026)
Diploma			
Primary level	0,021 (0,112)		-0,011 (0,037)
Secondary level	0,244 (0,127)		0,108 (0,041)
Baccalaureate	0,186 (0,129)		0,061 (0,042)
Graduate studies	0,130 (0,139)		0,065 (0,045)
Postgraduate studies	0,184 (0,148)		0,065 (0,047)
Marital Status			
Married	-0,205 (0,113)	0,298 (0,227)	-0,024 (0,036)
Unmarried couple (>=5 years)	-0,518 (0,183)	0,197 (0,423)	-0,122 (0,060)
Unmarried couple (<5 years)	-0,238 (0,169)	-0,082 (0,375)	-0,055 (0,056)
Widowed	0,023 (0,149)	-0,057 (0,298)	0,015 (0,048)
Divorced	-0,407 (0,160)	0,486 (0,365)	-0,089 (0,052)
Number of children at home	-0,040 (0,038)	-0,002 (0,081)	-0,014 (0,012)
Number of children away from home	0,023 (0,030)	0,101 (0,066)	0,012 (0,010)
Proxy for liquidity constraints	-1,919 (0,544)	0,821 (1,553)	-0,633 (0,179)
Urban resident	0,076 (0,064)	0,305 (0,132)	0,040 (0,021)
Parents own risky assets	0,250 (0,088)		0,070 (0,028)
Constant relative risk aversion (CRRA)			
No answer	0,211 (0,097)	0,253 (0,204)	0,064 (0,031)
2=<CRRA<3.76	0,164 (0,072)	0,161 (0,151)	0,055 (0,023)
1=<CRRA<2	0,010 (0,109)	0,361 (0,217)	0,025 (0,035)
CRRA<1	0,157 (0,139)	0,270 (0,270)	0,076 (0,044)
Gains at Stock exchange		1,008 (0,388)	
Loose at Stock Exchange		-0,152 (0,533)	
Portfolio management			
Manage portfolio individually		0,454 (0,176)	
Follow their financial advisor		0,383 (0,170)	
Financial advisor manager		0,871 (0,213)	
No indication about managing		0,520 (0,196)	
Constant	-4,537 (0,810)	-1,840 (2,316)	-1,396 (0,263)
Inverse of Mill's ratio		0,203 (0,396)	
Khi2(54) or Pseudo R2	494,43		0,211
Number of observations	2 383	749	2 383

Source : "Patrimoine 97" survey

(1) The dependant variable in demand equation (2) is the logistic transformation of the share (p) of risky assets in financial wealth: log p / (1-p). In Tobit estimation (3), the dependant variable is the share of risky assets in financial wealth.

(2) The income risk variable is calculated with lower and upper bounds of 50% for future income evolution.

* Household's characteristics refer to the head except for income risk and relative risk aversion. For these two variables, we assume that the variable of household can be proxied by the value estimated by the respondent or, when there were two respondents in the household, the value evaluated by the head of the household. Reference groups are : no diploma, single, CRRA>=3.76, no specific management.

Table 6b

The demand for risky assets among active households (direct or indirect stockholding)*

Variables	**(1) Probit estimates** Est. (s.e.)	**(2) Demand equation**[(1)] Est. (s.e.)	**(3) Tobit estimates**[(1)] Est. (s.e.)
Financial wealth (10E-7)	10,598 (1,498)	2,455 (3,047)	2,155 (0,421)
Financial wealth squared (10E-14)	-5,816 (1,036)	-1,844 (1,864)	-1,132 (0,296)
Total net wealth (10E-7)	1,202 (0,673)	-0,389 (1,318)	0,325 (0,216)
Total net wealth squared (10E-14)	-0,905 (0,493)	0,699 (0,860)	-0,213 (0,151)
Income (log.)	0,193 (0,082)	-0,160 (0,191)	0,054 (0,027)
Income risk (standard error of future income*10E-5)	0,693 (0,266)	0,048 (0,512)	0,197 (0,085)
Self-employed	-0,527 (0,131)	-0,682 (0,287)	-0,169 (0,043)
Age(10E-1)	1,028 (0,248)	-0,379 (0,644)	0,299 (0,083)
Age squared(10E-2)	-0,115 (0,028)	0,052 (0,073)	-0,032 (0,009)
Inheritance and gift received	0,177 (0,078)	-0,140 (0,174)	0,044 (0,026)
Inter vivos transfers	-0,145 (0,113)	-0,089 (0,239)	-0,042 (0,037)
Diploma			
Primary level	-0,021 (0,157)		-0,033 (0,054)
Secondary level	0,222 (0,163)		0,105 (0,056)
Baccalaureate	0,173 (0,171)		0,038 (0,058)
Graduate studies	0,145 (0,174)		0,054 (0,059)
Postgraduate studies	0,261 (0,183)		0,072 (0,061)
Marital Status			
Married	-0,108 (0,127)	0,311 (0,259)	0,002 (0,042)
Unmarried couple (>=5 years)	-0,352 (0,195)	0,140 (0,449)	-0,077 (0,066)
Unmarried couple (<5 years)	-0,171 (0,175)	-0,104 (0,387)	-0,039 (0,060)
Widowed	0,274 (0,217)	-0,383 (0,441)	0,079 (0,073)
Divorced	-0,339 (0,177)	0,308 (0,414)	-0,073 (0,060)
Number of children at home	-0,082 (0,042)	0,066 (0,091)	-0,024 (0,014)
Number of children away from home	0,065 (0,049)	0,147 (0,110)	0,028 (0,016)
Proxy for liquidity constraints	-2,195 (0,593)	-0,021 (1,809)	-0,700 (0,202)
Urban resident	0,114 (0,075)	0,381 (0,164)	0,049 (0,026)
Parents own risky assets	0,310 (0,100)		0,090 (0,033)
Constant relative risk aversion (CRRA)			
No answer	0,267 (0,124)	0,140 (0,273)	0,084 (0,042)
2=<CRRA<3.76	0,163 (0,085)	0,171 (0,185)	0,061 (0,029)
1=<CRRA<2	-0,008 (0,123)	0,218 (0,252)	0,010 (0,041)
CRRA<1	0,169 (0,161)	-0,041 (0,318)	0,050 (0,053)
Gains at Stock exchange		0,784 (0,566)	
Loose at Stock Exchange		-0,280 (0,679)	
Portfolio management			
Manage portfolio individually		0,561 (0,213)	
Follow their financial advisor		0,449 (0,219)	
Financial advisor manager		0,893 (0,277)	
No indication about managing		0,564 (0,209)	
Constant	-5,303 (0,958)	-0,373 (3,127)	-1,610 (0,320)
Inverse of Mill's ratio		0,388 (0,528)	
Khi2(54) or Pseudo R2	332,71		0,192
Number of observations	1 690	522	1 690

Source : "Patrimoine 97" survey

(1) The dependant variable in demand equation (2) is the logistic transformation of the share (p) of risky assets in financial wealth: log p / (1-p). In Tobit estimation (3), the dependant variable is the share of risky assets in financial wealth.

(2) The income risk variable is calculated with lower and upper bounds of 50% for future income evolution.

* Household's characteristics refer to the head except for income risk and relative risk aversion. For these two variables, we assume that the variable of household can be proxied by the value estimated by the respondent or, when there were two respondents in the household, the value evaluated by the head of the household. Reference groups are : no diploma, single, CRRA>=3.76, no specific management.

Table 7 : Specification tests

Test	***Test Statistic***	***p-value***	***Conclusion***
Instruments correlated with endogenous variable	$F\,(21,2382)=2{,}045$	0,003	Good instruments
Probability of direct stockholding ownership [1]			
Endogeneity	$\chi^2(1)= 0{,}019$	0,892	Not endogenous
Validity of instruments	$F\,(21,2382)=0{,}686$	0,851	Good instruments
Probability of direct or indirect stockholding ownership [1]			
Endogeneity	$\chi^2(1)= 0{,}034$	0,853	Not endogenous
Validity of instruments	$F\,(21,2382)=0{,}542$	0,954	Good instruments
Share of direct stockholding in financial wealth [2]			
Endogeneity	$\chi^2(1)= 2{,}167$	0,141	Not endogenous
Validity of instruments	$F\,(21,2382)=0{,}575$	0,937	Good instruments
Share of direct or indirect stockholding in financial wealth [2]			
Endogeneity	$\chi^2(1)= 0{,}828$	0,360	Not endogenous
Validity of instruments	$F\,(21,2382)=0{,}661$	0,874	Good instruments

Source : "Patrimoine 97" survey

Notes :

1) The probability is estimated with a linear probability model.

2) The model is estimated with OLS.