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Better Safe than Sorry?
The Effects of Income Risk, Unemployment Risk and the Interaction of these Risks on Wages

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Abstract

We examine whether income and unemployment risks are compensated by individual wages. Using a portfolio approach we show that the marginal income risk effect on wages is always positive whereas the marginal unemployment risk effect crucially depends on the income risk. The interaction effect between both risk measures is negative. Using administrative panel data from Germany we confirm the theoretically predicted signs for both risks and their interaction effect.

JEL Classification: J30, J31, J64.

Keywords: Income risk, unemployment risk, interaction effect, wages.

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1. Motivation

While employed, a worker faces two main uncertainties: the risk of unemployment and the uncertainty about the realized income level (income risk). Although both risks are likely to affect the worker's wage claim, their interaction has never been examined. To date, the effect of income risk on individual wages has been studied in portfolio models, whereas the effect of unemployment risk is usually discussed in the context of search and matching models.

In a portfolio model for the labor market, risk-averse individuals demand wage premiums to accept an uncertain income. The empirical literature generally confirms the presence of positive risk compensations for income risk. Earlier studies measure income risk as the dispersion of the wage distribution of different occupations (King, 1974; Johnson, 1977) or use the dispersion of the individual wage variation over a certain time period (Feinberg, 1981; Moore, 1995). Recent studies examine income risks in the context of the decision on investment in education. These studies use a two-stage approach to calculate a measure of dispersion in an occupational (e.g. Hartog *et al.*, 2003) or an educational group (e.g. Diaz-Serrano *et al.*, 2008).[1]

Unemployment risk is mostly considered in search and matching models. These models usually assume risk-neutral workers and show using an equilibrium analysis that unemployment risk decreases wages.[2] In addition to this literature, Berloffa and Simmons (2003) show using a model with a constant relative risk aversion (CRRA) utility function a negative effect of unemployment risk on labor force participation and the reservation wage. Abowd and Ashenfelter (1981) and Moretti (2000) empirically demonstrate a positive compensation for higher unemployment risk.

As a new approach, we show in a simple portfolio model the effect of the income risk, the unemployment risk and the interaction of these risks on individual wages. Although the two effects depend on each other, we show that the effect of the income risk is

[1] McGoldrick (1995) was the first to use this two-stage approach.

[2] In very complex models, the effect of unemployment risk on wages is ambiguous (see Rogerson *et al.*, 2005, for details).

always positive. The effect of the unemployment risk is ambiguous. The interaction effect of both risk measures is negative. In our empirical investigation, we confirm the theoretically derived effects. Using German administrative data (BA-Employment Panel), we are able to assess quarterly wage variances (income risk) and drop-out rates (unemployment risk) for 86 occupational groups from 2000 to 2007. We study both risks and their interaction separately for men and women in eastern and western Germany. The relative effects are higher in western Germany and higher for men in both parts of Germany.

The structure of the paper is as follows. Section 2 develops a theoretical model as a starting point for our empirical analysis in section 3. The data are described in section 4. We report and interpret our results in section 5 and conclude in the section 6 with an evaluation of the results.

2. Theory

To illustrate the effect of the income risk and the unemployment risk on individual wages, we employ a portfolio model for the labor market.[3] Individuals may choose between two types of jobs: one with a certain income Y_c,and another with a stochastic income Y_s. The expected value of the stochastic income is $E[Y_s] = \mu_s$. The expected value of the uncertain income can also be written as a mark-up of the certain alternative:

$$E\left[Y_s\right] = \mu_s = \left(1-\delta\right)^{-1} Y_c \text{ with } \delta \in]0,1[. \tag{1}$$

Individuals are risk averse and identical. Their utility function is strictly concave and satisfies CRRA. For the moment, we also assume that there is no unemployment. To be indifferent between the two jobs, the expected utilities $E[U]$ of both incomes must be equal:

[3] Our model is inspired by the approach to model income risks as Hartog and Vijverberg (2007) suggest.

$$E\left[U(Y_s)\right] = U(Y_c) = U\left[(1-\delta)\,\mu_s\right]. \tag{2}$$

The mark-up factor δ determines the risk premium an individual demands to be indifferent between the two jobs. To derive the equilibrium risk premium, we extend (2) on both sides with a second-order Taylor series expansion at point μ_s. The right-hand side of (2) becomes :

$$U(Y_c) = U(\mu_s) + (Y-\mu_s)U'(\mu_s) = U(\mu_s) + ((1-\delta)\mu_s - \mu_s)U'(\mu_s) = U(\mu_s) - \delta\mu_s U'(\mu_s). \tag{3}$$

The left hand side of (2) becomes:

$$E[U(Y_s)] = E\left[U(\mu_s) + (Y-\mu_s)U'(\mu_s) + \frac{1}{2}(Y-\mu_s)^2 U''(\mu_s)\right]. \tag{4}$$

$U'(\mu_s)$ and $U''(\mu_s)$ represent the first and second derivatives of the utility function at point μ_s. Because $E(Y-\mu_s)$ is 0 at point μ_s, equation (4) simplifies to:

$$E[U(Y_s)] = U(\mu_s) + E\left[\frac{1}{2}(Y-\mu_s)^2 U''(\mu_s)\right]. \tag{5}$$

Due to the indifference condition (2) equations (3) and (5) must be equal. Therefore, it is possible to derive δ as a function of the relative risk aversion R:[4]

$$\delta = \frac{1}{2}\frac{E\left[(Y-\mu_s)^2\right]}{\mu_s^2}R \tag{6}$$

with

$$R = -\frac{U''(\mu_s)}{U'(\mu_s)}\mu_s.$$

Equation (6) shows the positive effect of the variance $E\left[(Y-\mu_s)^2\right]$ of the wage dis-

[4] A detailed derivation is given in Appendix A.1.

tribution on the risk premium δ. Individuals demand a higher markup for a higher income risk. Because of the strict concavity, the utility function R is positive and thus the risk premium δ is positive. Furthermore, R is independent of the income level and is constant.

To make the model more manageable, we linearize (2) by assuming a logarithm utility function:

$$E(\ln Y_s) = \ln Y_c - \ln(1 - \delta). \tag{7}$$

We assume μ_s^2 to be much greater than $E[(Y - \mu_s)^2]$. Due to the concavity of the utility function, R is smaller than unity, so δ becomes very small.[5] For very small values, the approximation $-\ln(1 - \delta) \approx \delta$ holds. This simplification, together with (6) and (7), results in equation (8):

$$E(\ln Y_s) = \ln Y_c + \frac{1}{2}\frac{E\left[(Y - \mu_s)^2\right]}{\mu_s^2}R. \tag{8}$$

Equation (8) shows the positive effect of the variance $E\left[(Y - \mu_s)^2\right]$ on the expected value of the stochastic wage.

To show the effect of unemployment risk, we now ease the assumption of no unemployment. We model unemployment via an exogenous probability λ, where $\lambda \in [0, 1]$ of earning no income. The indifference condition (2) then becomes:

$$E\left[(1 - \lambda)U(Y_s)\right] = U((1 - \delta)^{-1}Y_c) = U\left[(1 - \delta)\,\mu_s\right]. \tag{9}$$

Analogously, equation (5) becomes:

$$E[(1 - \lambda)U(Y_s)] = (1 - \lambda)U(\mu_s) + (1 - \lambda)E\left[\frac{1}{2}(Y - \mu_s)^2 U''(\mu_s)\right]. \tag{10}$$

Together with (3) and adjusted for unemployment risk, the new mark-up factor δ_u,

[5] This presumption is supported by our data. The empirical distribution for the expression $\frac{E\left[(Y-\mu_s)^2\right]}{\mu_s^2}$ for men and women in eastern and western Germany can be found in the Appendix A.2.

becomes:[6]

$$\delta_u = \lambda A + (1-\lambda)\frac{1}{2}\frac{E\left[(Y-\mu_s)^2\right]}{\mu_s^2}R \tag{11}$$

with

$$A = \frac{U(\mu_s)}{U'(\mu_s)\mu_s}.$$

Due to the strict concavity of the utility function, A is a positive constant. Analogously to equation (8), we obtain:

$$E(\ln Y_s) = \ln Y_c + \lambda A + (1-\lambda)\frac{1}{2}\frac{E\left[(Y-\mu_s)^2\right]}{\mu_s^2}R \tag{12}$$

Equation (12) shows that the effects of the income risk and the unemployment risk on the expected stochastic income depend on each other. Although the marginal effect of the income risk on $E(\ln Y_s)$ now depends on the unemployment risk, it is positive:

$$\frac{\partial E(\ln Y_s)}{\partial E(Y-\mu_s)^2} = (1-\lambda)\frac{1}{\mu_s^2}R > 0. \tag{13}$$

It is easy to see that the income risk effect decreases with higher unemployment risk.[7] In contrast to the unambiguously positive income risk effect, the marginal effect of the unemployment risk is ambiguous:

$$\frac{\partial E(\ln Y_s)}{\partial \lambda} = A - \frac{1}{2}\frac{E[(Y-\mu_s)^2]}{\mu_s^2}R. \tag{14}$$

Without any income risk, the effect of the unemployment risk is unambiguously positive. However, in the presence of income risk, the marginal unemployment risk effect decreases and may become negative as the income risk increases.

[6] A detailed derivation is given in the Appendix A.3.

[7] This idea is consistent with the basic models in the search-theoretic literature (see Rogerson *et al.*, 2005; Cahuc and Zylberberg, 2004).

3. Empirical strategy

We measure income risk as the second moment of the wage distribution of a specific occupational group at a certain point in time. Accordingly, we measure unemployment risk as the quarterly drop-out rate within this specific occupational group. The drop-out rates are calculated as the fraction of the newly unemployed to all employees in an occupational group in the last period.[8] Therefore, the drop-out rate indicates the probability of a job loss in an occupational group. Assuming that workers and jobs are fairly identical within an occupational group, the drop-out rate thus also indicates the individual probability of losing the job.

We argue that the relevant income and unemployment risk for individuals is the income and unemployment risk of an occupational group.[9] With a certain vocational training or field of study, it is possible to work in several occupations, but all of these occupations are within one primary occupational group.[10] For example, when a construction engineer changes his job and becomes a land surveyor, he remains in the occupational group of engineers. A job change outside the occupational group, for example to become a chef or a physician, is very unlikely or impossible.

The second moments of the wage distributions and the drop-out rates are calculated quarterly for different occupational groups. We use the standard deviation as a measure of the second moment. To identify the effects of the income risk, the unemployment risk and the interaction of these risks on individual wages, we estimate the following fixed effects model:

$$\ln(wage_{ijt}) = c + \beta_1 \ln(sd_{jt}) + \beta_2 \ln(dr_{jt}) + \beta_3 \ln(sd_{jt}) \cdot \ln(dr_{jt}) + \beta_k X_{it} + a_i + T_t + \lambda_j + u_{ijt}. \tag{15}$$

[8] Whereas endogeneity may be a problem with individual risk measures, the risk measures derived for an occupational groups can be assumed to be exogenous for the individuals.

[9] This approach is consistent with that used by Fahr and Sunde (2009). Analyzing matching efficiency, they argue that the occupational group level is the relevant labor market.

[10] The classification of occupational groups follows the classification of the German federal employment agency (Statistics of the German Federal Employment Agency, 2009).

The logarithmic value of individual i's wage in occupational group j at time t is denoted $\ln(wage_{ijt})$. This value is regressed on a constant c, the logarithmic value of the standard deviation, as a measure of income risk $\ln(sd_{jt})$, the logarithmic values of the drop-out rate $\ln(dr_{jt})$ as a measure of unemployment risk; the interaction between both risk measures $\ln(sd_{jt}) \cdot \ln(dr_{jt})$, a set of control variables X_{it} and fixed effects.[11] We control for age, age^2, employment status and job tenure within a firm and apply individual a_i, time T_t (year and quarter dummies) and occupational group λ_j fixed effects. The error term is u_{ijt}. The marginal effects of the income and the unemployment risk on the wage are as follows:

$$\frac{\partial \ln(wage_{ijt})}{\partial \ln(sd_{jt})} = \beta_1 + \beta_3 \ln(dr_{jt}), \tag{16}$$

$$\frac{\partial \ln(wage_{ijt})}{\partial \ln(dr_{jt})} = \beta_2 + \beta_3 \ln(sd_{jt}). \tag{17}$$

The cross-derivative of (16) and (17) shows the interaction effect:

$$\frac{\partial[\partial \ln(wage_{ijt})/\partial \ln(sd_{jt})]}{\partial \ln(dr_{jt})} = \frac{\partial[\partial \ln(wage_{ijt})/\partial \ln(dr_{jt})]}{\partial \ln(sd_{jt})} = \beta_3. \tag{18}$$

As argued in section 2, we expect positive effects for both risk measures when the other risk measure is nonexistent [$\beta_1 > 0$ and $\beta_2 > 0$] and we expect the interaction effect to be negative [$\beta_3 < 0$]. For the marginal effect of income risk on wages (16) we expect a positive effect from equation (13) that decreases with unemployment risk:

$$\beta_1 + \beta_3 \ln(dr)_{jt} > 0 \ \forall \ \ln(dr_{jt}) \text{ with } \beta_3 < 0. \tag{19}$$

Equation (14) indicates that the marginal effect of unemployment risk on wages (17) may be positive, but this conclusion is not clear, and this effect should certainly decrease with income risk:

[11] To ensure positive values of the logarithmic standard deviation, we add 1 to every standard deviation before calculating the logarithmic values.

$$\beta_2 + \beta_3 \ln(sd)_{jt} \gtrless 0 \text{ with } \beta_3 < 0. \quad (20)$$

To identify gender-specific effects, we estimate the model (15) separately for men and women. We also estimate the model separately for eastern and western Germany to acknowledge structural differences (Smolny, 2009; Blien *et al.*, 2010). The standard deviation and the drop-out rate are calculated for all four subgroups (western German women, western German men, eastern German women, eastern German men) separately each quarter. All models are estimated with a heteroskedasticity-robust fixed-effects approach with robust standard errors clustered at the individual level.

4. Data

We use German administrative data: the BA-Employment Panel for 1998-2007 (German Federal Employment Agency, 2009). This panel is a representative two-percent sample of all employees subject to their social insurance contribution (employed and unemployed) in Germany.[12] We follow the official classification and identify 86 different occupational groups (Statistics of the German Federal Employment Agency, 2009).

In addition to individual wages, our data contain more comprehensive individual information (sex, age, employment status, type of employment, occupation, job tenure within a firm) on a quarterly basis. We include these variables in our regressions as control variables. All information is collected at the end of each quarter. We build a balanced panel of workers who are continuously part of the labor force from the first quarter of 2000 to the fourth quarter of 2007.[13] During this period, a worker only has to be employed full-time for one quarter and may be unemployed for the remaining time to be included in our data. We restrict our data to full-time employees because we are interested in regular jobs.

The wage is reported as the nominal gross salary per month. To derive a stationary

[12] A detailed description of the data can be found in the study by (Schmucker and Seth, 2009).
[13] For years prior to 2000, it is not possible to track individuals through unemployment spells.

dependent variable, we calculate the real gross salary per month using the German Harmonized Index of Consumer Prices (German Federal Statistical Office, 2012). Age is stated in years, and job duration is measured in quarters. The employment status of an individual can be an unskilled blue-collar worker, a skilled blue-collar worker, a foreman or a white-collar worker. The latter serves as the reference group.

We split our sample by job location between eastern and western Germany. Furthermore, we truncate the top and bottom 5 percentiles of the wage distributions for two reasons. First, with this truncation, we account for the problem that wages are reported voluntarily if they are above the maximum level up to which contributions to the social insurance must be paid. If the wage is not reported voluntarily, the maximum level up to which contributions to the social insurance must be paid is reported as the individual wage. Second, wages reported at the top and bottom of the wage distributions appear, to some extent, to be implausible.[14] After these restrictions, our sample contains 136,481 men and 87,065 women in western Germany and 26,650 men and 27,579 women in eastern Germany.

5. Results

We confirm the expected coefficients of income risk and unemployment risk in our estimations. The coefficients of $\ln(sd)$ and $\ln(dr)$ indicate the marginal effects of the income risk with no unemployment risk and the marginal effect of the unemployment risk with no income risk, respectively. The coefficient of $\ln(sd) \cdot \ln(dr)$ indicates the interaction effect between both risk measures. Table 1 (2) presents estimation results for men and women in western (eastern) Germany.

[14]The estimation results are not sensitive to this type of data truncation.

Table 1: Estimation results for men and women in western Germany

Dependent variable: ln(wage)	men	women
$\ln(sd)$	0.3238***	0.2540***
	(0.0028)	(0.0133)
$\ln(dr)$	1.2356***	1.0334***
	(0.0691)	(0.1475)
$\ln(sd) \cdot \ln(dr)$	-0.7333***	-0.5653***
	(0.0383)	(0.0768)
age	0.0287***	0.0171***
	(0.0003)	(0.0006)
age^2	-0.0003***	-0.0002***
	(0.0000)	(0.0000)
job tenure	0.0014***	0.0016***
	(0.0000)	(0.0000)
unskilled blue collar worker	-0.0452***	0.0429***
	(0.0023)	(0.0042)
skilled blue collar worker	-0.0380***	0.0346***
	(0.0022)	(0.0052)
foreman	0.0120***	0.0340*
	(0.0033)	(0.0186)
constant	2.1864***	2.2101***
	(0.0295)	(0.0822)
R^2 (within)	0.1042	0.0292
R^2 (overall)	0.2450	0.0760
observations	3,912,717	2,446,735
individuals	136,138	86,946

*** p<0.01, ** p<0.05, * p<0.1, robust standard errors clustered at individual level in parentheses. All models are estimated with fixed effects for individuals, time and occupational groups. White collar worker is the reference group.

Table 2: Estimation results for men and women in eastern Germany

Dependent variable: ln(wage)	men	women
$\ln(sd)$	0.2158***	0.1051***
	(0.0076)	(0.0121)
$\ln(dr)$	0.5521***	0.4358**
	(0.0627)	(0.1706)
$\ln(sd) \cdot \ln(dr)$	-0.3615***	-0.2836***
	(0.0373)	(0.0937)
age	0.0244***	0.0231***
	(0.0008)	(0.0010)
age^2	-0.0003***	-0.0003***
	(0.0000)	(0.0000)
job tenure	0.0018***	0.0015***
	(0.0000)	(0.0001)
unskilled blue collar worker	-0.0325***	-0.0118*
	(0.0053)	(0.0064)
skilled blue collar worker	-0.0329***	-0.0063
	(0.0048)	(0.0055)
foreman	0.0192**	0.0643***
	(0.0087)	(0.0195)
constant	2.1292***	2.3318***
	(0.0432)	(0.0580)
R^2 (within)	0.0665	0.0399
R^2 (overall)	0.2349	0.1129
observations	723,839	748,056
individuals	26,548	27,514

*** p<0.01, ** p<0.05, * p<0.1, robust standard errors clustered at individual level in parentheses. All models are estimated with fixed effects for individuals, time and occupational groups. White collar worker is the reference group.

The coefficients of $\ln(sd)$ and $\ln(dr)$ show the expected positive sign, and the coefficient of the interactions effect $\ln(sd) \cdot \ln(dr)$ show the expected negative sign for men and women. In absolute values, all three coefficients are greater for men. Compared to western Germany, all three coefficients are smaller in eastern Germany.

The marginal effect of $\ln(sd)$ on $\ln(wage)$ as calculated in (19) is shown in figure 1. The solid line depicts the theoretical marginal effect for every value of $\ln(dr)$ between 0 and 0.7. A value of 0 on the x-axis corresponds to an unemployment risk of 0. Therefore, at this point, the marginal effect of $\ln(sd)$ on $\ln(wage)$ is equal to β_1. The slope of the solid line indicates the strength of the interaction effect and is equal to β_3. The dashed lines represent the upper and lower bounds of the 95% confidence interval.

To determine the empirical range of the marginal effect of $\ln(sd)$ on $\ln(wage)$, the empirical measured range of $\ln dr$ is necessary. The empirical distribution of $\ln(dr)$ is provided in table 3 to show the relevant range of values. The column 'zero at' states the value of $\ln(dr)$ at which the point estimate of the marginal effect of $\ln(sd)$ on $\ln(wage)$ is 0.

Figure 1: Marginal effect of $\ln(sd)$ on $\ln(wage)$

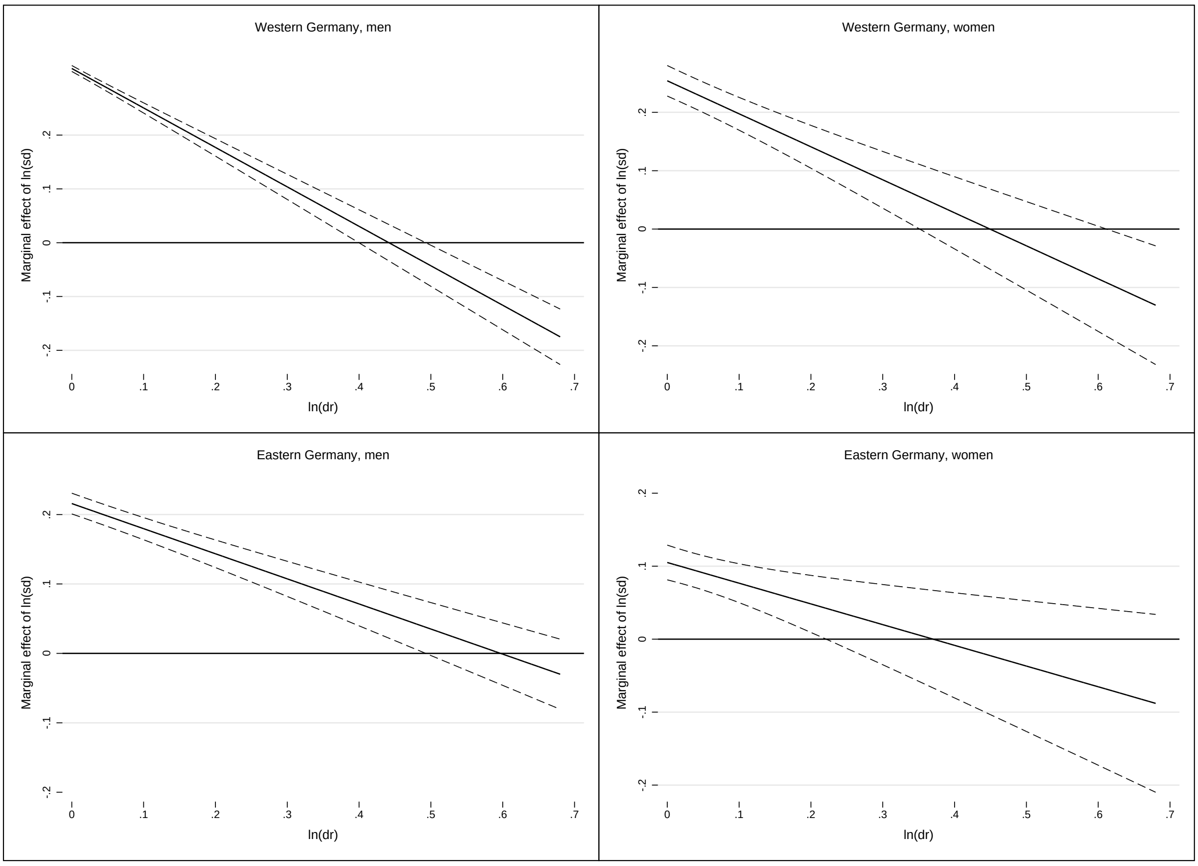

Table 3: Empirical distribution of $\ln(dr)$

	1%	5%	10%	25%	50%	75%	90%	95%	99%	min	max	mean	zero at
						Western Germany							
men	0.000	0.001	0.002	0.003	0.004	0.007	0.010	0.016	0.057	0.000	0.186	0.007	0.442
women	0.000	0.002	0.002	0.003	0.005	0.007	0.009	0.012	0.021	0.000	0.693	0.006	0.449
						Eastern Germany							
men	0.000	0.000	0.003	0.006	0.009	0.015	0.029	0.050	0.110	0.000	0.405	0.015	0.597
women	0.000	0.000	0.002	0.004	0.007	0.010	0.014	0.022	0.057	0.000	0.511	0.009	0.371

The marginal effect of $\ln(sd)$ on $\ln(wage)$ is statistically significant and positive for nearly all observed values of $\ln(dr)$.[15] Therefore, we find, as indicated by equation (19), strong evidence for a positive compensation of income risk, which decreases as

[15] There is only one case for western German women where the marginal effect of $\ln(sd)$ on $\ln(wage)$ is significant and negative. For eastern German women, there are three cases where the marginal effect of $\ln(sd)$ on $\ln(wage)$ is insignificant.

unemployment risk increases. Workers wish to be compensated for a higher wage variance, but this compensation becomes more modest as unemployment risk increases.

The marginal effect of $\ln(dr)$ on $\ln(wage)$ as calculated in (20) is shown in figure 2. Here, the solid line shows the theoretical marginal effect of $\ln(dr)$ on $\ln(wage)$ for every value of $\ln(sd)$ between 0 and 3. A value of 0 on the x-axis corresponds to an income risk of 0. Given no income risk, the marginal effect of $\ln(dr)$ on $\ln(wage)$ is equal to β_2. Again, the slope of the solid line indicates the strength of the interaction effect and is equal to β_3.

To determine the empirical range of the marginal effect of $\ln(dr)$ on $\ln(wage)$, the empirical measured range of $\ln sd$ is needed. The empirical distribution of $\ln(sd)$ is given in table 4 to show the relevant range of values. The column 'zero at' states the value of $\ln(sd)$ at which the point estimate of the marginal effect of $\ln(dr)$ on $\ln(wage)$ is 0.

Figure 2: Marginal effect of $\ln(dr)$ on $\ln(wage)$

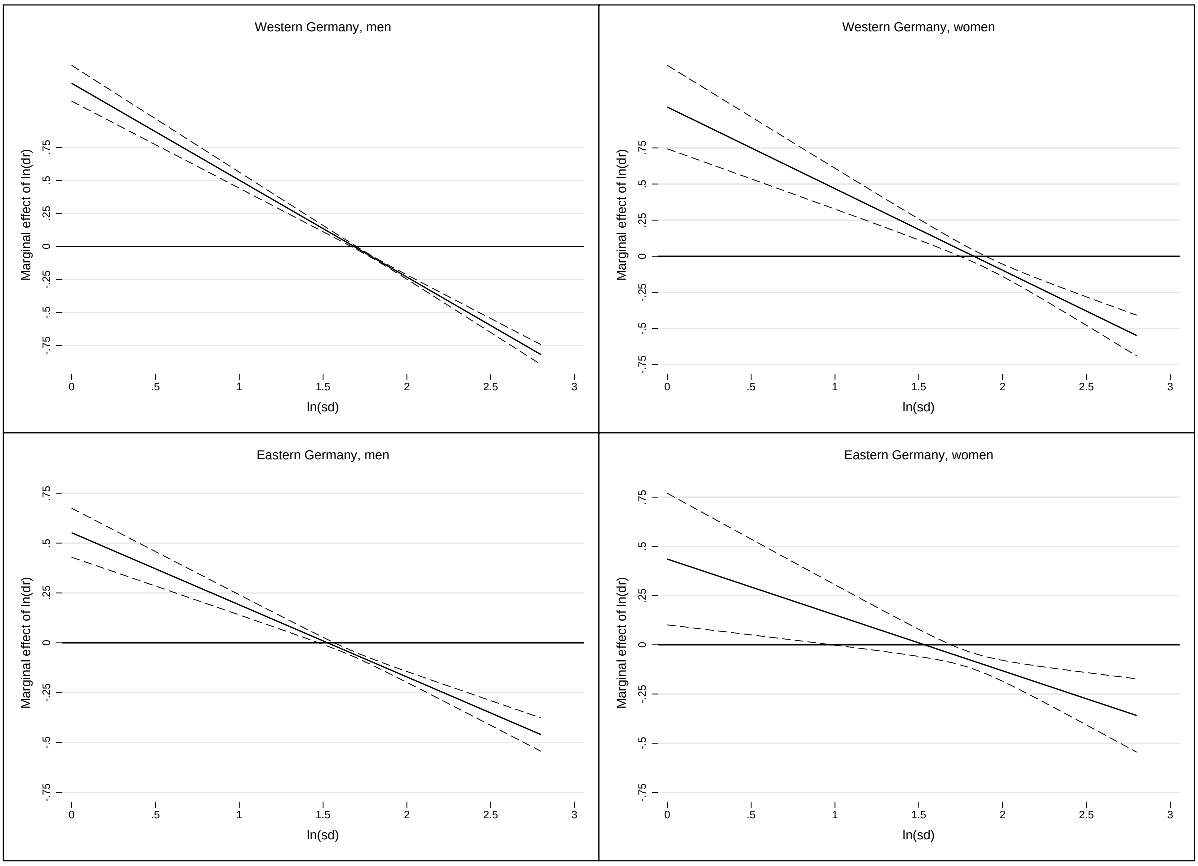

Table 4: Empirical distribution of $\ln(sd)$

	1%	5%	10%	25%	50%	75%	90%	95%	99%	min	max	mean	zero at
						Western Germany							
men	1.71	1.80	1.85	1.93	2.06	2.23	2.36	2.38	2.52	1.48	2.59	2.08	1.68
women	1.69	1.73	1.86	2.07	2.12	2.22	2.25	2.29	2.32	0.26	2.89	2.11	1.83
						Eastern Germany							
men	1.42	1.59	1.72	1.82	1.96	2.12	2.22	2.31	2.35	1.19	2.60	1.96	1.53
women	1.42	1.63	1.75	1.88	1.99	2.04	2.07	2.09	2.15	0.09	2.60	1.94	1.54

The marginal effect of $\ln(dr)$ on $\ln(wage)$ is statistically significant and negative for most of the observed values of $\ln(sd)$. For women, 90% (95%) of all realized values of $\ln(sd)$ show a significant negative marginal effect of $\ln(dr)$ on $\ln(wage)$ in western (eastern) Germany. Men show even higher shares of 99% (95%). As indicated in equation (20), the marginal effect of unemployment risk is ambiguous and decreases as income risk increases. However, we find evidence that for most values of $\ln(sd)$

the marginal effect of unemployment risk is negative. Workers facing low income risk wish to be compensated for higher unemployment risk. As the wage variance increases, the demanded wage compensation decreases. Therefore, we show evidence that most workers are willing to accept lower wages when they face higher unemployment risk.

To illustrate which risk effect dominates, we calculate the hypothetical total effect of both risk measures on $\ln(wage)$ at the mean values of their empirical distributions. The total effect is 0.67 (0.54) for men (women) in western Germany and 0.42 (0.20) in eastern Germany. At the mean values, the positive income risk effect dominates the negative unemployment risk effect.

6. Conclusion

We study the effect of the income risk, the unemployment risk and the interaction between these risks on wages. Using a simple interaction model, we show that the marginal effect of income risk is unambiguously positive, whereas the marginal effect of unemployment risk is ambiguous. The interaction effect between both risks is negative. To verify these effects, we use German administrative data. We measure income risk via the standard deviation of the wage distribution and the unemployment rate via the drop-out rate in an occupational group. Both risk measures are separately calculated for 86 different occupational groups for men and women in eastern and western Germany from 2000 to 2007. We apply a fixed-effects model to derive our results.

We confirm the positive coefficient of the income risk effect and the unemployment risk effect as well as the negative interaction effect. Empirically, we find strong support that workers demand to be compensated for a higher wage spread but that the demanded compensation decreases as the unemployment risk increases. The marginal effect of unemployment risk is empirically ambiguous but for most of the observations, negative. The decrease in the marginal effect of unemployment risk on wages as income risk increases is confirmed. Empirically, most workers accept lower wages in response to higher unemployment risk. Analyzing the effects simultaneously at the average values, we find evidence that the income risk effect is stronger than the unemployment risk effect.

The new key insight of our study is the consideration of interaction effects between two different risk measures. Our model reproduces the positive risk compensations when there is only one risk present but shows a negative interaction effect in the simultaneous consideration of both risks.

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A. Appendix

A.1. Appendix A1

Derivation of equation (6) from equations (3) and (5):

$$U(\mu_s) - \delta\mu_s U'(\mu_s) = U(\mu_s) + E\left[\frac{1}{2}(Y-\mu_s)^2 U''(\mu_s)\right]$$

$$-\delta\mu_s U'(\mu_s) = E\left[\frac{1}{2}(Y-\mu_s)^2 U''(\mu_s)\right]$$

$$-\delta = \frac{1}{2}\frac{E\left[(Y-\mu_s)^2\right]}{\mu_s}\frac{U''(\mu_s)}{U'(\mu_s)}.$$

Extending the equation delivers:

$$-\delta = \frac{1}{2}\frac{(E\left[Y-\mu_s)^2\right]}{\mu_s^2}\underbrace{\frac{U''(\mu_s)}{U'(\mu_s)}\mu_s}_{-R}.$$

$$\delta = \frac{1}{2}\frac{E\left[(Y-\mu_s)^2\right]}{\mu_s^2}R.$$

A.2. Appendix A2

Table 5 show the empirical distribution of $\frac{E\left[(Y-\mu_s)^2\right]}{\mu_s^2}$ for men an women in eastern and western Germany.

Table 5: Empirical Distribution of $\frac{E\left[(Y-\mu_s)^2\right]}{\mu_s^2}$

	1%	5%	10%	25%	50%	75%	90%	95%	99%	min	max	mean
Western Germany												
men	0,01	0,02	0,03	0,04	0,05	0,06	0,07	0,08	0,10	0,01	0,13	0,05
women	0,06	0,08	0,09	0,10	0,12	0,13	0,14	0,15	0,16	0,00	0,69	0,12
Eastern Germany												
men	0,03	0,04	0,05	0,06	0,07	0,09	0,10	0,11	0,13	0,02	0,28	0,07
women	0,04	0,06	0,06	0,08	0,09	0,10	0,13	0,14	0,15	0,00	0,34	0,09

A.3. Appendix A3

Derivation of equation (11) from equations (3) and (10):

$$U(\mu_s) - \delta\mu_s U'(\mu_s) = (1-\lambda)U(\mu_s) + (1-\lambda)E\left[\frac{1}{2}(Y-\mu_s)^2 U''(\mu_s)\right]$$

$$-\delta\mu_s U'(\mu_s) = -\lambda U(\mu_s) + (1-\lambda)E\left[\frac{1}{2}(Y-\mu_s)^2 U''(\mu_s)\right]$$

$$-\delta\mu_s U'(\mu_s) = -\lambda\frac{U(\mu_s)}{\mu_s U'(\mu_s)} + \frac{(1-\lambda)}{\mu_s U'(\mu_s)}E\left[\frac{1}{2}(Y-\mu_s)^2 U''(\mu_s)\right]$$

$$-\delta = -\lambda\underbrace{\frac{U(\mu_s)}{\mu_s U'(\mu_s)}}_{A} + \frac{(1-\lambda)}{\mu_s U'(\mu_s)}E\left[\frac{1}{2}(Y-\mu_s)^2 U''(\mu_s)\right]$$

$$-\delta = -\lambda A + (1-\lambda)E\left[\frac{1}{2}\frac{(Y-\mu_s)^2}{\mu_s}\frac{U''(\mu_s)}{U'(\mu_s)}\right].$$

Extending the equation delivers:

$$-\delta = -\lambda A + (1-\lambda)E\left[\frac{1}{2}\frac{(Y-\mu_s)^2}{\mu_s^2}\right]\underbrace{\frac{U''(\mu_s)}{U'(\mu_s)}\mu_s}_{-R}$$

$$\delta = \lambda A + (1-\lambda)E\left[\frac{1}{2}\frac{(Y-\mu_s)^2}{\mu_s^2}\right]R.$$

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