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ABSTRACT

Risk Attitude and Wage Growth: Replication and Reconstruction*

We replicate Shaw (1996) who found that individual wage growth is higher for individuals with greater preference for risk taking. Expanding her dataset with more American observations and data for Germany, Spain and Italy, we find mixed support for the earlier results. We present and estimate a new model and find that in particular the wage level is sensitive to attitudes towards risk taking.

JEL Classification: J24, J30

Keywords: wage growth, risk, post-school investment

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1. **Introduction**

Investment in human capital is risky. Both the amount of human capital produced from given effort and resources and the returns to the human capital are uncertain at the time of investment. As individuals are known to differ in risk attitudes (Hartog, Ferrer-i-Carbonell and Jonker, 2002; Dohmen et al., 2005), one predicts, given everything else, a relationship between risk attitudes, investment and wages: less risk averse individuals will invest more and will experience higher wage growth (and presumably, more volatility). This indeed, is exactly what Shaw (1996) attempted to test. She reports clear support for the prediction that risk averse individuals shy away from investing in (risky) human capital and hence, experience less wage growth. Other empirical research on this relationship barely exists. Belzil and Leonardi (2007) studied the impact of risk attitudes on formal education; Dohmen et al (2007) report that individuals sort themselves into jobs according to wage risk and that this creates a link between wage levels and risk attitudes, although no link is made between risk attitudes, human capital investment, and wage changes. Brown and Taylor (2005) estimate a relationship between risk attitude and wage growth for the United Kingdom that is inspired by Shaw (1996); they extend the model and find support for this extension, but they have not attempted a strict replication.

We replicate Shaw's estimates on datasets for four countries: an extension of her original American data set and data for Spain, Germany and Italy. We decided to this replication because the topic is relevant, the intuition of the model is appealing and because Shaw's original results were clearly in support of the key hypothesis[1]. We find that risk attitude and wages are indeed connected, but not in the way that the Shaw model predicts. In the next section we present the model. In section 3 we introduce and discuss our data sets, in section 4 we present the replication results, in 5 we test the constraints imposed on the model. In Section 6 we present a new model, 7 gives the estimation results and 8 concludes. Detailed data descriptions are given in an appendix.

2. The Shaw model

[1] In line with the growing interest in the relevance of risk for education issues (see the 2007 Special Issue of *Labour Economics*), interest in Shaw's paper is also growing.. In March 2009, the paper had 16 citations at IDEAS, one before 2000, 10 in 2005 or later.

For a given individual, suppressing possible subscripts for potential variation across individuals, Shaw starts from the standard human capital earnings function:

$$W_t = (1 - s_t)k_t \tag{1}$$

The observed wage equals the value of the human capital stock, net of new investment cost, at human capital rental rate equal to unity.

The capital stock grows from investment:

$$k_t = k_{t-1} + \gamma_t s_{t-1} k_{t-1} \tag{2}$$

where γ_t equals the productivity of the investment, i.e. the addition to the capital stock per unit of capital invested. Writing

$$W_{t-1} = (1 - s_{t-1})k_{t-1} \tag{3}$$

and assuming the differences between s_t and s_{t-1} are small enough to neglect, it is straightforward to derive the approximation

$$\Delta \ln W_t = \gamma_t s_{t-1} \tag{4}$$

Using a model for optimal lifetime investment in human and financial capital, following the footsteps of Williams (1979), the investment share s can be written as

$$s = \frac{\mu_h - \eta}{\sigma_h^2 R} \tag{5}$$

where R is the Arrow-Pratt measure of relative risk aversion and $\frac{\mu_h - \eta}{\sigma_h^2}$ is the Sharpe ratio for human capital: the expected net return to human capital investment relative to its variance (the return to risk). η is the marginal rate of substitution between financial wealth and human capital, assumed constant, μ_h is the expected rate of return on human capital .

Shaw applies two alternative strategies to measure individual risk attitude R: either use direct survey measures of risk attitude or derive a substitute by assuming that the same risk attitude determines financial investment. The latter is based on a similar equation for the share of financial investments allocated to risky assets:

$$\alpha = \frac{\mu_f - r}{\sigma_f^2 R} \tag{6}$$

where μ_f is the expected return to risky financial assets, σ^2_f its variance and r the return on safe assets. This financial Sharpe ratio is a constant determined in the capital market and can be written as $b = \sigma^2_f / \mu_f - r$; (6) can be used to write risk attitude R as inversely proportional to observable risky financial investment share α. We can then substitute for s in (4):

$$\Delta \ln W_t = b\alpha \left(\frac{\gamma(\mu_h - \eta)}{\sigma_h^2} \right) \tag{7}$$

Thus, an individual's wage growth is determined as a function of the benefits from human capital investment (productivity of investment multiplied by expected net returns per unit of risk), the share of financial wealth in risky assets and a constant derived from the capital market. The benefits from human capital investment are specified as

$$\gamma_i (\mu_{hi} - \eta) = X_i A + \xi_i \tag{8}$$

with ξ_i i.i.d. measurement errors and X a matrix of individual characteristics. This implies that the wage growth equation equals

$$\Delta \ln W_i = \frac{b\alpha_i}{\sigma_{hi}^2} (X_i A) + e_i \tag{9}$$

Thus, individual wage growth is related to the observable investment share of risky assets multiplied by the benefits from human capital investments. As Shaw notes, the error term is heteroscedastic, as it depends on the financial investment share α_i : $e_i = b\alpha_i \xi_i / \sigma_h^2$: residual variance is increasing in risky wealth share.

If we have direct observations on risk aversion *R*, we can use these as regressors, instead of the detour through financial investment. Substituting (5) in (4), we get

$$\Delta \ln W_t = \left[\gamma \left(\frac{(\mu_h - \eta)}{\sigma_h^2} \right) \Big/ R \right] \tag{10}$$

and again using (8) we get

$$\Delta \ln W_t = \frac{1}{\sigma_h^2 R}(X_i A) + e_i \tag{11}$$

with heteroscedastic errors as before as $e_i = \xi_i / \sigma_h^2 R_i$ depends on individual risk attitude R: residual variance is decreasing with increasing risk aversion. Now, wage growth is explained from productivity growth divided by risk aversion.

In her empirical application, Shaw estimates, for individual i,

$$\Delta \ln W_i = (1 + \beta_0 Riskattitude_i) X_i A + \gamma' H_i + e_i \tag{12}$$

where $\Delta \ln W_i$ is hourly wage growth, *Riskattitude* measures the attitude of an individual toward risk, X_i is the matrix for human capital variables and H_i includes additional controls. The essence of the model is a multiplicative specification of human capital stock and risk attitude.

As noted, risk attitudes R are measured in two ways. The first measure is based on equation (6). As the capital market sets the Sharpe ratio identical for everyone, the proportion of wealth invested in risky assets is proportional to the inverse of risk aversion R. Thus, in equation (12) risk aversion is represented by the share of financial wealth placed in risky assets. The second measure is a set of dummies taken from survey questions in which individuals were asked about their attitudes towards taking financial risks. The responses were categorized into four groups: “take substantial risks”, “take above-average risks”, “take average risks”, and “take no risks”.

The Shaw model formalizes the plausible argument that willingness to take risk may enhance careers. The details of the specification are open for discussion however and in fact, below (in section 6), we will propose a new model that is similar in spirit but remedies the weaknesses we identify. First, we will faithfully follow Shaw’s model and replicate and test the original specifications.

3. Datasets

To test Shaw’s model, we use data from four different sources: an extension of Shaw’s original American data (the Survey of Consumer Finances, SCF), the German Socio-Economic Panel (SOEP), the Spanish Survey of Household Finances (EFF) and the Italian Survey of Household Income and Wealth (SHIW). These datasets are described in the Appendix.

The Survey of Consumer Finances is the natural candidate to re-examine Shaw’s model, as it allows us to include the same controls and measures of risk as in her own paper. Using the SCF, and following Shaw, we present the results of two alternative measures of individual’s attitudes towards risk. One based on the financial assets owned by the household (ASSET) and one based on the self-reported attitude towards taking financial risks. In the empirical regression, risk attitude is introduced through two dummy variables, i.e. RISK3 (which equals 1 if individuals are willing to take average risks) and RISK4 (which equals 1 if individuals are not willing to take any risks). The reference group consists of people who reported to be willing to take “substantial” or “above-average” risks. So, RISK3 and RISK4 indicate increasing levels of risk aversion. In the two cases, the set of controls included in vector H_i are, as in Shaw, three dummy variables indicating whether the individual is a male, black, or member of a worker union. However, the time interval of the sample is now 1983-1989; Shaw's original dataset referring to 1983-1986 is no longer available.

In the German SOEP data we do not have the necessary information on individual possession of financial assets. There is however information on self-reported risk attitudes. This information differs slightly from that in the SCF. In the SOEP, respondents are asked to report their willingness to take risks in a variety of areas, such as financial matters, health, occupation and leisure and sport. We base our results on the willingness to take risks in the occupation. The answer to the willingness to take risk is recorded on a 0-10 scale, where 0 stands for complete unwilling to take risks and 10 for completely willing (see Dohmen et al., 2005, for validity issues). The results presented in the paper make use of a transformation of this 11-point risk measure into a continuous variable, assuming normality and using the conditional mean (Terza, 1987). In the German case control variables consist of three dummy variables that take value 1 if the respondent lives in East Germany, is of German origin, and is a male. The first two dummy variables are added to represent the ethnic component in the German sample. The gender variable included in the regression is defined as in the US case.

The Spanish EFF contains the same information on risk as the SCF. Thus, we present the results of two specifications: one based on the ASSET variable and one based on the risk dummies RISK3 and RISK4. There are, however, two differences relative to the specifications used with the SCF data. First, the EFF is not a panel and, consequently, data on individual's wages over time is missing. Still, we can compute wage growth within the firm, as the EFF includes a question in which individuals are asked their starting salary in the present company. Since there is information on tenure, we can compute the total wage growth of individuals since they entered the firm. This means that we are only looking at the subgroup of workers that Shaw calls 'job stayers' (see Table 3 of Shaw´s paper). A difference with Shaw's sub-sample of stayers however is that while she focuses only on job stayers in a 3-year period, we consider all the surveyed workers and their corresponding tenure in the present firm[2]. We divide reported wage growth by years of tenure. The second difference is that the EFF does not contain information on the number of hours worked in a normal week when the individual entered the firm This means that we can not compute the past hourly wage,

[2] We considered restricting our sample to 3-year-stayers only, but that leaves us with only 202 observations (down from 758). Non-linear regressions did not converge and almost all variables in Table 2 had insignificant coefficients.

although we know the yearly wage at that time. Therefore, the results from the EFF are based on yearly wages[3]. Finally, the controls included in vector H_i are four dummy variables indicating whether the individual works for a big firm (more than 500 workers), is a male, has a non-permanent contract and is single. The dummy variable big firm, no permanent contract and single is included to represent insider-outsider effects in Spain (outsiders are young rather than old, have a temporary rather than a permanent contract and work in small firms rather than in big firms).

Finally, the data for Italy comes from the Italian Survey of Household Income and Wealth (SHIW). It is a panel survey (annual from 1977 to 1987 and biannual from 1989 to 2000) carried out by *Banca d'Italia* (Bank of Italy). The survey contains detailed information on household characteristics, employment, income, assets, financial habits, type of home tenure and several questions related to homeownership and borrowing conditions. Additionally, starting from 1995, the survey also includes rotating questions aimed at the analysis of specific issues. The 1995 wave contains questions addressed to the household heads that allow us to construct a measure of absolute risk aversion (see Appendix); although the theoretical prediction is formulated with relative risk aversion we use absolute risk aversion, as the risk dummies are not identified as relative measures either and as multiplying with wealth adds much measurement error[4]. We use the waves corresponding to 1993 and 1995 to estimate real wage growth. We chose this particular three year interval since it provides an acceptable number of individuals with valid answers in the risk attitude question that are present in both waves (1,357 household heads).[5] Alternatively, the survey also provides information on the amount of assets held by the households. This allows us to construct a measure of risk behaviour based on the percentage of risky assets (bonds, shares and mutual funds) over all the household's assets, as with the SCF and the EFF data. The controls included in vector H_i are dummies for region (North, Centre and South), gender, marital status and part time work.

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[3] Hourly earnings is the common unit in analysis of wage differentials. Although this is less than satisfactory, as most labour markets do not operate on an hourly basis and many jobs have implicit contracts with undetermined hours and unspecified relationship between hours and pay. In our Italian dataset we get good results with annual earnings in all specifications; this is not the case with hourly earnings.

[4] The model predicts inverse proportionality between wage growth and risk attitude. We follow Shaw in estimating with direct proportionality. In the Italian dataset, using the inverse of risky asset share also gives significant results.

[5] If we also consider the missing values in the risk attitude question the total sample is of 1,654 household heads. Some of these missing responses have a number in the assets variable.

4. Replicating Shaw's results

For our empirical analysis we will proceed as follows. We will first replicate Shaw as close as possible on new data; we will use, to the extent possible, exactly her specifications and her choice of variables, adjusted for data availability and country specific relevance. This means that for the US we use male, black and union as controls (H); for Germany instead we use male, living in East and German origin; for Spain, male, big firm, single and temporary, for Italy we use male, single, part-time work and three regions. Being member of a union is not a relevant distinction in Europe, neither is being black; in the Spanish labour market, flexible contracts are akin to a non-union ("unprotected") position, in Italy single and part-time point to a weaker labour market position. Many other variables may be irrelevant, e.g. immigrant status, but for comparability we neglect these. We will start by strict and faithful replication, including some specification test and also add some new tests.

4.1 Basic replication

We start by replicating Shaw's baseline results as reported in her Table 1. To be precise[6], we estimated (13A) with the asset share specification for risk and (13D) with the dummy specification for risk (ignoring the straightforward linear part for the control variables in H):

$$\Delta \ln W_i = a_o + \sum_{j=1}^{J} a_j\, x_{ij} + \beta\, Asset_i\, a_o + \beta\, Asset_i \sum_{j=1}^{J} a_j\, x_{ij} + e_i \tag{13A}$$

$$\begin{aligned} \Delta \ln W_i = {} & a_o + \sum_{j=1}^{J} a_j\, x_{ij} + \left[\beta_3\, Risk_{3i} + \beta_4\, Risk_{4i}\right] a_o \\ & + \left[\beta_3\, Risk_{3i} + \beta_4\, Risk_{4i}\right] \sum_{j=1}^{J} a_j\, x_{ij} + e_i \end{aligned} \tag{13D}$$

[6] We deduced the specification from Shaw's equation (8), plus information in the text, the footnote to Table 1 and note 11.

The variable Asset is the share of financial wealth invested in risky assets, Risk3 ("take average risk") and Risk4 ("take no risk") are the risk attitude dummies, with taking substantial and above-average risk as the omitted category. For ease of comparison, we copy Shaw's Table 1, as our own Table 1.

Shaw does not report the coefficients on the controls in *H* nor the intercept. The variables included in *X* are: changes in tenure, changes in tenure squared, changes in experience squared and level of education[7]. The results Shaw reports are completely in line with her predictions: risk-taking individuals obtain, through tenure, experience, and education, higher increases on wages. These clear results provided a strong stimulus to the present replication study.

Table 1. Shaw's original results, SCF 83-86 ΔLn(hourly wage)

		ASSET		***Risk dummies***	
		Coef	t	Coef	t
Asset	β	1.04	2.39		
Risk aversion weak (RISK3)	β_3			-0.4650	-4.37
Risk aversion strong (RISK4)	β_4			-0.5080	-4.54
Change years tenure (DTENURE)	a_{x1}	0.0320	6.08	0.0450	5.08
Change years tenure^2 (DTEN2)	a_{x2}	-0.0006	-3.07	-0.0007	-2.23
Change years experience^2 (DEXP2)	a_{x3}	-0.0007	-3.49	-0.0007	-4.79
Years of education (EDUC)	a_{x4}	0.0071	2.42	0.0068	1.79
R^2		0.0559		0.0586	
Sum squared error/sum weights		22.25		22.05	

Source: Shaw (1996), Table 1.

We replicate Shaw's estimations using an extension of her data set (1983 to 1989 instead of 1983 to 1986) and the German, Spanish and Italian data set[8]. Results are presented in Table 2. Following her specification, we use sampling weights to restore representativity in case of oversampling particular groups (which is not necessary for the Italian sample). Although Shaw only presents results for the main variables, we show the complete table.

As mentioned above, a particularity of the Spanish sample is that we only have information on individual's current wage and their starting wage with the present

[7] See footnote 11 and the note to Table 1 in Shaw's paper. The constant term is required to identify *ß*: without it the distinction between *ß* and *A* would be arbitrary.
[8] Following Shaw, we use the 20-64 age interval. For the SCF and the EFF, the results do not change significantly when this interval is changed (23-61 and 25-59 give similar coefficients).

employer. This means that the Spanish data resemble Shaw's sub-sample of job stayers. Empirically, this implies that the changes in tenure are equal to changes in experience and the (linear) effects of experience on wage growth cannot be disentangled from the (linear) effects of tenure. Thus we refer to the relevant variable as change in years of tenure/years of experience.

Table 2. Shaw's results replicated, ΔLn(hourly wage)

		Risk Dummies and Risk Attitude								*AS*				
		USA		**Germany**		**Spain**		**Italy**		**USA**		**Spain**		
		Coef	t	Coef	t	Coef	t	Coef	t	Coef	t	Coef	t	Coef
Constant	$\mathbf{a_0}$	0.450	2.75	0.219	7.26	-0.222	-1.46	0.166	2.12	0.646	5.86	-0.113	-1.50	-0.042
Risk 3 (averse)	$\boldsymbol{\beta_3}$	-0.460	-4.96			-0.067	-0.31							
Risk 4 (more averse)	$\boldsymbol{\beta_4}$	0.118	0.94			-0.279	-1.71							
Risk (0-10 transf.)	$\boldsymbol{\beta}$			0.025	0.59									
Asset	$\boldsymbol{\beta}$									1.116	4.52	1.249	2.85	1.130
Absolute Risk Aversion	$\boldsymbol{\beta}$							-0.593	-7.03					
Δ years tenure/exper.	$\mathbf{a_{X1}}$					0.067	3.22					0.042	4.23	
Δ years tenure	$\mathbf{a_{X1}}$	-0.007	-1.03	0.003	1.82			0.016	1.34	0 .009	2.47			0.002
(Δ years tenure)^2	$\mathbf{a_{X2}}$	0.000	1.19	$-1\cdot10^{-4}$	-0.39	$-1\cdot10^{-4}$	-0.46	-0.001	-2.16	$-1\cdot10^{-5}$	-0.77	$1\cdot10^{-5}$	0.08	$-1\cdot10^{-5}$
(Δ years experience)^2		-0.001	-5.99	-0.001	-12.44	$-5\cdot10^{-4}$	-2.28	$-1\cdot10^{-4}$	-0.61	-0.001	-7.64	$-4\cdot10^{-5}$	-3.26	$1\cdot10^{-5}$
Years of education	$\mathbf{a_{X4}}$	-0.021	-2.31	-0.000	-0.04	0.023	2.25	-0.012	-1.88	-0.004	-0.76	0.010	1.81	-0.001
Union	$\mathbf{a_{H1}}$	-0.137	-3.38							-0.107	-2.57			
Black	$\mathbf{a_{H2}}$	-0.295	-4.70							-0.219	-3.05			
Male	$\mathbf{a_{H3}}$	0.047	1.01	0.001	0.07	0.108	2.24	0.007	0.15	-0.120	-2.54	0.154	3.50	0.009
East	$\mathbf{a_{H1}}$			-0.002	-0.22									
German	$\mathbf{a_{H2}}$			-0.002	-0.13									
Big firm	$\mathbf{a_{H1}}$					-0.014	-0.33					-0.027	-0.65	
Single	$\mathbf{a_{H2}}$					0.065	1.37	-0.012	-0.26			0.111	2.47	-0.036
No permanent	$\mathbf{a_{H4}}$					-0.122	-2.54					-0.111	-2.49	
Part time	$\mathbf{a_{H4}}$													0.208
Centre	$\mathbf{a_{H4}}$							-0.066	-1.82					-0.060
South	$\mathbf{a_{H4}}$							-0.055	-1.84					-0.038
Nbr. Observations			1746		7562		758		1,309		1688		751	
χ^2 statistic			232.0***		276.32***		103.84***		122.37***		191.1***		92.73***	48
R^2			0.196		0.075		0.393		0.013		0.214		0.398	

Table 2 shows that Shaw’s initial results cannot unequivocally be reproduced. Consider first the results on the core theme, the mediating effect of risk attitude on investment intensity. When we measure risk attitude through asset holdings, the theory is confirmed for the US and for Spain, but not for Italy. For the US, the magnitude of the effect is similar to the original estimate (1.11 against 1.04). With direct measures of risk attitude, the model is clearly rejected for Germany and support in Spain is weak. In the US, more risk averse workers still have lower wage growth, but the most risk averse (Risk4) have no longer a wage growth that differs from those who love to take risk. For Italy, with the measure of absolute risk aversion, the prediction is strongly supported. Thus, the replication results are mixed, even for the US. In the European countries, either the dummy measure has the predicted effects or the asset measure, but not both. In Germany we have only one measure and it does not have the predicted effect.

The role of the human capital variables in explaining wage growth is also different from the initial results. In Table 1, the effect of changes in tenure is mostly positive and concave and presumably, the same holds for changes in experience (where only the quadratic effect can be estimated), a result that holds both in the risk dummy specification and in the asset share specification. These patterns are only weakly reproduced. The positive effect of change in tenure is found for Spain in both specifications, in the US for assets and in Germany at low level of significance (8%). The change in tenure squared is never significant except for Italy in the dummy specification. Only the change in experience squared is solidly negative except for Italy. The positive effect of years of education is only convincingly reproduced for Spain. Instead, in the US and Spain for risk dummy the effect of education is negative, which contradicts Shaw´s results.

In her footnote 11, Shaw notes that gender and race are never significant, while union membership has a negative effect. We replicate, for the US, the negative effect of union membership. However, being black has a negative effect in the replication and male has a negative effect although only for the asset share specification. In Spain, men have faster wage growth, in Germany and Italy there are no differences by gender.

We also find big differences in explained variance (R^2). It increases threefold in the US replication (from 0.06 in Shaw to about 0.2), it is remarkably low in Italy (0.01) and even more remarkably high in Spain (about 0.4) . To the latter outcome we will return later.

4.2 Heteroscedasticity

As Shaw notes, the model implies heteroscedasticity, as risk attitude is correlated with the error term (see equations (9) and (11)). There would be even more heteroscedasticity if we allow measurement errors in risk *R* or investment share *α*, as the error term would then also correlate with *X*. In her test, however, Shaw shows that heteroscedasticity is rejected (cf p. 639). She does not pay much attention to it, although in fact it strikes at the heart of the model: the very structure of the theory implies heteroscedasticity. We use the same test (White and Domowitz, 1984)[9] and present the results in the penultimate row (with the heading χ^2 statistic) of Table 2. We find significant levels of heterocedasticity in all specifications and countries. Thus, we now find support for the model where Shaw did not[10].

As heteroscedasticity is an important feature of the model, we regressed the squared residual from the regressions in Table 2 on risk attitude, schooling, experience and tenure. Results are reported in Table 3. Risk attitude is indeed related to the residual

[9] Using White and Domowitz's (1984) notation, our wage growth equation can be written as $Y = f(M,\theta) + e$, where *M* is a vector containing all explanatory variables (*Risk*, *X*, and *H*) and *θ* is the vector of coefficients (β, a_x, a_h). White and Domowitz's test consist on regressing the residuals squared of the above equation on the gradient vector $\partial f(M,\hat{\theta})/\partial\theta$ and all non-redundant products $\partial f(M,\hat{\theta}_i)/\partial\theta_i \cdot \partial f(M,\hat{\theta}_j)/\partial\theta_j, \forall i, j$. The resulting $N{\cdot}R^2$ follows a χ^2 distribution with K(K+1)/N degrees of freedom.

[10] In the results reported in Section 4 and 5, we do not correct for heteroscedasticity, to maintain comparability with Shaw's results. In our own empirical exercise, reported in Section 6, we will estimate robust standard errors.

variance, but only in three out of the seven specifications[11]. In the Asset specification, there is never a significant effect, in the dummy specification we find higher residual variance for the less risk averse, except for Spain, where there is no significant relationship at all. Education increases residual variance in the US, but not in the other countries. Men, remarkably, have lower residual variance in the US and Germany but not elsewhere. Tenure has no effect in the US, positive effect in Spain but negative effect in Germany and a weakly significant non-linear effect in Italy. With the exception of Germany, experience barely affects residual variance.

[11] Shaw does not run regressions but shows in a tabulation in footnote 22 that the variance of residual income growth and the variance of residual log income level are higher for individuals in classes with lower risk aversion.

Table 3. The sources of heteroscedasticity (squared residuals from regressions in Table 2)

		Risk Dummies and Risk Attitude												
		USA		**Germany**		**Spain**		**Italy**		**USA**		**Spain**		
		Coef	t	Coef	t	Coef	t	Coef	t	Coef	t	Coef	t	C
Constant	$\mathbf{a_0}$			0.274	7.17	0.041	0.18	0.378	2.40			0.030	0.15	0.
Risk 3 (averse)	$\boldsymbol{\beta_3}$	-0.351	-2.56			$-6\cdot10^{-5}$	-0.01							
Risk 4 (more averse)	$\boldsymbol{\beta_4}$	-0.026	-0.15			0.049	0.81							
Risk (0-10 transf.)	$\boldsymbol{\beta}$			0.029	4.54									
Asset	$\boldsymbol{\beta}$									0.028	0.22	0.008	0.09	-0.
Absolute Risk Aversion	$\boldsymbol{\beta}$							-0.086	-2.67					
Δ years tenure/exper.	$\mathbf{a_{X1}}$					0.066	2.69					0.063	2.57	
Δ years tenure	$\mathbf{a_{X1}}$	0.0014	0.13	-0.008	-3.53			0.025	1.49	0.003	0.26			0.
(Δ years tenure)^2	$\mathbf{a_{X2}}$	$-4\cdot10^{-5}$	-0.12	$-1\cdot10^{-4}$	-0.67	$3\cdot10^{-5}$	0.68	-0.001	-1.86	$-2\cdot10^{-5}$	-0.75	$1\cdot10^{-5}$	0.13	-0.
(Δ years experience)^2	$\mathbf{a_{X3}}$	$-1\cdot10^{-4}$	-0.28	$-1\cdot10^{-4}$	-4.82	$-6\cdot10^{-5}$	-1.86	$-1\cdot10^{-5}$	-0.51	$-1\cdot10^{-5}$	-0.23	$-5\cdot10^{-5}$	-1.64	1·
Years of education	$\mathbf{a_{X4}}$	0.047	2.84	0.001	0.25	-0.004	-0.25	0.006	0.71	0.051	2.46	$-7\cdot10^{-5}$	-0.06	0.
Union	$\mathbf{a_{H1}}$	-0.176	-1.67							-0.162	-1.62			
Black	$\mathbf{a_{H2}}$	-0.065	-0.66							-0.216	-3.10			
Male	$\mathbf{a_{H3}}$	-0.609	-3.20	-0.044	-3.65	0.037	0.92	-0.088	-0.68	-0.607	-3.11	0.044	1.22	-0.
East	$\mathbf{a_{H1}}$			-0.011	-0.75									
German	$\mathbf{a_{H2}}$			-0.002	-0.08									
Big firm	$\mathbf{a_{H1}}$					-0.148	-1..69					-0.145	-1.71	
Single	$\mathbf{a_{H2}}$					-0.020	-0.41	-0.101	0.84			-0.033	-0.76	-0.
No permanent	$\mathbf{a_{H4}}$					-0.034	-1.11					-0.031	-0.87	
Part time	$\mathbf{a_{H4}}$							0.513	1.89					0.
Centre	$\mathbf{a_{H4}}$							-0.054	-0.59					-0.
South	$\mathbf{a_{H4}}$							0.002	0.03					-0.
# Observations			1746		7562		758		1309		1746		751	
R^2			0.196		0.0179		0.137		0.0136		0.184		0.124	

4.3 The effect of risk on wage growth is the same through all the human capital variables.

Like Shaw, we consider the option that the effect of risk on wage growth is different for each of the four human capital variables used in the model. To do so, we expand the regression equations as follows:

$$\Delta \ln W_i = a_o + \sum_{j=1}^{J} a_j\, x_{ij} + \beta_o\, Asset_i\, a_o + \sum_{j=1}^{J} \beta_j\, Asset_i\, a_j\, x_{ij} + e_i \tag{14A}$$

$$\begin{aligned} \Delta \ln W_i = a_o + \sum_{j=1}^{J} a_j\, x_{ij} + \left[\beta_{3o}\, Risk_{3i} + \beta_{4o}\, Risk_{4i}\right] a_o + \\ + \sum_{j=1}^{J} \left[\beta_{3j}\, Risk_{3i} + \beta_{4j}\, Risk_{4i}\right] a_j\, x_{ij} + e_i \end{aligned} \tag{14D}$$

Shaw concludes that the coefficients β_j are not identical for all the x_j in the risk attitude dummy specification and that therefore the constraint imposed in equation (13) is not acceptable (footnote 14). In the Asset specification, she reports “lower significance levels”, without giving details[12].

The estimation results for equation (14) are given in Appendix Table B1. For Germany, we can confirm (as in Table 2) that risk does not play a role in determining wage growth. For the US we find that the specification still performs well, while for Spain, both specifications perform worse. For Italy, the absolute risk aversion specification performs very strongly, the asset share specification has mostly insignificant coefficients.

Let us now focus on whether or not the constraint of single risk interaction imposed in equation 13 (Table 2) is justifiable. We do this by testing for each interaction term whether the product of a_j and β (Table 2) is identical to the product of a_j and β_j (Table

[12] In footnote 14 Shaw also notes that she dropped interaction of the intercept with the risk attitude dummies. We decided not to follow her and stick to the full model.

B1), using a t-test for statistical difference[13]. The test results (t-values on significant differences are given in Table 4, column I; full details are in Appendix Table B2. For the case of Germany, we only show the t-tests for the interaction between risk attitude and changes in years of experience squared since this is the only coefficient in Tables 2 and 3 that shows a level of significance approaching acceptable levels. Equality of the risk aversion interactions is strongly rejected for the US, Germany and Spain, and less strongly but still significantly for Italy.[14]

[13] Since comparing estimates involves combined coefficients (e.g. $\beta \cdot a_{Xi}$), we need to take into account the standard deviation of such combination. This is done by using the "nonlinear combinations of estimators" option in STATA.

[14] For Italy the null hypothesis is not rejected for the interaction between ARA and years of schooling

Table 4: Testing model constraints

			t-values on the test		
			I	**II**	**III**
		Variable	$\beta a_j = \beta_j a_j$	$\theta_j = \beta a_j$	$\theta_j = \beta_j a_j$
US		Constant	58.61	-76.98	89.03
		Δ years tenure	-115.42	-109.04	35.74
	ASSET	(Δ years tenure)^2	129.59	-26.38	-35.11
		(Δ years experience)^2	-23.40	118.53	114.92
		Years of education	-48.33	3.43	-2.45
		Constant	167.66	-191.23	261.17
		Δ years tenure	-181.16	-132.58	0.90
		(Δ years tenure)^2	113.19	156.55	-37.10
		(Δ years experience)^2	-152.80	-121.10	-10.90
		Years of education	-104.53	-90.43	0.62
	RISK				
		Constant	167.36	-166.03	238.04
		Δ years tenure	-157.42	-101.07	0.70
		(Δ years tenure)^2	76.08	82.33	-19.94
		(Δ years experience)^2	-150.65	-100.79	-6.26
		Years of education	-153.90	-120.83	1.07
Germany	RISK	(Δ years experience)^2	-102.40	-138.01	-49.17
Spain		Constant	-18.64	19.12	15.01
		Δ years tenure/exp.	-83.47	-49.01	0.01
	ASSET	(Δ years tenure)^2	4.92	3.78	-0.04
		(Δ years experience)^2	87.61	49.43	0.13
		Years of education	22.12	28.84	0.02
		Constant	22.83	-0.26	18.86
		Δ years tenure/exp.	28.44	-18.43	31.49
		(Δ years tenure)^2	-41.51	6.99	-30.75
		(Δ years experience)^2	-9.60	9.64	-13.17
		Years of education	-23.92	0.81	-14.64
	RISK				
		Constant	17.88	0.23	14.24
		Δ years tenure/exp.	39.40	-13.81	34.17
		(Δ years tenure)^2	-41.29	-5.17	-20.79
		(Δ years experience)^2	-24.84	8.56	-19.97
		Years of education	-15.50	10.01	-17.48
Italy		Constant	1.76	66.08	66.01
		Δ years tenure	-2.96	2.10	-0.83
	RISK	(Δ years tenure)^2	4.50	3.07	7.59
		(Δ years experience)^2	-2.83	3.40	0.56
		Years of education	-1.55	4.16	2.58
		Constant	-77.25	-0.61	-80.28
	ASSET	Δ years tenure	279,11	-280.42	-0.97
		(Δ years tenure)^2	-116,77	117.99	1.81
		(Δ years experience)^2	-5,84	278.44	197.06
		Years of education	863,52	-870.11	-4.38

Column I: Table B2; column II: Table B5a; column III: Table B5b

4.4 Sensitivity to outliers and other misreporting

In the replication for the US we have tested the sensitivity of the results for outliers. If we exclude the top and bottom 1%, 2% or 5%, respectively, of wage growth, many coefficients are stable but the coefficients on some risk interaction terms change drastically, in magnitude, from significant to insignificant, from positive to negative. Shaw is silent on treatment of outliers, presumably because she does not apply any adjustment.

Another important issue is the treatment of inconsistencies, for example measured experience increasing more than the time elapsed between two moments of observation. Our results for Germany appeared quite sensitive to corrections of such inconsistencies (like restricting the change in experience to time elapsed between observations). However, since Shaw is also silent on these issues, we did not attempt a systematic correction and choose to accept inconsistencies as measurement errors.

As noted in the Appendix, the variable Asset has a very high proportion of zero's. This would imply that the individual's relative risk aversion is infinite, a rather extreme assumption. We tested the sensitivity to this extreme value by distinguishing zero and positive values: we added a dummy to the regression, thus including a dummy for having any risky financial assets at all and the share of risky financial assets. In the SHIW data for Italy, with the highest proportion of zero's, including the dummy has no effect on the results for the other variables; the significance level for the share of risky assets does not change in any relevant way[15].

[15] Brown and Taylor (2003), discussed below, also finds significant results if the sample is restricted to households with positive risky asset shares.

5. Testing constraints in Shaw's model

5.1 Introduction

Shaw derives her specification from a theoretical model and thereby imposes a number of *a priori* restrictions. In this section we will test whether the restrictions are accepted by the data. We can write a general specification of the equations as

$$\Delta \ln W_i = a_o + \sum_{j=1}^{J} a_j \, z_{i\,j} + \theta_o \, Asset_i + \sum_{j=1} \theta_j \; Asset_i \, z_{i\,j} + e_i \tag{15A}$$

$$\begin{aligned} \Delta \ln W_i = a_o + \sum_{j=1}^{J} a_j \, z_{i\,j} + \theta_3 \, Risk_{3i} + \theta_4 \; Risk_{4i} + \\ + \sum_{j=1}^{J} \theta_{3\,j} \; Risk_{3\,j} \; z_{i\,j} + \sum_{j=1}^{J} \theta_{4\,j} \; Risk_{4\,j} \; z_{i\,j} + e_i \end{aligned} \tag{15D}$$

We call this model the unconstrained model, as it does not constrain the parameters to reflect a strict multiplicative effect of risk or assignment of explanatory variables to risk sensitive human capital variables *X* and other variables *H*. Starting from this most general specification (15), we consider three questions.

The first question is whether risk is a relevant variable at all in the countries we study. This is a simple test of significance on coefficients relating to risk, θ. The second question is whether the assignment of variables to *X* (interaction) and to *H* (no interaction) is accepted by the data. The null hypothesis here is that $\theta_j = 0$ for some j so that the interaction with risk is not relevant, for variables such as male, union and black. The third question is whether the parameter constraints on the interaction terms are acceptable. Equations (13) and (14) follow from restrictions on (15). Hence, we test whether $\theta_j = \beta a_j$ (equation (13)) and whether $\theta_j = \beta_j a_j$ (equation (14)). Estimation results for equation (15) are given in Appendix Tables B3a-B3d. We will now seek an answer to our three questions.

5.2 Is risk statistically relevant at all?

As is clear from Table 5, the answer is yes. In each specification, in each country, there is some evidence that less risk averse individuals can have different wage growth either through a direct effect or by risk attitude affecting the impact of other relevant variables. Nevertheless, support for the underlying theory is sometimes quite weak. In Germany, the entire risk effect comes from one significant interaction term.

Table 5. Is risk attitude relevant at all?

	USA		***Germany***	***Spain***		***Italy***	
	Dummy	**Assets**	**Dummy**	**Dummy**	**Assets**	**ARA**	**Assets**
Risk attitude R	x	x	-	-	-	-	-z
R x Human Capital	x	x	x	-z		x	x
R x controls	x	x	-	x	-	x	x

x: t≥ 1.96 for at least one variable in the group, equation (15); source: Appendix Tables B3a-B3d
z: t≥ 1.64 for at least one variable in the group, equation (15); source: Appendix Tables B3a-B3d
ARA: Absolute risk aversion.

5.3 Is the assignment of variables between H and X statistically acceptable?

Shaw's distinction is an *a priori* distinction between variables that are postulated to affect investment and variables that do not. Education, tenure and experience are selected to affect post-school investment, union membership, race and gender are supposed not to affect investment intensity or pay-off. The investment variables interact with risk attitudes as the share of wealth invested in risky human capital depends on risk attitude. If this model structure is correct, Union, Black and Male should have no wage effects through the investment process: interaction with risk attitude should be rejected by the data.

As is clear from Table 5, this prediction of no interaction effects is not supported. Except for Germany and Spain (for Assets), interaction terms are significant for each country (see Appendix Tables B3a-B3d for details). Shaw's a priori choices are not even supported in the replication for the US. In the attitude dummy specification, Black interacts significantly with risk attitude, while in the asset specification interaction with male is significant. In Spain, single and male has significant interaction in the dummy specification, while indeed in the asset specification no control variable has significant interaction. In Italy, part-time has significant interaction in the absolute risk aversion specification, while male and single significantly interact in the asset specification.

Conversely, we find no significant interaction[16] with many human capital variables: not with education in Spain and Germany and not with education in the asset specification for the US, not for tenure in all specifications except the US with risk dummy and Spain (with assets and Italy with the self-assessed risk attitude, not for experience in Spain and Italy).

We must conclude that in the US, in Spain and in Italy but not in Germany some variables not directly connected to the investment process but reflecting demographic differences also interact with risk attitude. Conversely, for all specifications except the dummy specification in the US, there are human capital variables that should have an effect through interaction with risk attitude but that do not.

5.4 Are the parameter constraints on interaction terms acceptable?

Shaw's model constrains the interaction terms to a multiplicative specification with a risk attitude term and human capital terms. We could test these restrictions by comparing the coefficients on interaction terms in specification (15) with the constrained versions of (13) (identical risk attitude terms, Table 2) and of (14) (risk attitude terms vary by investment term, Table 3). However, as we are still in the replication and testing stage, we decided to stay closer to Shaw's specification and test the restriction on the model including Shaw's a priori distinction between human capital variables X and control variables H. The estimation results of (15) including this distinction (but without the restriction that the interaction term is the product of a and β) are given in Appendix Table B4a-B4d; we call this the unconstrained a priori model.

[16] At 5%; at 10% level results are slightly stronger.

In Appendix Tables B5a-b we test the constraints, by testing whether the difference between the constrained and unconstrained estimates is significant[17]. For Germany, this implies to focus exclusively on the coefficients of changes in years of experience squared and its interaction with risk, as this is the only statistically significant coefficient. In Table 4, we have collected the test results (t-values on the differences).

In column II of Table 4, where we test against Table 2 (single risk effect), the result is clear: equality of coefficients is rejected for the US, Spain, Germany and Italy. In column III, we test against Table 3, where the risk attitude term is allowed to vary with the variables in *X*. Now, the model is rejected outright for the USA and Germany, for Spain with the risk attitude dummies but not for the asset specification and it is weakly rejected for Italy in both specifications.

[17] As before, to test the equality of the estimates, we use a t-test statistic. Since comparing estimates involves combined coefficients (e.g. $\beta \cdot a_{Xj}$), we need to take into account the standard deviation of such combination. This is done by using the “nonlinear combinations of estimators” option in STATA.

5.5 Conclusion on the replications

We draw the general conclusion that Shaw's results are not very robust. Replicating the model as faithful as possible, we find many deviations from her original estimates. The unequivocal support that she reports in her Table 1 does not generally hold. In our view, the strongest blow to the model specification is the rejection of coefficients on interaction being equal to the product of coefficients on the separate terms, with only support in the asset specification for Spain. Yet, in all countries we find that risk attitude is relevant for wage growth: in the general specification, risk attitude has always some significant impact, one way or another. We also found support where Shaw did not: heteroscedasticity, solidly predicted by the model, was rejected in the original estimates, but we could not reject it in any of the four countries.

The outcomes of the replication studies differ between countries. Judging from the basic replications in Table 2 and the relevance of risk attitude assessed in Table 5, we conclude that there is a fair amount of support for the approach for the US and much less support for the other three countries. The strong result in Italy when risk attitude is measured with absolute risk aversion and the results in Table 5 suggest that support is stronger in Italy than in Spain and Germany, although the differences among the three European countries are quite weak. Before claiming any systematic effects here, we should reiterate differences in the data that may also leave their traces. There are differences in sample sizes (1746 for the US, 7562 for Germany, 758 for Spain and 1357 for Italy; the original US sample covered 2199 individuals), in the measurement of risk attitudes (ordinal intervals in US, Spain and Germany, reservation price for a lottery ticket in Italy) and in the length of the observation interval of wages (6 years in the US, 4 years in Germany, 3 years in Italy and a variable length -tenure- in Spain; the original interval was 3 years). We know that the length of the observation interval has an impact: results improve for longer intervals (Brown and Taylor, 2003; our own exercises for Germany). The data for Spain are most removed from the original dataset. They refer to job stayers only, we do not know working hours and the sample size is smallest. Shaw also estimates separately for job stayers, but this does not affect her results in a relevant way (R^2 increases from

0.06 to 0.08). These features may explain the very high share of explained variance in the Spanish data (see Table 2): smaller sample, longer observation period[18], stayers only.

It is tempting to relate the different outcomes to different features of the labour markets. Institutional rigidities and more formalised wage setting may preclude exploitation of differences in risk attitudes. Table 6 presents indicators of the scope for rewards to risk taking, by looking at wage dispersions. The dispersion of log wage is highest in the US and substantially lower in Europe. Within Europe, wage dispersion is indeed highest in Italy but not much higher than in Germany, while in Spain it is substantially lower, suggesting (somewhat) more opportunity for gainful risk taking in Italy than in Spain (and Germany). In the change in log wages, we find that Spain and Germany are close together, with smaller dispersion than in the US. The remarkable finding is the very high dispersion in Italy. We should note here that we measure the standard deviation of the average annual wage change i.e the wage change observed over the interval length as dictated by the sample. By averaging change over the length of the interval, transitional shocks are averaged out, presumably converging to their mean zero. Thus, it is not surprising that Spain has the lowest dispersion, as it has the longest interval (interval lengths are equal to tenure and on average these are much larger than 2 or 3 years). In Italy the interval is only two years long, and this would push towards high measured dispersion. Other data sources do not support the notion that Italy has relatively high inequality. In fact, in the European Community Household Panel, Italy comes out with the lowest earnings inequality of the four countries[19].

We can also look at institutional features of the labour market. Labour market regulation is much stronger in the US than in Europe. Within Europe there are also market differences but Italy is not known as markedly less regulated than the other two European countries. From the tables in Nickell (1997) we can see that in Italy union density and bargaining coordination, both on the employer side and on the union side, are at rather

[18] Brown and Taylor (2003), discussed below, report a strong increase in R^2 if the wage growth interval is increased from 2 to 3 to 5 years: 0.021, 0.087, 0.168.
[19] Inequality is measured in decile ratio’s; data from Wiemer Salverda, private communication. Budría and Díaz-Giménez (2007) report the same result in their Table 16: Italy has the lowest inequality of our three European countries in terms of Gini coefficient and coefficient of variation.

intermediate levels, union coverage (through collective bargaining) is high and the level of employment protection is very high. Support in case of unemployment, however, is at the low extreme among 20 OECD countries, with a replacement ratio of 20% and a benefit duration of 6 months.

Table 6. Standard deviations log-wages, changes in log-wages and residuals of Table 2 (dummies)

	US	Germany	Spain	Italy
Log wages	0.607	0.499	0.342	0.547
Change Log wages (annual averages)	0.138	0.103	0.087	0.257
Residuals (not squared)	0.873	0.408	0.485	0.492

With institutions endogenous, it is also interesting to look at measures of cultural differences between populations (although the relationship can easily go both ways, with institutions also shaping "tastes"). Hofstede (2008), in his project on measuring cultural differences between societies, measured risk attitudes by the Index of Uncertainty Avoidance. To cite its definition: "It indicates to what extent a culture programs its members to feel either uncomfortable or comfortable in unstructured situations. Unstructured situations are novel, unknown, surprising, different from usual. Uncertainty avoiding cultures try to minimize the possibility of such situations by strict laws and rules, safety and security measures, and on the philosophical and religious level by a belief in absolute Truth; 'there can only be one Truth and we have it". The score on the index is 46 for the US, 65 for Germany, 75 for Italy and 86 for Spain. The differences underline the commonly assumed gap in risk attitudes between the US and Europe, and in this sense match our results. But the ranking of the three European countries does not match our ranking of the replication results: relative to Spain and Germany, Italy does not stand out as a risk seeking society.

We conclude that our replication results appear to be in conformity with indicators of labour market differences between the US and Europe. The less regulated American labour market is more conducive to risk taking and in this environment Shaw's model performs better. But we are unable to link the differences in model performance within Europe to differences in labour market settings.

We should note that conceivably, an effect of risk attitude on wage growth may not be causal but reflect the impact of other variables that correlate with risk attitude. For example, ability as measured by IQ is known to have such correlation. Controlling for schooling, also known to correlate strongly with ability should at least partly remedy this defect. But in fact, we cannot rule out that the correlation between ability and risk attitude originates in the fact that both correlate with education.

6 A perspective on further research

The replications have taught us that risk attitude does have some relationship with wage growth. However, the restrictions implied by Shaw's model are not supported by the data. Moreover, we indicated in section 2 that we are critical about some features of the model. Here, we will comment on Shaw's model, specify a new model and present some final estimation results based on the new model.

6.1 Reflections on the Shaw model

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The Shaw model is interesting as it formalises an attractive intuitive notion on risk, individual risk attitudes and wages within the human capital framework. But as always, one can take issue with the details of the specification. We identify five issues where we do not fully agree with the specification. First, the share of investment in new human capital *s* is approximated as a constant, on the argument that differences between two periods will be small. But a constant investment rate is at variance with the key prediction from human capital theory that it declines with experience, because of declining marginal benefits (as remaining working life shortens) and increasing marginal cost (as opportunity cost goes up from increasing pay-off from accumulated earlier investments). In practice, the change in the investment share has a non-negligible effect on wage growth. A one percentage point drop per year does not appear unrealistic, but neglecting this would neglect one percent point wage growth per year, which may be a substantial share of annual wage growth. In the empirical specification, concavity of the earnings profile is restored by relating the productivity of investment in producing new human capital to the variables that in the conventional Mincer equation generate concavity (experience and tenure). While empirically it is immaterial whether concavity is due to declining investment volume or to declining investment productivity, the former interpretation is both more appealing and in line with standard human capital theory.

Second, equation (8) specifies an empirical relationship for the value of human capital itself, not for the value per unit of risk. This implies that the value of human capital investments depends on individual characteristics but that returns do not depend on risk. One would be inclined to predict that the labour market compensates for human capital risk as markets commonly do (see the evidence summarized in Hartog (2007), the example for the US in Hartog and Vijverberg (2007) and for Denmark in Diaz-Serrano et al. (2008)). If so, human capital risk would appear on the left hand side of (8). Remarkably, this would explain why Shaw does not find heteroscedasticity

Third, equation (8) relates the value of human capital investment to the *level* of schooling and to *changes* in tenure and experience. This is an unmotivated ad hoc specification. Why would the value of investment depend on the change in tenure, rather than on tenure itself?

Fourth, risk is not visible in the pay off to investment. The risky investment share responds to human capital risk (see equation (5)), but wages, ie the return to human capital, shows no sign of risk: according to equation (8) the value of human capital investments is subject to measurement errors but not to any volatility.

Fifth, it is not clear what the return to human capital is. If μ-η in equation (5) refers to the rental rate of human capital, one would expect it to appear in the wage equation. If it is the discounted return per unit of investment, one would expect it to decline with age because of the shrinking horizon, unless infinite working life is assumed.

6.2 A new model

In reaction to the shortcomings we identified above, we have constructed a new model to deal with risky human capital investment. We are rather pragmatic about this attempt. We do not intend our model to serve purely analytical purposes, with all the required precision and detail, we just want it as a framework for guidance and interpretation of empirical work.

Suppose, individuals at age t invest a share s_t of their stock of human capital in the production of new capital. From standard human capital theory we know that this share will be declining in t, as marginal benefits fall from an approaching finite horizon and marginal costs increase with the returns to earlier investment. The result is a capital stock net of new investment, K_t, that is increasing in t at a decreasing rate and possibly declining after some point if depreciation starts to bite.

Suppose, after deciding on their total investment, individuals decide on the degree of risk of their human capital portfolio (this means we neglect possible effects of risk attitude on total investment). There are two types of human capital, safe and risky. The safe human capital has return r, the risky has return $\mu + \varepsilon_t$, where $E(\varepsilon_t) = 0$, $E\left(\varepsilon_t^2\right) = \sigma^2$ and $E\left(\varepsilon_t \varepsilon_{t+j}\right) = 0$. Standard investment theory tells us that the share invested in the risky asset, s^r ,equals

$$s^r = \frac{\mu - r}{\sigma^2 R} \qquad (16)$$

where R is half the Arrow-Pratt measure of relative risk aversion. This is just like Shaw's model (see also Hartog and Vijverberg, 2007, which spells out the derivation).

We can now write the wage at age t, W_t, as the return on human capital:

$$W_t = K_t \left\{ \frac{\mu - r}{\sigma^2 R}\left(\mu + \varepsilon_t\right) + \left(1 - \frac{\mu - r}{\sigma^2 R}\right) r \right\} \tag{17}$$

The first part is the return on risky human capital, the second on safe human capital, both weighted by their share in total net wealth *K*. We can rewrite this to

$$W_t = K_t \left\{ r + \frac{\mu - r}{\sigma^2 R}\left(\mu - r\right) + \frac{\mu - r}{\sigma^2 R}\,\varepsilon_t \right\} = K_t P_t \tag{18}$$

P_t is the average return on the individual's human wealth. Note that we made the assumption that the individual always invests in the same proportion in safe and risky human capital, whether in school or in the post-school environment. In school, this involves selecting the proper mix of courses (Hartog and Vijverberg, 2007), when in the labour market this involves selecting the relevant career profile in terms of on-the-job training, formal courses, type of firm and industry, type of employment contract (.e.g length of probation periods), etc. Note that Shaw explicitly models growth of the human capital stock but does so at a constant investment rate. We just assume the standard human capital stock profile and model the share of risky investments in total human capital investment; this share will be constant unless some parameter would change with age.

Equation (18) provides a good framework for estimation and interpretation. The wage is multiplicative in net human wealth and its rental price *P*. The price *P* is a weighted average of returns on the safe investment, of the risk premium and of the stochastic shock. We will derive key predictions, both for wage levels and for wage changes. Wage changes are defined as

$$\Delta W_t = W_t - W_{t-1} = P\Delta K_t + K_t \frac{\mu - r}{\sigma^2 R}\left(\varepsilon_t - \varepsilon_{t-1}\right) \tag{19}$$

Expected wage growth follows the net capital profile, actual wage growth dances around this profile according to the difference in shocks, weighted by a term in *R*: both wage and wage growth have heteroscedastic errors, in risk aversion *R* and in capital stock *K*, i.e. in the dimensions of time (age, experience, tenure).

The expected wage level is negative in risk aversion *R*:

$$\frac{\partial W_t}{\partial R} = -K_t \left\{ \frac{(\mu - r)^2}{\sigma^2 R} + \frac{\mu - r}{\sigma^2 R} \varepsilon_t \right\} \frac{1}{R} \tag{20}$$

which has a negative expectation, as $E(\varepsilon_t) = 0$. (remember that we have assumed a two-step decision process, where individuals first decide on total investment and then on the degree of risk in their portfolio; total investment is then not affected by risk attitude).

Wage growth is also negative in risk aversion:

$$\frac{\partial \Delta W_t}{\partial R} = -K_t \frac{\mu - r}{\sigma^2 R} \frac{1}{R} \left(\varepsilon_t - \varepsilon_{t-1} \right) + \Delta K_t \frac{\partial P_t}{\partial R} \tag{21}$$

With $E\left(\frac{\partial P_t}{\partial R}\right) < 0$, this implies a negative expected derivative if K is increasing and a positive derive if K is decreasing: higher risk aversion gives smaller absolute values of expected wage growth.

We can also be explicit on wage variances. The variance of the wage level can be derived as

$$V(W_t) = E\left\{W_t - E(W_t)\right\}^2 = K^2 \left(\frac{\mu - r}{\sigma^2 R} \right)^2 \sigma^2 \tag{22}$$

which implies

$$\frac{\partial V\left(W_t\right)}{\partial t}=2V\left(W_t\right)K_t^{-1}\frac{\partial K_t}{\partial t}$$

$$\frac{\partial V\left(W_t\right)}{\partial R}=-2V\left(W_t\right)\frac{1}{R}<0 \tag{23}$$

The variance of the wage level increases or decreases with the change in the capital stock and declines with increasing risk aversion. The variance of wage growth can be derived as

$$V\left(\Delta W_t\right)=K_t^2\left(\frac{\mu-r}{\sigma^2 R}\right)^2 V\left(\varepsilon_t-\varepsilon_{t-1}\right)=2K_t^2\left(\frac{\mu-r}{\sigma^2 R}\right)^2\sigma^2 \tag{24}$$

This is simply twice the variance of the wage level and thus, the derivatives of wage level and wage growth variance have the same sign.

Thus, our model has the same key predictions as Shaw's: wage level, wage change, wage variance and variance of wage change are all declining in risk aversion. Empirical work can focus on these key predictions.

6.2 Implications for estimation.

The structure of the wage equation leads to suggestions for estimation. The wage function is built up as a multiplication of size of the net capital stock and its rental price. The capital stock develops in function of age, experience and tenure. The (initial) level of the capital stock will also vary with education. The pricing equation depends on what we assume about the market for human capital. If human capital is homogeneous and divisible, like financial capital, rental rates r and μ are identical across the market and the variance of the return for the risky asset may also be the same throughout. The individual rental rate then only varies with R. If the market has subsets (i.e. capital heterogeneity across types, e.g. industries, or education) the price will vary across subsets with these characteristics.

The wage equation we derived is highly similar to that developed by Shaw. But our clear separation in a human capital component and a pricing component can provide good guidance to specifications for estimation, as just suggested. We will not pursue this in the present paper. We will simply conclude by estimating a wage level equation and a wage change equation derived from the same specification, thus avoiding the curious ad hoc mixture of level and change variables that Shaw applied. If we estimate a *wage level* equation, we should have variables to reflect the capital stock: education, experience, experience squared, tenure, tenure squared. The pricing component should be represented by risk attitude, multiplicatively and the error term should also enter multiplicatively. We can use a multiplicative specification for the wage level, or estimate a log specification.

If we estimate in *wage changes*, we can still use education, experience, experience squared and tenure, tenure squared, to reflect the changes in the capital stock, and there should be a multiplicative component in capital stock, risk attitude and error.

More specifically, we have

$$W_t = \left\{k_0 + k_1 S + k_2 E + k_3 E^2 + k_4 T + k_5 T^2\right\} \left\{a + bR^{-1}\right\} + u \qquad (25)$$

$u_t = K_t \dfrac{\mu - r}{\sigma^2 R} \varepsilon_t$, i.e. heteroscedastic in K and R.

In changes, we would have

$$\Delta W_t = \left(a + bR^{-1}\right) \left\{k_2 \Delta E + k_3 \Delta E^2 + k_4 \Delta T + k_5 \Delta T^2\right\} + u_t \qquad (26)$$

$$u_t = K_t \frac{\mu - r}{\sigma^2 R}\left(\varepsilon_t - \varepsilon_{t-1}\right),$$ i.e. heteroscedastic in K and R.

The difference with the Shaw model is that we systematically distinguish between the capital stock and its price, and between a level specification and a change specification derived from the same basic model; we do not allow education to affect the change in wages. . As in Shaw, we do not invert the risk attitude measures but just enter them as they are, multiplicatively. To link up with the earlier results and common practice, we estimate earnings in logs. Table 7 presents the results.

As Table 7a shows, the relevance of risk attitudes for wage levels is almost uniformly supported. Only in the ARA specification for Italy is risk attitude not significant. When we estimate in changes (of log earnings), in Table 7b, results are somewhat weaker: standard errors increase, and for the US, the most risk averse have no longer the largest wage growth, the coefficient for Germany is no longer significant. For Italy there is a reversal: risk attitude measured through asset holdings is no longer significant, but when measured directly in attitude it is[20]. Note that we also find remarkably similar rates of return to education in the European countries: 7%, as compared to 9% in the US. Thus, we find remarkably strong support for our specifications. In wage levels, risk attiudes is only insignificant in the dummy specification for Italy; in all other cases, we find the predicted signs at conventional significance levels. In wage changes, our results are closer to the replication results: no significance in Germany, no significance in Italy for assets, a non-monotonic result for the USA in dummies.

Brown and Taylor (2003) use data from the British Household Panel Surveys and also estimate the relationship of wage growth to risk attitude. The panel has no direct evidence on risk attitudes but it does have evidence on the risky asset share. They estimate Shaw's

[20] We have also estimated the models for wages rather than log wages. In levels the result are qualitatively quite similar to those in log levels (only the asset coefficient for Italy is no longer significant). In changes, estimation results are markedly weaker: a perverse result for the US in dummies, the Spanish dummy coefficients are no longer significant and the ARA specification for Italy does not converge. The risk coefficient for Germany is significant though. Thus we now find for Germany that risk attitude is significant in all specifications except in changes of log wages.

model, with an a priori distinction between human capital variables X and controls H. However they deviate from Shaw by measuring experience in levels, allowing experience squared to be included, by omitting tenure and by measuring education in degrees rather than years. Asset share has a significant effect on wage growth; magnitude and t-value increase if they extend the interval of observed wage growth from 1995-1996 to 1995-1998 and further to 1995-2000. Coefficient and significance level also increase if they instrument asset share. Thus their results also indicate that there is some sort of a relationship, but they relate wage growth to levels of experience, which does not seem proper to us.

Finally, we tested the prediction that residual wage variance (risk) is higher for those who are less afraid to take risk. As Table 8 shows, the results are mixed. There is clear support for the prediction in Germany, a fair amount of support in Spain, weak support in the US, support in Italy for the absolute risk aversion specification but not for the asset specification. Significance levels do not change when we add the other variables to the regression equation, and magnitudes of coefficients are only marginally affected. Again we find better performance for the level specification than for wage changes. In levels, only the coefficient for Risk 4in the US and the coefficient for assets in Italy violates the prediction of wage variance increasing in willingness to take risk.

Table 7a. Estimating the new model, in levels

	Risk dummies and Risk Attitude								*Assets*						
	USA		**Germany**		**Spain**		**Italy**		**USA**		**Spain**		**Italy**	
	Coef	t	Coef	t	Coef	t	Coef	t	Coef	t	Coef	t	Coef	t
Constant	0.933	9.12	0.738	24.48	6.12	79.48	0.803	0.10	1.031	10.62	5.844	100.51	0.809	8.14
Risk 3 (averse)	0.002	0.17			-0.033	-4.40								
Risk 4 (more adverse)	-0.078	-6.34			-0.042	-5.88								
Risk (0-10 transf)			0.008	3.52										
Absolute Risk Aversion							-0.001	-0.23						
Asset									0.134	9.27	0.026	6.03	0.008	2.21
Years of tenure/exp.					0.008	1.20					0.011	1.69		
Years of tenure	0.024	5.93	0.023	15.71			0.013	3.01	0.015	4.02			0.013	3.09
(Years of tenure)^2	$-3\cdot10^{-4}$	-2.20	$-1\cdot10^{-4}$	-7.88	$-1\cdot10^{-5}$	-0.22	$-1\cdot10^{-4}$	-1.81	$-1\cdot10^{-5}$	-0.86	$-1\cdot10^{-5}$	-0.22	$-1\cdot10^{-4}$	-1.93
Years of experience	0.005	0.83	0.024	14.02			0.018	2.91	0.009	1.51			0.018	0.00
(Years of experience)^2	$-1\cdot10^{-4}$	-0.83	$-1\cdot10^{-4}$	-11.90	$3\cdot10^{-5}$	0.42	-0.000	-2.34	$-2\cdot10^{-4}$	-1.88	$-1\cdot10^{-5}$	-0.30	-0.000	-2.37
Years of education	0.090	19.54	0.071	43.20	0.074	18.69	0.069	18.14	0.075	15.69	0.071	19.03	0.067	17.29
Union	0.119	4.82							0.130	5.08				
Black	-0.300	-8.64							-0.192	-4.70				
Male	0.243	9.06	0.241	26.40	0.285	10.46	0.123	2.52	0.207	7.55	0.289	10.60	0.119	2.45
East			-0.324	-30.33										
German			-0.022	-1.20										
Big firm					0.186	8.03			0.175	7.55				
Single					0.014	0.55			0.034	1.30				
No permanent					-0.135	-4.87			-0.126	-4.53				
Part-time														
Centre							-0.003	-0.10					0.004	0.14
South							-0.090	-3.06					-0.081	2.74
Married							0.017	0.37					0.018	0.39
N	2028		10402		1364		1309		1949		1353		1309	
R^2	0.965		0.960		0.998		0.94		0.966		0.998		0.940	

Table 7b. Estimating the new model, in changes

	Risk dummies and Risk Attitude								*Assets*					
	USA		**Germany**		**Spain**		**Italy**		**USA**		**Spain**		**Italy**	
	coef	t	coef	t	coef	t	coef	t	coef	t	coef	t	coef	t
Constant	0.855	9.70	0.216	19.40	0.094	2.14	0.030	1.13	0.396	7.58	0.068	2.54	-0.023	-1.38
Risk 3 (averse)	-0.546	-7.13			-0.083	-0.48								
Risk 4 (more adverse)	-0.045	-0.41			-0.298	-2.30								
Risk (0-10 transf)			0.026	0.62										
Absolute Risk Aversion							-0.621	-5.26						
Asset									1.878	4.33	0.815	3.66	0.044	0.11
Δ years of tenure/exp.					0.089	4.23					0.057	5.82		
Δ years of tenure	0.003	0.45	0.003	1.81			0.010	0.92	0.007	2.40			0.005	0.79
(Δ years of tenure)^2	$4\cdot10^{-4}$	1.69	$-1\cdot10^{-4}$	-0.38	-0.001	-1.55	-0.001	-1.71	$-1\cdot10^{-4}$	-1.07	$-1\cdot10^{-4}$	-0.88	$-1\cdot10^{-4}$	-0.67
Δ years of experience			-0.001	-12.64										
(Δ years of experience)^2	-0.002	-7.45			-0.001	-2.70	$-1\cdot10^{-4}$	-0.49	-0.001	-6.50	$-4\cdot10^{-4}$	-3.78	$1\cdot10^{-4}$	0.41
N	1746		7561		758		1309		1688		751		1359	
R^2	0.175		0.07		0.377		0.005		0.202		0.389		0.002	

Table 8 Regression of squared residuals on risk attitude

	USA		Germany		Spain		Italy	
	coef	t	coef	t	coef	t	coef	t
ln wages								
Risk 3	0.003	0.09			-0.052	-1.44		
Risk 4	-0.041	-1.03			-0.072	-2.08		
Risk (0-10)			0.024	5.61				
Absolute risk aversion							-0.082	-2.77
Assets	$1\cdot10^{-7}$	6.99			0.042	2.28	-0.018	-0.87
Δ ln wages								
Risk 3	-.445	-3.87			0.018	0.15		
Risk 4	-.035	-0.29			0.048	0.42		
Risk (0-10)			0.035	5.66				
Absolute risk aversion							-0.089	-2.77
Assets	$4\cdot10^{-9}$	0.07			0.133	1.92	-0.004	-0.21

The residuals are from the regressions in Table 7a and 7b

7. Conclusion

Shaw's model can be considered a forerunner of the emerging research on the role of risk taking in schooling choices and their consequences. In her contribution she reports clear support for the prediction that individuals who are less afraid to take risk will experience higher wage growth. The prediction is based on the notion that human capital is a risky investment: less risk averse individuals invest more and thus will reap more benefits. In our replication we found a fair amount of support for the US, but les support for three European countries. We found little support for her specific model; restrictions on parameters following from her model were generally rejected. As we were not fully comfortable with the analytical model itself, we formulated a new model in the same spirit, taking the life-cyle investment profile as given and focusing on the mix between safe and risky human capital. Just as when testing of Shaw's model, we found general support for the basic predictions of our model: wages are sensitive to an individual's risk attitude and residual wage variance, a measure of risk, is indeed higher for individuals with lower risk aversion. Support is stronger for a regression in wage levels than in wage changes. Support for the relevance risk attitudes is also reported by Brown and Taylor (2003) for the UK and by Bonin at al (2007) for Germany. The impact on residual variance has not gotten much attention so far, but is an essential part of the story.

Our conclusion from this paper is that continuing the line of research is promising. Both intuition and direct observation as well as empirical research indicate that risk taking is relevant in the labour market and that risk attitudes will matter. To move ahead, it would seem important to reflect on the possible channels of transmission of risk attitude on wages and wage growth. One may think of participation in training, the nature of these training programs (one type of training may provide more protection in the labour market than another) and of mobility, between jobs and employers. Job mobility may involve taking on new risks (although this depends on the nature of labour contracts) and we also know that voluntary movers usually have higher wage growth than stayers (see e.g. García-Pérez and Rebollo (2005)). But also within firms, depending on the level and the nature of the job, there will be scope for more or less risky actions and initiatives and this may impact on careers. Charting his territory will be an interesting next step.

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Appendix A. Description of the datasets.

The results reported in this paper are based on the Survey of Consumer Finances (SCF), issued by the US Federal Reserve Board in cooperation with the Department of the Treasury; the German Socio-Economic Panel (SOEP), conducted by the German Institute for Economic Research in Berlin, the Bank of Spain's Encuesta Financiera de las Familias (EFF) and the Bank of Italy's Survey of Household Income and Wealth (SHIW).

These surveys include rich information on a large number of socio-economic variables on demography, education, employment, income, housing and wealth. The main goal of the SCF, the EFF and the SHIW is to provide detailed microeconomic information about the households' wealth status and financial decisions. The GSOEP, in turn, puts less emphasis on household wealth to focus more explicitly on labour market and living conditions.

In the following we describe the waves that we have used in the paper.

SCF (1983-1989). The SCF is a cross sectional survey conducted every three years since 1983. Even though it has no panel structure, in 1986 a very brief re-interview was conducted with the 1983 SCF respondents. Shaw's (1996) results are based on data from these re-interviewed households. However, this information is no longer publicly available: alter the 1989 wave it was decided to base the panel on the 1983 and 1989 waves and disregard most of the information collected in 1986. Specifically, in the 1983-1989 panel "the 1986 SCF is treated only as a source of limited information for the construction of the cross-section variables mentioned above and for some very limited editing. No other information from the 1986 SCF is used in the construction of the 1983-1989 panel file and 1986 variables were not used to condition either the 1983 or 1989 imputations". The results in this paper are, thus, based on the 1,479 households from the 1983 wave that were re-interviewed in 1989. For further details see Kennickell and Starr-McCluer (1997).

GSOEP (2000-2004). The German Socio-economic Panel (SOEP) is a large household panel which includes all individuals older than 16 living in a sampled household. The SOEP panel started in the old Federal Republic of Germany in 1984 and included the former East-Germany from 1990 onwards. In 2004 the panel included for the first time a question on risk. In the empirical analysis we therefore include the year 2004 and go back to 2000. The changes in wage and any other variable are defined on the 4-year span (from 2000 to 2004), to give the model a fair chance (the German results get very weak for shorter periods). In this way we closely replicate Shaw's results. Using yearly changes instead leads to mostly non-significant coefficients. For obvious reasons the sample is restricted to those individuals who are working in both years. In order to look at wage changes, we have to assume that individuals' risk attitudes measured in 2004 have been stable from 2000 to 2004.

In the sample there are 7740 individuals who were present in both years, i.e. 2000 and 2004. Following Shaw we delete from the sample individuals younger than 21 and older than 64 in 2004. Then we are left with 7631 observations. These are the ones we use in our regressions.

EFF (2003). The first wave of the EFF is based on data collected from October 2002 to May 2003. During that time, 5,143 households were interviewed. The EFF was modeled after the American SCF. Only 758 individuals out of 5 143 in the original sample report the starting salary in their actual firm. Since this variable is needed to calculate the annual wage growth used in our regressions, we are forced to work with such a small subsample.

SHIW (1993-1995). The data we use in our study comes from the Italian Survey of Household Income and Wealth (SHIW). It is a panel survey (annual from 1977 to 1987 and biannual from 1989 to 2000) carried out by *Banca d'Italia* (Italian Central Bank). The survey contains detailed information on household characteristics, employment, income, assets, financial habits, type of home tenure and several questions related to homeownership and borrowing conditions. Additionally, starting from 1995, the survey also includes rotating questions aimed at the analysis of specific issues. The 1995 wave contains questions addressed to the household heads that allow us to construct a measure of absolute risk aversion. We use the waves corresponding to 1993 and 1995 to estimate real wage growth. We chose this two-year interval as it provides an acceptable number of individuals with valid answers in the risk attitude question that are present in both waves (1,357 household heads). Alternative samples could be also constructed using the waves corresponding to 1995 and 1998, or 1995 and 2000. However, these two periods would provide small samples, i.e. about 550 and 350 observations, respectively.

The survey also provides information on the amount of assets held by the households. It allows us to construct a measure of risk behaviour based on the percentage of risky assets over all assets (see below).

There are some concepts that are common across surveys and that we use in this paper:

Households. A household is defined as a group of people that share expenses and the same dwelling. It includes household members that are temporarily absent and excludes domestic servants. The SCF and the EFF consider the person who chiefly deals with the financial issues of the household to be the household head.

Earnings. We define labour earnings as the sum of after tax labour income both from paid employment and from self-employment. Note that we include only wage income from a person’s own business firm, not all income.

Hourly wages. We define hourly earnings as after tax annual labour income divided by hours worked per period. Hours per period are based on measured hours per week, adjusted to match the observation period for earnings. In the Italian and the Spanish data, wages are deflated to real terms using the CPI series, in the other datasets they are not. This makes no difference if observation spells have equal length.

Wealth. We define wealth as the value of assets minus debts. Our definition of assets includes financial and real assets, including the value of residences and real estate, businesses, vehicles, jewels, works of art, antiques, stock and fixed-income securities; bank accounts; mutual funds; the present value of pension schemes; the cash value of insurance policies, and other assets, including lent assets. The SCF and the EFF oversample wealthier households. Oversampling is intended to better characterize the economic status of the wealthy, and to get a sample that represents the total wealth holdings of the population.

Weighting. To make the sample representative of the total population, the surveys include sampling weights. These weights are the inverse of the probability of being included in the sample, given the oversampling of the wealthy, geographical stratification, and differential unit non-response. This probability is calculated using the household socio-economic characteristics, such as the size of the municipality where the household is located, its census area, and its wealth and income level. In the Italian SHIW we do not apply weighting, as the sample is representative.

Risk attitude (SCF, EFF and SHIW)

Following Shaw (1996), we proxy the attitude of individuals towards risk using two different types of information. The first one is based on the proportion of risky assets that the individuals has relative to his total net worth. We follow Shaw in taking the share of risky financial assets among financial assets and not among all assets (or wealth). Residential investment, included in wealth but not in financial assets, is investment in a far less perfect market than the stock market and involves other considerations that would make the home investment less informative on risk attitudes. In line with Shaw we call this variable ‘ASSET’.

The problem with the asset variable is of course that many households have no risky assets. In the original Shaw data, 1072 households out of 2199 or 48.75 % have no risky financial assets. In our four data sets, the percentages having no risky financial assets are 42.8% in SCF, 55.8% in EFF and 88.1% in SHIW.

The second type of information is form individual self-assessment of risk attitude. In SCF and EFF this is based on the question:

- *Which of the following statements do you feel best describes your household in terms of the amount of financial risk you are willing to run when you make an investment?*

  1.-Take on a lot of risk in the expectation of obtaining a lot of profit

  2.-Take on a reasonable amount of risk in the expectation of obtaining an above-normal profit

  3.-Take on a medium level of risk in the expectation of obtaining an average profit

  4.-You are not willing to take on financial risk

Following Shaw, we define the dummy RISK4 = 1 if the individual answers “4” (= 0 otherwise) and RISK3 = 1 if the individual answers “3” (= 0 otherwise) to the above question.

In the SOEP, the individuals’ risk attitudes are measured using a self-reported measure of willingness to take risks (for an extensive discussion on the validity of this measure in the SOEP see Dohmen et al., 2005). The question runs as follows, with different worodings for the different areas, e.g. occupation, health, or financial matters:

People can behave differently in different situations. How would you rate your willingness to take risks in the following areas (……..)?
where 0 means: 'risk averse' and the value 10 means: 'fully prepared to take risks'

We use the risk measure with respect to occupation.

Finally, in the SHIW, the second measure of risk-aversion is based on individual responses to the following question:

> "*You are offered the opportunity of acquiring a security permitting you, with the same probability, either to gain 10 million lire* (≅ €5,200) *or to lose all the capital invested. What is the most you are prepared to pay for this security?*"

Using a Taylor series approximation to the utility function Hartog et al. (2002) obtained the following expression for the Arrow-Pratt measure of absolute risk aversion (ARA):

$$ARA_i = \frac{(\lambda Z - P_i)}{\left[\frac{1}{2}(P_i^2 + \lambda Z^2) - \lambda P_i Z\right]}, \qquad (1)$$

where λ is the probability of wining this "lottery", Z is the "prize" and P is the amount that individuals are willing to pay. According to (1), individuals who are willing to pay about 5 million lire (P≅€2,600) are assumed to be risk neutral (ARA=0). Below this amount, individuals are assumed to be risk averse (ARA>0); and above this amount, risk lovers (ARA<0). For maximum risk aversion (P=€0) we get ARA=2/Z, and for maximum risk loving (P≅€5,200) we get ARA=-2/Z. In the estimates we present we have multiplied ARA by 10, to get a more convienent scale.

This measure has proven a good performance in studies regarding the effect of risk attitudes on individuals' economic decisions (Diaz-Serrano, 2005). This author shows that this ARA measure computed with the same data exerts a significant negative effect on e.g. the investment in risky assets, the probability of being self-employed or the probability of being homeowner for households with risky incomes.

APPENDIX B. ADDITIONAL TABLES

Table B1. Allowing ß to vary for human capital variables (equation (14)), ΔLn(hourly wage)

		Risk dummies and Risk Attitude								*Assets*					
		US		**Germany**		**Spain**		**Italy**		**US**		**Spain**		**Italy**	
		coef	t	coef	t	coef	t	coef	t	coef	t	coef	t	coef	t
Constant	a_0	1.588	5.4	0.216	7.13	-0.068	-0.12	0.143	1.52	0.555	3.21	-0.342	-2.62	-0.086	-1.47
Asset	β_0									1.223	1.59	-1.472	-2.22	-0.671	-1.26
Risk (0-10 transf.)	β_0			-0.055	-0.44										
Risk 3 (averse)	β_{30}	-1.045	-10.23			3.720	0.09								
Risk 4 (more averse)	β_{40}	-0.912	-9.36			0.761	0.05								
Absolute Risk Aversión (ARA)	β_0							-0.713	-2.30						
Risk3 * (Δ years tenure/exp.)	β_{31}					3.011	0.17								
Risk3 * (Δ years tenure)	β_{31}	-1.673	-5.97												
Risk3 * (Δ years tenure)^2	β_{32}	-1.474	-6.29			2.760	0.05								
Risk3 * (Δ years experience)^2	β_{33}	-0.873	-9.10			2.147	0.11								
Risk3 * Years education	B_{34}	-1.411	-3.24			-0.097	-0.07								
Risk4 * (Δ years tenure/exp.)	β_{41}					2.449	0.16								
Risk4 * (Δ years tenure)	β_{41}	-1.473	-5.10												
Risk4 * (Δ years tenure)^2	β_{42}	-1.008	-3.51			-1.462	-0.19								
Risk4 * (Δ years experience)^2	β_{43}	-0.620	-4.73			2.522	0.12								
Risk4 * Years education	β_{44}	-2.677	-2.63			-0.641	-1.15								
ARA * (Δ years tenure/exp.)	β_1							-0.387	-2.23						
ARA * (Δ years tenure)	β_2							-0.486	-4.56						
ARA * (Δ years tenure)^2	β_3							-1.331	-0.45						
ARA * (Δ years experience)^2	β_4							-0.612	-3.16						
$Risk_{0-10}$ * (Δ years tenure/exp.)	β_1			0.716	0.99										
$Risk_{0-10}$ * (Δ years tenure)	β_2			2.864	0.39										
$Risk_{0-10}$ * (Δ years tenure)^2	β_3			0.130	1.63										

$Risk_{0-10}$ * (Δ years experience)^2	β_4			17.945	0.06										
(Δ years tenure/exp.)	a_{X1}					0.015	0.23					0.050	2.99		
(Δ years tenure)	a_{X1}	-0.043	-3.34	0.003	1.73			0.022	1.74	0.002	0.21				
(Δ years tenure)^2	a_{X2}	0.001	3.74	$-1\cdot10^{-4}$	-0.41	$-1\cdot10^{-4}$	-0.07	-0.001	-2.43	0.001	2.35	-0.001	-2.94		
(Δ years experience)^2	a_{X3}	-0.003	-6.55	-0.001	-12.65	$-1\cdot10^{-4}$	-0.16	$-3\cdot10^{-5}$	-0.30	-0.001	-6.06	$-2\cdot10^{-4}$	-0.76		
Years education	a_{X4}	-0.032	-1.82	$1\cdot10^{-4}$	0.06	0.032	0.74	-0.012	-1.76	0.007	0.63	0.030	3.37		
Asset * (Δ years tenure/exp.)	β_1											0.969	1.04		
Asset * (Δ years tenure)	β_1									6.805	0.18			-0.728	-0.59
Asset * (Δ years tenure)^2	β_2									-1.394	-3.82	-1.846	-3.63	-0.389	-0.28
Asset * (Δ years experience)^2	β_3									0.482	3.05	5.320	0.59	1.363	0.43
Asset * Years education	β_4									-2.522	-0.86	-1.346	-2.42	-2.058	-0.72
Male	a_{H1}	-0.125	-3.08	0.002	0.20	0.114	2.29	0.019	0.36	-0.146	-3.46	0.114	2.34	0.012	0.25
Union	a_{H2}	-0.265	-4.22							-0.209	-2.88				
Black	a_{H3}	0.059	1.23							-0.113	-2.36				
East	a_{H2}			-0.001	-0.10										
German	a_{H3}			-0.001	-0.05										
Big firm	a_{H2}					0.001	0.01					-0.057	-1.35		
Single	a_{H3}					0.069	1.46	-0.014	-0.28			0.077	1.66	-0.037	-0.81
Nonpermanent	a_{H4}					-0.116	-2.36					-0.102	-2.04		
Part time	a_{H4}							0.183	1.65					0.224	2.27
Centre	a_{H4}							-0.066	-1.78					-0.058	-1.67
South	a_{H4}							-0.052	-1.68					-0.031	-1.08
Number of Observations		1,746		7,562		758		1,309		1,688		751		1,564	
χ^2 statistic		238.6^{***}		279.5^{***}		188.99^{***}		73.94^{***}		92.1^{***}		90.15^{***}		38.51^{***}	
R^2		0.215		0.076		0.399		0.016		0.227		0.426		0.015	

Table B2: Testing equality constraints of uniform risk interaction.

		Variable	Coeff. Table 2				Coeff. Table B1			Test
US	ASSET	Constant	1.116	*	0.646	=	1.223	*	0.555	58.61
		Δ years tenure	1.116	*	0 .009	=	6.805	*	0.002	-115.42
		(Δ years tenure)^2	1.116	*	$-1\cdot10^{-4}$	=	-1.395	*	0.001	129.59
		(Δ years experience)^2	1.116	*	-0.001	=	0.482	*	-0.001	-23.40
		Years of education	1.116	*	-0.004	=	-2.522	*	0.007	-48.33
	RISK	Constant	-0.460	*	0.450	=	-1.045	*	1.588	167.66
		Δ years tenure	-0.460	*	-0.007	=	-1.673	*	-0.043	-181.16
		(Δ years tenure)^2	-0.460	*	0.000	=	-1.474	*	0.001	113.19
		(Δ years experience)^2	-0.460	*	-0.001	=	-0.873	*	-0.003	-152.80
		Years of education	-0.460	*	-0.021	=	-1.411	*	-0.032	-104.53
		Constant	0.118	*	0.450	=	-0.912	*	1.588	167.36
		Δ years tenure	0.118	*	-0.007	=	-1.473	*	-0.043	-157.42
		(Δ years tenure)^2	0.118	*	0.000	=	-1.008	*	0.001	76.08
		(Δ years experience)^2	0.118	*	-0.001	=	-0.620	*	-0.003	-150.65
		Years of education	0.118	*	-0.021	=	-2.677	*	-0.032	-153.90
Germany	RISK	(Δ years experience)^2	0.025	*	-0.001	=	0.130	*	-0.001	-102.40
Spain	ASSET	Constant	1.249	*	-0.113	=	-1.472	*	-0.342	-18.64
		Δ years tenure/exp.	1.249	*	0.042	=	0.968	*	0.050	-83.47
		(Δ years tenure)^2	1.249	*	$1\cdot10^{-5}$	=	-1.846	*	-0.001	4.92
		(Δ years experience)^2	1.249	*	$-4\cdot10^{-4}$	=	5.320	*	$2\cdot10^{-4}$	87.61
		Years of education	1.249	*	0.010	=	-1.346	*	0.030	22.12
	RISK	Constant	-0.067	*	-0.222	=	3.720	*	-0.068	22.83
		Δ years tenure/exp.	-0.067	*	0.067	=	3.011	*	0.015	28.44
		(Δ years tenure)^2	-0.067	*	$-1\cdot10^{-4}$	=	2.760	*	$-1\cdot10^{-4}$	-41.51
		(Δ years experience)^2	-0.067	*	$-5\cdot10^{-4}$	=	2.147	*	$-1\cdot10^{-4}$	-9.60
		Years of education	-0.067	*	0.023	=	-0.097	*	0.032	-23.92
		Constant	-0.279	*	-0.222	=	0.761	*	-0.068	17.88
		Δ years tenure/exp.	-0.279	*	0.067	=	2.449	*	0.015	39.40
		(Δ years tenure)^2	-0.279	*	$-1\cdot10^{-4}$	=	-1.462	*	$-1\cdot10^{-4}$	-41.29
		(Δ years experience)^2	-0.279	*	$-5\cdot10^{-4}$	=	2.522	*	$-1\cdot10^{-4}$	-24.84
		Years of education	-0.279	*	0.023	=	-0.641	*	0.032	-15.50
Italy	RISK	Constant	-0.593	*	0.166	=	-0.713	*	0.143	1,76
		Δ years tenure	-0.593	*	0.016	=	-0.387	*	0.022	-2.96
		(Δ years tenure)^2	-0.593	*	-0.001	=	-0.486	*	-0.001	4.50
		(Δ years experience)^2	-0.593	*	$-1\cdot10^{-4}$	=	-1.331	*	$3\cdot10^{-5}$	-2.83
		Years of education	-0.593	*	-0.012	=	-0.612	*	-0.012	-1.55
	ASSET	Constant	1.130	*	-0.042	=	-6.714	*	-0.086	-77.25
		Δ years tenure	1.130	*	0.002	=	-7.280	*	0.005	279.11
		(Δ years tenure)^2	1.130	*	$2\cdot10^{-5}$	=	-3.890	*	$-1\cdot10^{-4}$	-116.77
		(Δ years experience)^2	1.130	*	$4\cdot10^{-5}$	=	13.620	*	$3\cdot10^{-5}$	-5.84
		Years of education	1.130	*	-0.001	=	-20.576	*	0.002	863.52

Note: we test whether βa_j (equation (13), Table 2) equals $\beta_j a_j$ (equation (14), Table B1)

Table B3a: US, unconstrained (equation (15))

		Risk dummies		*ASSETS*	
		Coef	t	Coef	t
Constant	$\mathbf{a_0}$	1.314	3.48	0.264	1.22
Risk3 (averse)	β_3	-1.271	-3.05		
Risk4 (more averse)	β_4	-1.021	-1.96		
Asset	β_0			1.805	3.59
Risk3 *(Δ years tenure)	β_{31}	0.081	3.55		
Risk3 *(Δ years tenure)^2	β_{32}	-0.002	-4.32		
Risk3 *(Δ years experience)^2	β_{33}	0.003	4.76		
Risk3 * Years education.	β_{34}	0.037	1.46		
Risk3* Union	β_{35}	0.130	0.87		
Risk3 * Black	β_{36}	-0.371	-2.01		
Risk3 * Male	β_{37}	-0.250	-1.1		
Risk4 *(Δ years tenure)	β_{41}	0.064	2.32		
Risk4 *(Δ years tenure)^2	β_{42}	-0.001	-1.74		
Risk4 *(Δ years experience)^2	β_{43}	0.002	2.51		
Risk4 * Years education	β_{44}	0.065	2.27		
Risk4* Union	β_{45}	-0.081	-0.49		
Risk4 * Black	β_{46}	-0.870	-4.00		
Risk4 * Male	β_{47}	-0.376	-1.47		
Asset *(Δ years tenure)	β_1			-0.005	-0.28
Asset *(Δ years tenure)^2	β_2			$-4{\cdot}10^{-4}$	-0.70
Asset *(Δ years experience)^2	β_3			-0.002	-2.70
Asset * years education	β_4			-0.039	-1.49
Asset * Union	β_5			-0.146	-1.35
Asset * Black	β_6			-0.234	-1.32
Asset * Male	β_7			-0.432	-1.98
Δ years tenure	$\mathbf{a_{x1}}$	-0.051	-2.37	0.013	1.37
(Δ years tenure)^2	$\mathbf{a_{x2}}$	0.001	3.35	$3{\cdot}10^{-4}$	0.94
(Δ years experience)^2	$\mathbf{a_{x3}}$	-0.003	-5.99	-0.001	-3.01
Years education	$\mathbf{a_{x4}}$	-0.021	-0.92	0.010	0.64
Union	$\mathbf{a_{x5}}$	-0.142	-1.01	-0.093	-1.38
Black	$\mathbf{a_{x6}}$	0.240	1.62	-0.151	-1.79
Male	$\mathbf{a_{x7}}$	0.281	1.31	0.005	0.05
Number of observations			1,746		1,688
χ^2 statistic			343.4^{***}		260.3^{***}
R^2			0.135		0.122
F-test			8.58		8.03

Table B3b: Germany, unconstrained (equation (15))

		Risk dummies	
		Coef	t
Constant	$\mathbf{a_0}$	0.273	8.98
Risk (0-10 transf.)	$\boldsymbol{\beta_0}$	0.020	0.60
$Risk_{0-10}$ * (Δ years tenure)	$\boldsymbol{\beta_1}$	-0.001	-0.32
$Risk_{0-10}$ * (Δ years tenure)^2	$\boldsymbol{\beta_2}$	0.000	0.42
$Risk_{0-10}$ * (Δ years experience)^2	$\boldsymbol{\beta_3}$	0.000	-2.11
$Risk_{0-10}$ * Years education	$\boldsymbol{\beta_4}$	0.001	0.58
$Risk_{0-10}$ * Male	$\boldsymbol{\beta_5}$	-0.015	-1.37
$Risk_{0-10}$ * East	$\boldsymbol{\beta_6}$	-0.014	-1.16
$Risk_{0-10}$ * German	$\boldsymbol{\beta_7}$	0.004	0.26
Δ years tenure	$\mathbf{a_{x1}}$	0.003	1.31
(Δ years tenure)^2	$\mathbf{a_{x2}}$	$1 \cdot 10^{-4}$	0.27
(Δ years experience)^2	$\mathbf{a_{x3}}$	-0.001	-13.57
Years of education	$\mathbf{a_{x4}}$	-0.002	-1.03
East	$\mathbf{a_{x5}}$	0.010	1.04
German	$\mathbf{a_{x6}}$	0.001	0.07
Male	$\mathbf{a_{x7}}$	-0.015	-1.64
Number of observations			6052
χ^2 statistic			776^{***}
R^2			0.057
F-test			16.57

Table B3c: Spain, unconstrained (equation (15))

		Risk dummies		*ASSETS*	
		Coef	t	Coef	t
Constant	$\mathbf{a_0}$	-0.419	-0.87	-0.303	-1.90
Risk3 (averse)	$\boldsymbol{\beta_3}$	0.165	0.31		
Risk4 (more averse)	$\boldsymbol{\beta_4}$	0.283	0.55		
Asset	$\boldsymbol{\beta_0}$			0.379	1.02
Risk3 * (Δ years tenure/exp.)	$\boldsymbol{\beta_{31}}$	0.130	1.78		
Risk3 * (Δ years tenure)^2	$\boldsymbol{\beta_{32}}$	-0.002	-1.53		
Risk3 * (Δ years experience)^2	$\boldsymbol{\beta_{33}}$	-0.001	-0.86		
Risk3 * Years education	$\boldsymbol{\beta_{34}}$	-0.016	-0.46		
Risk3 * Bigfirm	$\boldsymbol{\beta_{35}}$	-0.290	-1.40		
Risk3 * Single	$\boldsymbol{\beta_{36}}$	-0.687	-4.77		
Risk3 * Nopermanent	$\boldsymbol{\beta_{37}}$	0.036	0.17		
Risk3 * Male	$\boldsymbol{\beta_{38}}$	0.130	-1.67		
Risk4 * (Δ years tenure/exp.)	$\boldsymbol{\beta_{41}}$	0.132	1.92		
Risk4 * (Δ years tenure)^2	$\boldsymbol{\beta_{42}}$	-0.002	-1.43		
Risk4 * (Δ years experience)^2	$\boldsymbol{\beta_{43}}$	-0.001	-0.96		
Risk4 * Years education	$\boldsymbol{\beta_{44}}$	-0.032	-0.92		
Risk4 * Bigfirm	$\boldsymbol{\beta_{45}}$	-0.290	-1.51		
Risk4 * Single	$\boldsymbol{\beta_{46}}$	-0.655	-4.91		
Risk4 * Nopermanent	$\boldsymbol{\beta_{47}}$	0.173	0.90		
Risk4 * Male	$\boldsymbol{\beta_{48}}$	-0.318	-2.16		
Asset * (Δ years tenure/exp.)	$\boldsymbol{\beta_1}$			0.057	1.20
Asset * (Δ years tenure)^2	$\boldsymbol{\beta_2}$			0.002	2.28
Asset * (Δ years experience)^2	$\boldsymbol{\beta_3}$			-0.001	-1.73
Asset * Years education	$\boldsymbol{\beta_4}$			-0.036	-1.37
Asset * Bigfirm	$\boldsymbol{\beta_5}$			-0.106	-0.64
Asset * Single	$\boldsymbol{\beta_6}$			0.172	0.96
Asset * Nopermanent	$\boldsymbol{\beta_7}$			0.051	0.43
Asset * Male	$\boldsymbol{\beta_8}$			0.060	0.40
(Δ years tenure/exp.)	$\mathbf{a_{x1}}$	-0.076	-1.20	0.048	1.74
(Δ years tenure)^2	$\mathbf{a_{x2}}$	0.002	1.53	-0.001	-2.04
(Δ years experience)^2	$\mathbf{a_{x3}}$	$3 \cdot 10^{-3}$	0.40	$-2 \cdot 10^{-4}$	-0.51
Years of education	$\mathbf{a_{x4}}$	0.045	1.39	0.028	2.50
Bigfirm	$\mathbf{a_{x5}}$	0.275	1.58	-0.027	-0.41
Single	$\mathbf{a_{x6}}$	0.701	5.97	0.042	0.78
Nopermanent	$\mathbf{a_{x7}}$	-0.249	-1.33	-0.111	-2.29
Male	$\mathbf{a_{x8}}$	0.406	3.03	0.100	2.15
Number of observations			758		751
χ^2 statistic			240.93		213.07
R^2			0.209		0.231
F-test			11.29		9.11

Table B3d: Italy, unconstrained (equation (15))

		ARA		ASSETS	
		Coef	t	Coef	t
Constant	a_0	0.139	1.13	-0.081	-1.37
Absolute Risk Aversion (ARA)	β_0	-0.104	-1.54		
Asset	β_0			0.747	1.66
ARA * (Δ years tenure)	β_1	-0.006	-0.83		
ARA * (Δ years tenure)^2	β_2	$4\cdot10^{-4}$	2.03		
ARA * (Δ years experience)^2	β_3	$6\cdot10^{-5}$	0.91		
ARA* Years education	β_4	0.008	2.25		
ARA* Male	β_5	-0.071	-1.33		
ARA * Part time	β_6	0.616	4.36		
ARA * Single	β_7	-0.049	-1.13		
ARA * Centre	β_8	0.024	0.68		
ARA * South	β_9	0.033	1.08		
Asset * (Δ years tenure)	β_1			-0.043	-0.82
Asset * (Δ years tenure)^2	β_2			$4\cdot10^{-4}$	0.36
Asset * (Δ years experience)^2	β_3			$3\cdot10^{-4}$	0.68
Asset * Years education	β_4			-0.050	-2.17
Asset * male	β_5			-0.824	-2.24
Asset * part time	β_6			1.403	1.49
Asset * single	β_7			-0.670	-2.39
Asset * Centre	β_8			0.087	0.35
Asset * South	β_9			0.305	1.51
(Δ years tenure)	a_{x1}	0.017	1.33	0.005	0.73
(Δ years tenure)^2	a_{x2}	-0.001	-2.29	$-1\cdot10^{-4}$	-0.52
(Δ years experience)^2	a_{x3}	$-6\cdot10^{-5}$	-0.48	$3\cdot10^{-5}$	0.57
Years of education	a_{x4}	-0.014	-2.04	0.002	0.59
Centre	a_{x5}	-0.084	-1.33	-0.062	-1.72
South	a_{x6}	-0.050	-1.63	-0.034	-1.18
Male	a_{x7}	0.133	1.39	0.051	0.98
Single	a_{x8}	0.057	0.74	0.002	0.04
Part time	a_{x9}	-0.824	-3.25	0.199	1.94
Number of observations			1,309		1,564
χ^2 statistic			61.20		20.68^{**}
R^2			0.032		0.016
F-test			2.39^{**}		1.39

Table B4a: US, Estimated coefficients β, unconstrained a priori model (equation (15) with Shaw H,X distinction.

		β_{ki} (eq.15)		β_i (eq.15)	
		Coef	t	Coef	t
Constant	$\mathbf{a_0}$	1.588	4.15	0.639	3.32
Risk 3 risk averse	$\boldsymbol{\beta_3}$	-1.491	-3.44		
Risk 4 more risk averse	$\boldsymbol{\beta_4}$	-1.657	-3.38		
Asset	$\boldsymbol{\beta_0}$			-0.792	-1.30
Risk3 * (Δ years tenure)	$\boldsymbol{\beta_{31}}$	0.072	3.36		
Risk3 * (Δ years tenure)^2	$\boldsymbol{\beta_{32}}$	-0.002	4.09		
Risk3 * (Δ years experience)^2	$\boldsymbol{\beta_{33}}$	0.002	4.20		
Risk3 * Years education	$\boldsymbol{\beta_{34}}$	0.045	1.82		
Risk4 * (Δ years tenure)	$\boldsymbol{\beta_{41}}$	0.064	2.39		
Risk4 * (Δ years tenure)^2	$\boldsymbol{\beta_{42}}$	-0.001	-1.93		
Risk4 * (Δ years experience)^2	$\boldsymbol{\beta_{43}}$	0.002	2.25		
Risk4 * Years education	$\boldsymbol{\beta_{44}}$	0.087	2.99		
Asset * (Δ years tenure)	$\boldsymbol{\beta_1}$			0.115	2.80
Asset * (Δ years tenure)^2	$\boldsymbol{\beta_2}$			-0.004	-3.05
Asset * (Δ years experience)^2	$\boldsymbol{\beta_3}$			0.001	2.17
Asset * Years education	$\boldsymbol{\beta_4}$			0.042	1.11
Δ years tenure	$\mathbf{a_{X1}}$	-0.043	-2.15	-0.004	-0.43
(Δ years tenure)^2	$\mathbf{a_{X2}}$	0.001	3.15	$1 \cdot 10^{-5}$	2.10
(Δ years experience)^2	$\mathbf{a_{X3}}$	-0.003	-5.46	-0.001	-5.56
Years of education	$\mathbf{a_{X4}}$	-0.032	-1.41	0.005	0.41
Union	$\mathbf{a_{H1}}$	-0.125	-2.58	-0.113	-2.40
Black	$\mathbf{a_{H2}}$	-0.265	-2.97	-0.301	-3.71
Male	$\mathbf{a_{H3}}$	0.059	0.72	0.002	0.02
Number of observations			1,746		1,746
χ^2 statistic			357^{***}		237^{***}
R^2			0.115		0.091
F-test			9.98		9.40

Table B4b: German SOEP, Estimated coefficients β, unconstrained a priori model (equation (15) with Shaw H, X distinction)

		β_{kj} **(eq15)**	
		Coef	t
Constant	$\mathbf{a_0}$	0.272	9.03
Risk (0-10 transf.)	$\boldsymbol{\beta_0}$	0.013	0.42
$Risk_{0-10}$ * (Δ years tenure)	$\boldsymbol{\beta_1}$	-0.001	-0.28
$Risk_{0-10}$ * (Δ years tenure)^2	$\boldsymbol{\beta_2}$	$1{\cdot}10^{-4}$	0.36
$Risk_{0-10}$ * (Δ years	$\boldsymbol{\beta_3}$	$-1{\cdot}10^{-4}$	-2.17
$Risk_{0-10}$ * Years education	$\boldsymbol{\beta_4}$	0.001	0.54
Δ years tenure	$\mathbf{a_{X1}}$	0.003	1.30
(Δ years tenure)^2	$\mathbf{a_{X2}}$	$1{\cdot}10^{-4}$	0.29
(Δ years experience)^2	$\mathbf{a_{X3}}$	-0.001	-13.65
Years education	$\mathbf{a_{X4}}$	-0.002	-1.01
East	$\mathbf{a_{H1}}$	0.011	1.07
German	$\mathbf{a_{H2}}$	$1{\cdot}10^{-4}$	0.03
Male	$\mathbf{a_{H3}}$	-0.014	-1.51
Number of observations			6,052
χ^2 statistic			722^{***}
R^2			0.056
F-test			16.57

Table B4c: Spain, Estimated coefficients β, unconstrained a priori model (equation (15) with Shaw H, X distinction)

		β_{kj} (eq.15)		β_j (eq.15)	
		Coef	t	Coef	t
Constant	a_0	-0.068	-0.12	-0.342	-2.17
Risk 3 (averse)	β_3	-0.252	-0.44		
Risk 4 (more averse)	β_4	-0.052	-0.09		
Asset	β_0			0.504	1.63
Risk3 * (Δ years tenure/exp.)	B_{31}	0.046	0.56		
Risk3 * (Δ years tenure)^2	β_{32}	$-2 \cdot 10^{-4}$	-0.20		
Risk3 * (Δ years experience)^2	β_{33}	$-3 \cdot 10^{-4}$	-0.26		
Risk3 * Years education	β_{34}	-0.003	-0.07		
Risk4 * (Δ years tenure/exp.)	β_{41}	0.037	0.48		
Risk4 * (Δ years tenure)^2	β_{42}	$1 \cdot 10^{-4}$	0.11		
Risk4 * (Δ years experience)^2	β_{43}	$3 \cdot 10^{-4}$	-0.31		
Risk4 * Years education	β_{44}	-0.020	-0.44		
Asset * (Δ years tenure/exp.)	β_1			0.048	1.04
Asset * (Δ years tenure)^2	β_2			0.002	2.39
Asset * (Δ years experience)^2	β_3			-0.001	-1.62
Asset * Years education	β_4			-0.040	-1.64
Δ years tenure/exp.	a_{X1}	0.015	0.21	0.050	1.81
(Δ years tenure)^2	a_{X2}	$-1 \cdot 10^{-4}$	-0.08	-0.001	-2.17
(Δ years experience)^2	a_{X3}	$-1 \cdot 10^{-4}$	-0.13	$-2 \cdot 10^{-4}$	-0.49
Years education	a_{X4}	0.032	0.71	0.030	2.60
Bigfirm	a_{H1}	0.001	0.01	-0.057	-1.01
Single	a_{H2}	0.069	1.42	0.077	1.58
Nopermanent	a_{H3}	-0.116	-2.96	-0.102	-2.51
Male	a_{H4}	0.114	2.44	0.114	2.51
Number of observations			758		751
χ^2 statistic			229.3^{***}		198.9^{***}
R^2			0.195		0.229
F-test			9.06		11.60

Table B4d: Italy. Estimated coefficients β, unconstrained a priori model (equation (15) with Shaw H, X distinction)

		ARA		ASSETS	
		Coef	t	Coef	t
Constant	$\mathbf{a_0}$	0.143	1.52	-0.086	-1.47
Absolute Risk Aversion (ARA)	$\boldsymbol{\beta_3}$	-0.102	-2.24		
Asset	$\boldsymbol{\beta_0}$			0.576	1.89
ARA * (Δ years tenure)	$\boldsymbol{\beta_{41}}$	-0.088	-1.23		
ARA * (Δ years tenure)^2	$\boldsymbol{\beta_{42}}$	$5{\cdot}10^{-4}$	2.18		
ARA * (Δ years experience)^2	$\boldsymbol{\beta_{43}}$	$5{\cdot}10^{-5}$	0.71		
ARA * Years education	$\boldsymbol{\beta_{44}}$	0.007	1.94		
Asset * (Δ years tenure)	$\boldsymbol{\beta_1}$			-0.035	-0.68
Asset * (Δ years tenure)^2	$\boldsymbol{\beta_2}$			$4{\cdot}10^{-4}$	0.28
Asset * (Δ years experience)^2	$\boldsymbol{\beta_3}$			$4{\cdot}10^{-4}$	0.85
Asset * Years education	$\boldsymbol{\beta_4}$			-0.052	-2.28
Δ years tenure	$\mathbf{a_{X1}}$	0.022	1.74	0.005	0.75
(Δ years tenure)^2	$\mathbf{a_{X2}}$	-0.001	-2.43	$-1{\cdot}10^{-4}$	-0.55
(Δ years experience)^2	$\mathbf{a_{X3}}$	$4{\cdot}10^{-5}$	-0.30	$3{\cdot}10^{-5}$	0.57
Years education	$\mathbf{a_{X4}}$	-0.012	-1.76	0.002	0.69
Male	$\mathbf{a_{H1}}$	0.012	0.36	0.012	0.25
Single	$\mathbf{a_{H2}}$	-0.014	0.28	-0.037	-0.81
Part time	$\mathbf{a_{H3}}$	0.183	1.65	0.224	2.27
Centre	$\mathbf{a_{H4}}$	-0.066	-1.78	-0.058	-1.67
South	$\mathbf{a_{H4}}$	-0.052	-1.68	-0.031	-1.08
Number of observations		1,309		1,564	
χ^2 statistic		$37{,}85^{***}$		17.83^{***}	
R^2		0.015		0.011	
F-test		1.41		1.21	

Table B5a: Testing model constraints: identical risk effect ($\theta_j = \beta a_j$)

		Variable	Coeff. Table 2				Coeff. Table B4	Test
US	ASSET	Constant	1.116	*	0.646	=	0.639	-76.98
		Δ years tenure	1.116	*	0 .009	=	-0.005	-109.04
		(Δ years tenure)^2	1.116	*	$-1 \cdot 10^{-4}$	=	$-1 \cdot 10^{-5}$	-26.38
		(Δ years experience)^2	1.116	*	-0.001	=	-0.001	118.53
		Years of education	1.116	*	-0.004	=	0.006	3.43
	RISK	Constant	-0.460	*	0.450	=	1.589	-191.23
		Δ years tenure	-0.460	*	-0.007	=	-0.043	-132.58
		(Δ years tenure)^2	-0.460	*	0.000	=	0.001	156.55
		(Δ years experience)^2	-0.460	*	-0.001	=	-0.003	-121.10
		Years of education	-0.460	*	-0.021	=	-0.032	-90.43
		Constant	0.118	*	0.450	=	1.588	-166.03
		Δ years tenure	0.118	*	-0.007	=	-0.043	-101.07
		(Δ years tenure)^2	0.118	*	0.000	=	0.001	82.33
		(Δ years experience)^2	0.118	*	-0.001	=	-0.003	-100.79
		Years of education	0.118	*	-0.021	=	-0.032	-120.83
Germany	RISK	(Δ years experience)^2	0.025	*	-0.001	=	$1 \cdot 10^{-4}$	-138.01
Spain	ASSET	Constant	1.249	*	-0.113	=	-0.342	19.12
		Δ years tenure/exp.	1.249	*	0.042	=	0.050	-49.01
		(Δ years tenure)^2	1.249	*	$1 \cdot 10^{-5}$	=	-0.001	3.78
		(Δ years experience)^2	1.249	*	$-4 \cdot 10^{-4}$	=	$-2 \cdot 10^{-4}$	49.43
		Years of education	1.249	*	0.010	=	0.030	28.84
	RISK	Constant	-0.067	*	-0.222	=	-0.068	-0.26
		Δ years tenure/exp.	-0.067	*	0.067	=	0.015	-18.43
		(Δ years tenure)^2	-0.067	*	$-1 \cdot 10^{-4}$	=	$-1 \cdot 10^{-4}$	6.99
		(Δ years experience)^2	-0.067	*	$-5 \cdot 10^{-4}$	=	$-1 \cdot 10^{-4}$	9.64
		Years of education	-0.067	*	0.023	=	0.032	0.81
		Constant	-0.279	*	-0.222	=	-0.068	0.23
		Δ years tenure/exp.	-0.279	*	0.067	=	0.015	-13.81
		(Δ years tenure)^2	-0.279	*	$-1 \cdot 10^{-4}$	=	$-1 \cdot 10^{-4}$	-5.17
		(Δ years experience)^2	-0.279	*	$-5 \cdot 10^{-4}$	=	$-1 \cdot 10^{-4}$	8.56
		Years of education	-0.279	*	0.023	=	0.032	10.01
Italy	RISK	Constant	-0.593	*	0.166		-0.015	66.08
		Δ years tenure	-0.593	*	0.016	=	-0.009	2.10
		(Δ years tenure)^2	-0.593	*	-0.001	=	$5 \cdot 10^{-4}$	3.07
		(Δ years experience)^2	-0.593	*	$-1 \cdot 10^{-4}$	=	$5 \cdot 10^{-5}$	3.40
		Years of education	-0.593	*	-0.012	=	0.008	4.16
	ASSET	Constant	1.130	*	-0.042		-0.049	-0.6143
		Δ years tenure	1.130	*	0.002	=	-0.035	-280.42
		(Δ years tenure)^2	1.130	*	$2 \cdot 10^{-5}$	=	$4 \cdot 10^{-4}$	117.99
		(Δ years experience)^2	1.130	*	$4 \cdot 10^{-5}$	=	$4 \cdot 10^{-4}$	278.44
		Years of education	1.130	*	-0.001	=	-0.052	-870.11

We test the constraints while maintaining the Shaw a priori H, X distinction: Table2 against B4

Table B5b: Testing model constraints: specific risk effects ($\theta_j = \beta_j a_j$)

		Variable	Coeff. Table B1				Coeff. Table B4	Test
US		Constant	1.223	*	0.555	=	0.639	89.03
	ASSET	Δ years tenure	6.805	*	0.002	=	-0.005	35.74
		(Δ years tenure)^2	-1.395	*	0.001	=	$-1 \cdot 10^{-5}$	-35.11
		(Δ years experience)^2	0.483	*	-0.001	=	-0.001	114.92
		Years of education	-2.522	*	0.007	=	0.006	-2.45
	RISK	Constant	-1.045	*	1.588	=	1.589	261.17
		Δ years tenure	-1.673	*	-0.043	=	-0.043	0.90
		(Δ years tenure)^2	-1.474	*	0.001	=	0.001	-37.10
		(Δ years experience)^2	-0.873	*	-0.003	=	-0.003	-10.90
		Years of education	-1.411	*	-0.032	=	-0.032	0.62
		Constant	-0.912	*	1.588	=	1.588	238.04
		Δ years tenure	-1.473	*	-0.043	=	-0.043	0.70
		(Δ years tenure)^2	-1.008	*	0.001	=	0.001	-19.94
		(Δ years experience)^2	-0.620	*	-0.003	=	-0.003	-6.26
		Years of education	-2.677	*	-0.032	=	-0.032	1.07
Germany	RISK	(Δ years experience)^2	0.130	*	-0.001	=	$1 \cdot 10^{-4}$	-49.17
Spain		Constant	-1.472	*	-0.342	=	-0.342	15.01
	ASSET	Δ years tenure/exp.	0.968	*	0.050	=	0.050	0.01
		(Δ years tenure)^2	-1.846	*	-0.001	=	-0.001	-0.04
		(Δ years experience)^2	5.320	*	$2 \cdot 10^{-4}$	=	$-2 \cdot 10^{-4}$	0.13
		Years of education	-1.346	*	0.030	=	0.030	0.02
	RISK	Constant	3.720	*	-0.068	=	-0.068	18.86
		Δ years tenure/exp.	3.011	*	0.015	=	0.015	31.49
		(Δ years tenure)^2	2.760	*	$-1 \cdot 10^{-4}$	=	$-1 \cdot 10^{-4}$	-30.75
		(Δ years experience)^2	2.147	*	$-1 \cdot 10^{-4}$	=	$-1 \cdot 10^{-4}$	-13.17
		Years of education	-0.097	*	0.032	=	0.032	-14.64
		Constant	0.761	*	-0.068	=	-0.068	14.24
		Δ years tenure/exp.	2.449	*	0.015	=	0.015	34.17
		(Δ years tenure)^2	-1.462	*	$-1 \cdot 10^{-4}$	=	$-1 \cdot 10^{-4}$	-20.79
		(Δ years experience)^2	2.522	*	$-1 \cdot 10^{-4}$	=	$-1 \cdot 10^{-4}$	-19.97
		Years of education	-0.641		0.032	=	0.032	-17.48
Italy	RISK	Constant	-0.713		0.143		-0.015	66.01
		Δ years tenure	-0.387	*	0.022	=	-0.009	-0.83
		(Δ years tenure)^2	-0.486	*	-0.001	=	$5 \cdot 10^{-4}$	7.59
		(Δ years experience)^2	-1.331	*	$-3 \cdot 10^{-5}$	=	$5 \cdot 10^{-5}$	0.56
		Years of education	-0.612	*	-0.012	=	0.008	2.58
	ASSET	Constant	-6.714		-0.086		-0.049	-80.28
		Δ years tenure	-7.280	*	0.005	=	-0.035	-0.97
		(Δ years tenure)^2	-3.890	*	$-1 \cdot 10^{-4}$	=	$4 \cdot 10^{-4}$	1.81
		(Δ years experience)^2	13.620	*	$3 \cdot 10^{-5}$	=	$4 \cdot 10^{-4}$	197.06
		Years of education	-20.576	*	0.002	=	-0.052	-4.38

We test the constraints while maintaining the Shaw a priori H, X distinction: Table B1 against B4