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Organized by the Croatian National Bank

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Singles and Couples in a Risky Labor Market

Hotel "Palace"

Dubrovnik

May 24 – 25, 2023

Draft version

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EUROSYSTEM

Singles and Couples in a Risky Labor Market *

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February 2022

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Abstract

Income sharing within couples operates as an insurance mechanism against negative income shocks. I investigate how this insurance influences labor market decisions of workers with a spouse , compared to singles, and how these decisions translate into differentiated labor market outcomes.

First, I document the separation-risk heterogeneity and the joint distribution of separation risks and wages of jobs in the German labor market. I then develop a Joint-Search model of the labor market, incorporating household types, separation-risk heterogeneity and on-the-job search. By matching moments to the German labor market, I quantify the model for otherwise identical 1-worker and 2-worker households.

The presence of a spouse tilts the risk-wage trade-off towards high risk –high wage jobs and implies different 2-dimensional job-ladders for singles and couples. On average, the model generates a 4.5% wage premium for married workers. Furthermore, the presence of a spouse reduces average precautionary savings by a factor of 13, compared to a single household.

The insurance mechanism within a couple is an important mechanism for generating dispersed labor market outcomes and consumption patterns. It furthermore reduces the need for self-insurance via precautionary savings. The quantitative importance of the insurance mechanism on economic choices should be taken into account for optimal (public) insurance design and more generally for modeling decisions under risk-heterogeneity with different household types.

JEL: J12, J31, J64, E21, D14,

*I am grateful to my supervisor Leo Kaas for his advice. I also thank Simon Mongey, Fabien Postel-Vinay, the members of the Frankfurt Quantitative Macro Group, the participants of the 18th BiGSEM Doctoral Workshop on Economics and Management and participants of the 16th RGS Doctoral Conference in Economics for helpful comments. Any remaining errors are my own.

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1 Introduction

For better, for worse, for richer, for poorer - a central feature of couples is that the spouses provide for each other economically. I investigate the labor market consequences of having a partner and expecting their support in bad times. The amount of labor market risk that workers are willing to take on may well depend on whether you have a pillar of strength to support you.

While the majority of the working age population is part of a couple, most economic models of the labor market assume workers to be atomic units without a partner. Recent strands of economic literature started to investigate outcomes and mechanisms under more realistic household configurations. These studies show the impact of the presence of a second potential worker for, among other, household consumption, aggregate female employment over business cycles or migration patterns.
In this paper, I study one particular channel through which the presence of a spouse changes labor market outcomes: the insurance channel. When spouses share their income, a negative income shock for one will be partially absorbed by the other.
Furthermore, by adding separation risk heterogeneity, another feature of the labor market is taken into account, which is often abstracted from in macroeconomic labor market models. Thus, choices about how much risk to accept are introduced into the model.

To fix concepts, households are thought of as joint decision making units with income pooling. In such cases the spouse's (potential) income can attenuate the negative effects of job loss. A worker who is aware of this insurance, should be willing to accept jobs with a higher separation risk, that single workers would decline. Thus, married workers climb the job ladder more towards higher wages, while singles tend to move stronger towards job stability.
This insurance mechanism can influence choices and outcomes in the labor market, that may explain different empirical regularities observed in the data.
One of these regularities is the Marital Wage Premium (MWP), the fact that married workers earn ceteris paribus higher wages. If married workers are willing to take on more labor market risk than their single counter-parts, they will have better chances of getting a high-wage job.
Another interesting effect of the insurance mechanism is the influence on precautionary savings. Workers typically self-insure against income risk in incomplete markets. Here,

having a spouse with a given income may act as a substitute.
Finally, taking into account the interaction of household configurations and labor market risk heterogeneity might be important for optimal unemployment insurance design.

In order to answer these questions, I propose a labor market model featuring heterogeneous household types, joint search and separation risk heterogeneity in 2. The empirical facts are documented and empirical moments are derived from the data in 3, and the quantitative model is then solved in 4 and brought to the data in 5. I then discuss the results in 6.

Related Literature

This work builds on two major strands of economic literature: the study of earnings- and employment risk heterogeneity, and the joint search theory.
Further related studies can be found in the marital wage premium literature, which studies the potentially causal effect of marriage on wages, as well as in a series of studies in the finance literature, which study marital risk-sharing by focusing on risky asset holdings in financial portfolio choice.

Risk-Heterogeneity

Empirical studies on wage/earnings/employment-risk heterogeneity dates back at least to Feinberg (1981), who estimated a compensating wage differential for earnings risk. More recent empirical evidence show that workers receive a compensation for taking up jobs which are associated with a larger risk, either in terms of firing risk or variance of earnings. Hartog and Vijverberg (2007) use earnings distributions of occupation groups to show empirically, that at least for men, average earnings rise with occupational earnings variance and decreases with skewness. Peters and Wagner (2014) show that CEO compensation increases with expected turnover (or separation) risk, using an IV approach. Vieira et al. (2019) confirm that earnings variance is associated with higher individual wages, using quantile regressions.

From a macro-perspective, several papers investigate the importance of job stability for labor market results and other outcomes: Pinheiro and Visschers (2015) show that job stability cannot be treated as an amenity of a job, since the value of job stability to the worker increases in the valuation of the other job characteristics. Cubas and Silos (2017) document that 40% of observed cross-industry earning residuals can be explained by compensation for industry-specific risk, and workers self-insure against industry risk via precautionary savings. Dillon (2018) shows that workers would be willing to give up a significant share of their income in order to reduce the riskiness of their job. Furthermore, the study stresses the importance of occupational mobility for avoiding the consequences of negative shocks on the occupation level. Kuhn and Ploj (2020) show that savings relative to wages increase in tenure and decrease in number of previous employers (after controlling for age). They conclude that job stability is important for wealth accumulation, while having an unstable job early in the career severely decreases the worker's lifetime wage profile. The impact of job risk on job ladders is also discussed in Jarosch (2021), who looks at single workers. He finds a higher separation risk at the lower rungs of the job ladder, as workers climb the job ladder towards higher wages and higher stability. The loss in job-stability is a key driver for long-lasting and severe effects of unemployment shocks.

Joint Search

Joint search theory moves the focus from single-earner households to dual earner households. It takes into account that labor market decisions[1] of one person in the household influence labor market decisions of the spouse. This approach was first proposed by Guler et al. (2012). Flabbi and Mabli (2018) estimate a richer model of joint decision making, which features endogenous search and labor supply choices.
An important feature of couples' behavior in the labor market, relative to singles, is that the spouse can adjust labor supply or participation, after the primary earner experiences a negative labor market shock (e.g. job loss). In such cases, the spouse's reaction acts as an 'insurance' against the materialized labor market risk. This "added worker effect" has been investigated inter alia by Ellieroth (2019), Wang (2019), Halla et al. (2020), García-Pérez and Rendon (2020) and Birinci (2021).
The policy relevance of considering dual-worker households has been studied by Choi and Valladares-Esteban (2020), who design of optimal unemployment insurance with household heterogeneity, and Wu and Krueger (2021), who analyze optimal income tax under family labor supply. Fernández-Blanco et al. (2020) studies optimal unemployment insurance schemes, when spouses can influence the (expected) time until they are

[1] e.g. decisions about the reservation wage, search, negotiation strategies

hired in a directed search model. García-Pérez and Rendon (2020) build a model of joint search with exogenous search effort, and allow for wealth accumulation under a borrowing constraint. Closely related to this paper is the study by Pilossoph and Wee (2021), who construct a dual-searcher household model with endogenous search effort. They find that under concave utility and income pooling, the income of a spouse increases the reservation wage of the worker. Furthermore, search intensity is higher, since workers internalize the effect on the search behavior of their spouse. However, their model does not feature heterogeneous job/income risk as a characteristic of a job offer.

Marital Wage Premium

The Marital Wage Premium (MWP) is empirical finding that married workers earn higher wages than their non-married counterparts. Early empirical research on the MWP includes Hill (1979). In recent works, Juhn and McCue (2016) and McConnell and Valladares-Esteban (2021) confirm the MWP for males and show that the MWP for females turned from negative to positive over time. Potential explanations for the MWP include the specialization hypothesis Becker (1985), which claims that within-household specialization increases labor market performance of married males. However, more recent empirical evidence show that married men do not spend more time in home production Hersch and Stratton (2000), and that the MWP for males is not driven by higher productivity Loh (1996).

Risk-sharing in the Household Finance Literature

Finally, several papers in the finance literature show that marriage can affect investment behavior. Schooley and Worden (1996) show that married household heads tend to hold a higher risky asset share. Love (2010) models optimal portfolios and argues that the first marriage affects the optimal risky asset share differently over gender and age. Bertocchi et al. (2011) show that married household heads are more likely to invest in risky assets, compared to single ones.

2 Model

The benchmark model combines a unitary dual-worker household with a frictional labor market and job-specific separation risks. It builds on the joint search model by Guler et al. (2012), augmented with on-the-job search similar to Burdett and Mortensen (1998), savings decisions and separation risk heterogeneity. I model two types of households, singles and couples, which ex-ante solely differ in the number of workers. The key feature that I add to a standard joint search model is that jobs are characterized not only by a wage, but also by a job-specific separation rate. The households make decisions about which job offers to accept, and how much to save in order to insure against future labor market shocks. As households are risk-averse, the presence of a spouse, and his/her labor market status will influence these decisions.

2.1 Environment

The model is set in infinite horizon, discrete time with common discount factor β. The agents in the model are risk-averse households, which are ex-ante homogeneous, except for the number of workers in the household. All households derive instantaneous utility from consumption. Financial markets are incomplete but households can self-insure by holding risk-free assets, which generate interests at rate r. Households cannot borrow.

The household size is exogenously given and fixed over time. The two types of households h considered are single households (indicated by subscript $_s$) , consisting of one worker, and couples (indicated by subscript $_c$), consisting of two workers. A couple household is a pair of workers which pools income for consumption, and makes joint decisions. Thus, this models features a unitary household, and precludes intra-household bargaining or strategic redistribution.

A job in this model has two characteristics: a wage $w \in [\underline{w}, \overline{w}]$, and a separation risk $\delta \in [0, 1]$, which represents the rate of exogenous job destruction. Both job characteristics are exogenously given, and not subject to bargaining between firms and workers. A job offer is a draw (w, δ) from the exogenously given joint offer distribution $F(w, \delta)$. Both employed and non-employed workers receive job offers from the job offer distribution $F(w, \delta)$, which arrive stochastically at rate $\lambda_{l,h}$[2]. After a worker

[2] I allow the arrival rates to differ over labor market and household states. This is in line with other studies, such as Pilossoph and Wee (2021) and Braun et al. (2021)

receives an offer (w, δ), the respective household decides whether the worker accepts the new job and quits the the old job (or non-employment, respectively). Rejected job offers, as well as exogenously or endogenously separated[3] jobs are destroyed. While employed, the workers generate wage income w according to the respective job characteristic, while non-employed workers receive benefits b. After exogenous separations (δ) or voluntary quits, previously employed workers enter into non-employment.

2.2 Single Households

Single households consist of a single worker. Thus, the single household can be either in the employment or non-employment labor market state. Since there is no income-sharing, the single household's optimization problem reduces to a McCall-type problem with risk heterogeneity, savings and job-to-job transitions. The following value functions for the two states represent the single households' problem, which consists of a consumption-savings choice, as well as a job-offer acceptance decision.

2.2.1 value functions

The non-employed single worker receives benefit payments b and generates job offers with probability $\lambda_{u,s}$, as random draws from a distribution $F(w, \delta)$. If the value of a job offer draw(w, δ) exceeds the non-employment value, conditional on current assets, the worker accepts the offer. The worker also chooses optimal consumption given the current level of assets and labor market state[4]:

$$
\begin{aligned}
U(a) = \max_{c}\; u_s(c) + \beta\lambda_{u,s} \left[\int \max\left\{U(a'), E(w,\delta,a')\right\} dF(w,\delta)\right] \\
+\beta(1-\lambda_{u,s})U(a') \\
\text{s.t. } c = (1+r)\cdot a + b - a' \\
c, a' \geq 0
\end{aligned}
\tag{1}
$$

While employed, the worker receives job-specific wages w. Consumption is chosen

[3]workers may choose to quit their job and move into the unemployment state

[4]For ease of notation, I drop the brackets around the terms on the RHS of the value function equation after the max operator. This will also be the case in the following value functions. To be clear, the RHS of the value function is the maximum of the period utility and discounted, probability-weighted continuation values.

given the current labor market state and current assets. With job-specific separation rate δ, the worker is separated from the job and fall back into unemployment. Job offers are received at rate $\lambda_{e,s}$, which may cause the worker to transition to a new job. Finally, the worker may endogenously quit and move into unemployment:

$$
\begin{aligned}
E(w,\delta,a) = \max_c \ u_s(c) + \beta\lambda_{e,s}\left[\int \max\left\{E(w,\delta,a'), E(w',\delta',a'), U(a')\right\} dF(w',\delta')\right] \quad (2) \\
+ \beta\delta U(a') \\
+ \beta(1-\lambda_{e,s}-\delta)\left[\max\left\{E(w,\delta,a'), U(a')\right\}\right] \\
\text{s.t. } c = (1+r)\cdot a + b - a' \\
c, a' \geq 0
\end{aligned}
$$

2.3 Couple Households

Couple households consist of two workers. In the baseline model, workers of both genders are identical, i.e. they do not differ in the job offer rate or job offer distribution. As each worker can be either employed or non-employed, couple households move between 3 different situations: both workers non-employed (UU-Household), one worker employed (EU), or both workers employed (EE).

2.3.1 value functions

Compared to the single household case, the couples' decision problem is augmented by the spouse's labor market decision. As labor market events (exogenous separations, arrival of new offer) can occur simultaneously for both workers, their interactions have to be taken into account, and the number of joint labor market events to be considered increases accordingly.

UU - both nonemployed

If both workers are non-employed, they receive the flow of unemployment benefits b. As in the single household case, a job offer may arrive and be accepted, in which case the household moves to the single earner state. If two offers arrive in the same period, the household has four options: reject both, accept the first, accept the second, or accept both offers. The household then changes the earner-state accordingly. Non-negative consumption is chosen to maximize value, while the borrowing-constraint forbids negative asset holdings:

$$\begin{aligned}
UU(a) = & \max_c \; u_c(c) \\
& + \beta \cdot 2 \cdot \left(\lambda_{u,c} - \lambda_{u,c}^2\right) \left[\int \max \left\{UU(a'), EU(w,\delta,a')\right\} dF(w,\delta)\right] \\
& + \beta \lambda_{u,c}^2 \left[\int \int \max \Omega_{UU} dF(w,\delta) dF(w^*,\delta^*)\right] \\
& + \beta(1 - 2 \cdot \lambda_{u,c} + \lambda_{u,c}^2) UU(a') \\
& \text{s.t. } c = (1+r) \cdot a + 2 \cdot b - a' \\
& c, a' \geq 0
\end{aligned} \tag{3}$$

With $\Omega_{UU} = \{UU(a'), EU(w,\delta,a'), EU(w^*,\delta^*,a'), EE(w,\delta,w^*,\delta^*,a')\}$

EU - one worker employed

If one worker is employed while the other is non-employed, the household receives the wage flow and the unemployment benefit payments flow. The continuation value includes the possibilities for job loss and for accepting a job switching offer (as in the single employed worker case), as well as the possibility of the non-employed worker receiving a job offer. This offer may be i) rejected or ii) accepted and the spouse decides to quit or iii) accepted while the spouse retains his/her job. Combining three possible events for the employed worker (separation, no offer, offer) with the two possible events for the unemployed worker (no offer, offer), results in 6 possible joint labor market events. They arise with probability p, which is the product of the respective single worker labor market event. Here, lines 2 to 4(with probabilities $p_1 - p_3$) represent the different events for the employed worker, while the non-employed worker does not receive a job offer. The respective labor market choices are similar to the single worker version. Line 5 to 7 represent cases where the non-employed worker receives an offer. The number of elements of the choice sets in each case thus doubles. Ω_1 represents the case, where the non-employed worker receives an offer, while the employed one has no shock realization. The choices then are (reject,quit), (reject,stay),(accept,quit) and (accept, stay): $\Omega_1 =$

$\{UU(a'), EU(w,\delta,a'), EU(w^*,\delta^*,a'), EE(w,\delta,w^*,\delta^*,a')\}$. If the employed worker also receives an offer, the choice set contains $\Omega_2 = \{\Omega_1, EU(w',\delta',a'), EE\,(w',\delta',w^*,\delta^*,a')\}$, adding the choice combinations if this offer is accepted.

$$
\begin{aligned}
EU(w,\delta,a) = \max_c \; & u_c(c) \\
& + \beta \cdot p_1 \cdot UU(a') \\
& + \beta \cdot p_2 \cdot \max\{EU(w_1,\delta_1,a'), UU(a')\} \\
& + \beta \cdot p_3 \cdot \int \max\{EU(w,\delta,a'), EU(w',\delta',a'), UU(a')\} dF(w',\delta') \\
& + \beta \cdot p_4 \cdot \int \max\{EU(w^*,\delta^*,a'), UU(a')\} dF(w^*,\delta^*) \\
& + \beta \cdot p_5 \cdot \int \max \Omega_1(.,a') dF(w^*,\delta^*) \\
& + \beta \cdot p_6 \cdot \int\int \max \Omega_2(.,a') dF(w',\delta') dF(w^*,\delta^*) \\
& \text{s.t. } c = (1+r)\cdot a + w + b - a' \\
& c, a' \geq 0
\end{aligned}
\tag{4}
$$

The probabilities of the different labor market event combinations are listed below:

	Value	Events
p_1	$(1-\lambda_u)\cdot\delta$	no offer, fired
p_2	$(1-\lambda_u)\cdot(1-\delta-\lambda_e)$	no offer, nothing
p_3	$(1-\lambda u)\cdot\lambda_e$	no offer, offer
p_4	$\lambda_u\cdot\delta$	offer, fired
p_5	$\lambda_u\cdot(1-\delta-\lambda_e)$	offer, nothing
p_6	$\lambda_u\cdot\lambda_e$	offer, offer

Table 1. Labor Market Events I

EE - both workers employed

Finally, if both workers are employed, two wage incomes are generated. Both workers might receive and accept value-improving job offers, quit or be separated from their job. The resulting value function is a natural extension of the previous ones. However, as the number of cases and elements increases, readability declines. The intuition of the decisions is nonetheless easy to follow. All combinations of the labor market event sets $[separate, nothing, offer] \times [separate, nothing, offer]$ give (by multiplication of the individual probabilities) the joint probabilities q, and define the choice sets[5]. The household accepts or rejects offers and decides about quits in order to maximize the value function. Besides, the household chooses consumption and savings subject to the budget constraint and the non-negativity constraints on consumption and assets.

$$\begin{aligned}
EE(w_1, \delta_1, w_2, \delta_2, a) = &\max_c \; u_c(c) \\
&+ \beta \cdot q_1 \cdot UU(a') \\
&+ \beta \cdot q_2 \cdot \max\{EU(w_2, \delta_2, a'), UU(a')\} \\
&+ \beta \cdot q_3 \cdot \int \max\{EU(w_2, \delta_2, a'), EU(w_2', \delta_2', a'), UU(a')\} dF(w_2', \delta_2') \\
&+ \beta \cdot q_4 \cdot \max\{EU(w_1, \delta_1, a'), UU(a')\} \\
&+ \beta \cdot q_5 \cdot \max\{EE(., a'), EU(w_1, \delta_1, a') EU(w_2, \delta_2, a'), UU(a')\} \\
&+ \beta \cdot q_6 \cdot \int \max \Phi_1 dF(w_2^*, \delta_2^*) \\
&+ \beta \cdot q_7 \cdot \int \max\{EU(w_1, \delta_1, a') EU(w_1', \delta_1', a'), UU(a')\} dF(w_1', \delta_1') \\
&+ \beta \cdot q_8 \cdot \int \max \Phi_2 dF(w_1', \delta_1') \\
&+ \beta \cdot q_9 \cdot \int\int \max \Phi_3(., a') dF(w', \delta') dF(w^*, \delta^*) \\
&\text{s.t. } c = (1+r) \cdot a + w_1 + w_2 - a' \\
&c, a' \geq 0
\end{aligned} \tag{5}$$

The sets Φ_1, Φ_2 and Φ_3 contain the continuation values of given labor market events: $\Phi_1 = \{UU, EU, UE, EE, UE^*, EE^*\}$ (with * denoting offers for worker 2), $\Phi_2 = \{UU, EU, E'U, UE, EE, E'E\}$ and $\Phi_3 = \{UU, EU, E'U, UE, EE, E'E, UE^*, EE^*, E'E^*\}$. The fully specified sets can be found in the appendix A.

[5] The choice sets are a subset of $\Phi_3 = \{UU, EU, E'U, UE, EE, E'E, UE^*, EE^*, E'E^*\}$, where the superscripts represent the respective job offer

Symbol	Value	Events
q_1	$\delta_1 \cdot \delta_2$	fired, fired
q_2	$\delta_1 \cdot (1-\delta_2-\lambda_e)$	fired, nothing
q_3	$\delta_1 \cdot \lambda_e$	fired, offer
q_4	$(1-\delta_1-\lambda_e)\cdot \delta_2$	nothing, fired
q_5	$(1-\delta_1-\lambda_e)\cdot(1-\delta_2-\lambda_e)$	nothing, nothing
q_6	$(1-\delta_1-\lambda_e)\cdot \lambda_e$	nothing, offer
q_7	$\lambda_e \cdot \delta_2$	offer, fired
q_8	$\lambda_e \cdot (1-\delta_2-\lambda_e)$	offer, nothing
q_9	$\lambda_e \cdot \lambda_e$	offer, offer

Table 2. Labor Market Events II

2.4 Analysis of the mechanism

This section shows analytically how the presence of a spouse influences the risk-wage trade-off of workers. The derivations of the results can be found in appendix B.
Representing the trade-off faced by employed single workers, the slope of the indifference curve is given by

$$MWPS_{\text{single}} = \frac{\beta\left(E(w,\delta)-U\right)}{\frac{\partial u_s(w)}{\partial w}} \tag{6}$$

Two results can be derived from the single workers' MWPS:
First, let R be the reservation set, i.e. the set of all (w,δ) combinations that satisfy $E(w,\delta)=U$. For each job in R, the MWPS is zero. This implies that unemployed workers make job acceptance decisions based only on the wage, independent of the separation risk of an offer.
Next, note that above the reservation set, the enumerator is positive, as the worker would not accept or quit a job if $E<U$. Under risk aversion, the denominator is positive and decreasing in the wage w. Thus, the indifference curve is increasing and concave.

For couples, the slope of the indifference curve is given by (see details in B.2):

$$MWPS_{\text{couple}} == \frac{\beta\left(\mathcal{C}-\frac{\partial EU(w_1,\delta_1)}{\partial \delta_1}\cdot(q_4+q_7F_{1EU})\right)}{\frac{\partial u_c(w_1+w_2)}{\partial w_1}+\beta\cdot\frac{\partial EU(w_1,\delta_1)}{\partial w_1}\cdot(q_4+q_7F_{1EU})} \tag{7}$$

Again, it is important to note that the separation-risk dimension of a job offer does not influence the acceptance decision making when a worker comes from unemployment.

At the reservation job[6], the enumerator collapses to zero, and the indifference curve is a horizontal line in the (δ, w)-space. Thus, when deciding about an U to E transition, the wage is the only job characteristic a worker is interested in, and the policy is characterized by a single reservation wage. This reservation wage will nonetheless be influenced by the current labor market state of the spouse.

The slope depends mainly on the loss in rent if the first worker loses his/her job (denoted by $\mathcal{C}$) and the marginal utility of consumption. Besides the model parameters and functional form choices, the slope also depends on the labor market state of the spouse. Under a 50-50 income split within couples, and a spouse with the same wage, it can be shown that the slope is steeper for couples.

The difference in decision-making between singles and couple workers is illustrated in the graph (1), which depicts the indifference curves for a currently employed worker of both household types, based on a simplified numerical implementation of the model. . Given the same current job, the single worker accepts all jobs in regions A and B. The couple worker accepts all job offers in regions A and C. Thus, the single worker will tend do move faster towards more stable jobs, while a worker of a 2-person household will tend to move faster towards higher wage jobs.

The non-identical acceptance regions imply different job-ladders, where singles are more concerned with job stability, while couple workers are more driven towards higher wages. In order to quantify the effect of this mechanism, the model needs to be solved and matched to the empirical moments derived in the next section.

Table 3. Parameters for illustrative monthly model

β	λ_e	λ_u	ι	b	μ_w	σ_w	μ_δ	σ_δ	distributions
0.997	0.05	0.3	3	0.25	2.5	0.5	0.7	0.3	truncated log-normal

[6]setting $EU = UU$, $EE = EU$, depending on the spouse's labor market status.

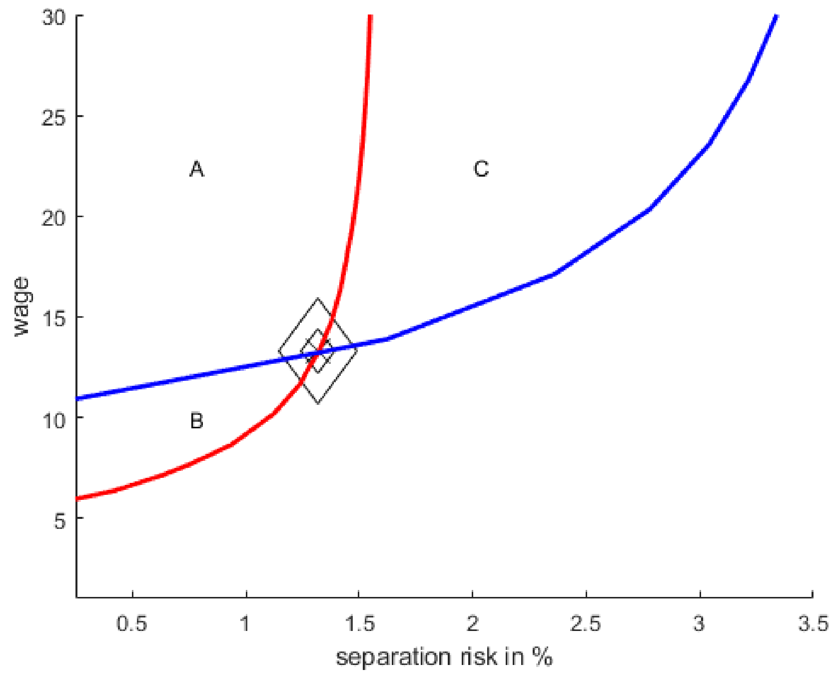

Figure 1. Job Acceptance Regions
Example: Current job is marked by diamond. red: indifference curve single, blue: indifference curve couple.

3 Empirics

3.1 Data

The main data source is the SIAB Data, provided by the IAB-FDZ. This *Sample of Integrated Labour Market Biographies*-dataset contains a random 2%-sample of all German employment histories between 1975 and 2019 from administrative sources[7], which equals roughly 2 million individuals. Several features of this data set are especially useful for the purposes of this analysis: As the individual labor market data, e.g. the wage and duration of each spell, come from administrative sources, the filling rates are high while measurement and other errors can be assumed to be very low. The sequence of different spells of an individual's labor market history allow for identification of different types of labor market transitions. Furthermore, important individual and establishment characteristics are available, such as education, industry,

[7]To be more specific: it contains the labor market histories compiled from different administrative data sources of a 2%-sample of all individuals who were employed and subject to social security contributions during the indicated time period.

occupation or establishment size, where the establishment level data is merged from the IAB's Establishment History Panel (BHP). This data-structure allows to control for effects of both worker characteristics and job characteristics.

3.1.1 Data preparation and sample selection

The SIAB data is first prepared for analysis and transformed from a spell-dataset into a monthly panel, as described in appendix C.1.

The SIAB data has some special features that have to be taken into account for the sample selection process. The empirical work will focus on male full-time regular workers, thus part-time and marginal employment spells will be dropped. Furthermore, the sample is restricted to prime age (25-55) workers. The time frame considered are the years 2010 to 2014. Details on the sample selection procedure can be found in appendix C.2.

3.1.2 Summary Statistics

The following table shows the summary statistics of important socio-economic variables of the selected sample. The 5-year monthly panel from 2010 to 2014 contains around 320,000 individuals, observed up to 60 times. Further summary statistics are attached in C.3. In the selected sample, the unemployment rate is 3.14%.

	mean	min	max	sd	count
age	41.14487	25	55	8.672437	1.38e+07
wage_imp	127.0491	13.54274	3056.977	97.5037	1.34e+07
wage	110.4861	13.54274	192.5829	46.03373	1.34e+07
tenure	2964.961	1	14610	2817.168	1.34e+07
logUduration	3.954717	0	8.757469	1.380727	567203
establishment size	983.6371	0	51032	4087.733	1.34e+07
establishment age	21.88677	0	39	12.97718	1.34e+07
N	13794006				

Table 4. Sample Summary

3.2 Empirical strategy

In order to estimate the model, I identify a list of important empirical moments to match. As the model focuses on job heterogeneity and workers' decisions which job offers to accept as they climb the job ladder, the main empirical objects the model should replicate are the 2-dimensional distribution of workers over different jobs, as well as the transition rates between different jobs and unemployment.

In the model, a job is a combination of a wage and a separation risk, (w, δ). While the wage of an employed worker is directly observable in the data, the separation risk is not. I therefore aggregate individual workers into job-type cells, which are defined by occupation and employer characteristics, in order to estimate separation risk on the cell-level. Specifically, I define the categorical variable job-type J as the following Cartesian product[8]:

$$J = [job\ type] = [occupation] \times [industry] \times [firm\ size] \tag{8}$$

Details on the construction of these job-type cells can be found in the appendix (C.4). As the model focuses on job heterogeneity, I will eliminate as much worker heterogeneity from the data as possible. Therefore, all regressions contain a vector of individual worker control variables $X_{i,t}$. After the regressions, the respective variables will be predicted for a 'generic worker', with fixed individual characteristics $\overline{X}$, as described in C.6.

3.2.1 Empirical labor market transitions

The first set of moments stems from the transitions between labor market states. After transforming the SIAB-data into a monthly panel, the average rate of leaving unemployment ($U2ER$) and the average job to job transition rate ($E2ER$) are estimated by regressing the transitions[9] on the workers' characteristics using a linear probability model. Details of these regressions can be found in C.6:

$$U2E_{i,t} = \beta \cdot X_{i,t} + \epsilon_{i,j,t} \tag{9}$$

$$E2E_{i,j,t} = \beta \cdot X_{i,t} + \epsilon_{i,j,t} \tag{10}$$

[8] The squared brackets stand for categorical variables. $[firm\ size]$ refers to number of full time employees categorized into ranges.

[9] The exact definitions of the transitions are found in (C.5)

In a second step, these transition probabilities are predicted for a generic worker with characteristics $\overline{X}$.

$$U2ER = \widehat{Pr(U2E|\overline{X})} = \widehat{\beta} \cdot \overline{X} \tag{11}$$

$$E2ER = \widehat{Pr(E2E|\overline{X})} = \widehat{\beta} \cdot \overline{X} \tag{12}$$

3.2.2 Empirical job distribution

The second set of moments is derived from the distribution of workers over the different job types (J). The main challenge is to derive the empirical distribution of jobs in the two dimensions (wages and job separation risk), while the separation risk is only observed indirectly once it materializes and forces a separation. However, a materialized separation may still occur at low separation risk if the worker is unlucky. Therefore, the wages and separation rates are estimated at the job-type cell level, while controlling for the effects of the observable worker characteristics. The separation risk of a worker i with characteristics X in a job-cell of type j is estimated in a linear probability model, while wages are estimated in a log-linear model with the same regressors.

$$E2U_{i,j,t} = \alpha_0 + \beta \cdot X_{i,t} + J_{j,t} + \epsilon_{i,j,t} \tag{13}$$

$$\ln(wage_{i,j,t}) = \alpha_0 + \beta \cdot X_{i,t} + J_{j,t} + \epsilon_{i,j,t} \tag{14}$$

The job-type specific separation rate δ_j will then be defined as the predicted probability of a generic worker to separate from the job into unemployment from one month to the next. The log-wage w is the predicted log-wage of a generic worker in job-type j:

$$\delta_j = \widehat{Pr(E2U|\overline{X}, J)} = \widehat{\alpha_0} + \widehat{\beta} \cdot \overline{X} + \widehat{J_j} \tag{15}$$

$$w_j = \widehat{\ln\left(wage|\overline{X}, J\right)} = \widehat{\alpha_0} + \widehat{\beta} \cdot \overline{X} + \widehat{J_j} \tag{16}$$

This method results in the joint distribution of the two relevant job characteristics, shown in figure 2. A strong negative correlation between risk and wages is visible, in line with Jarosch (2021) and others.

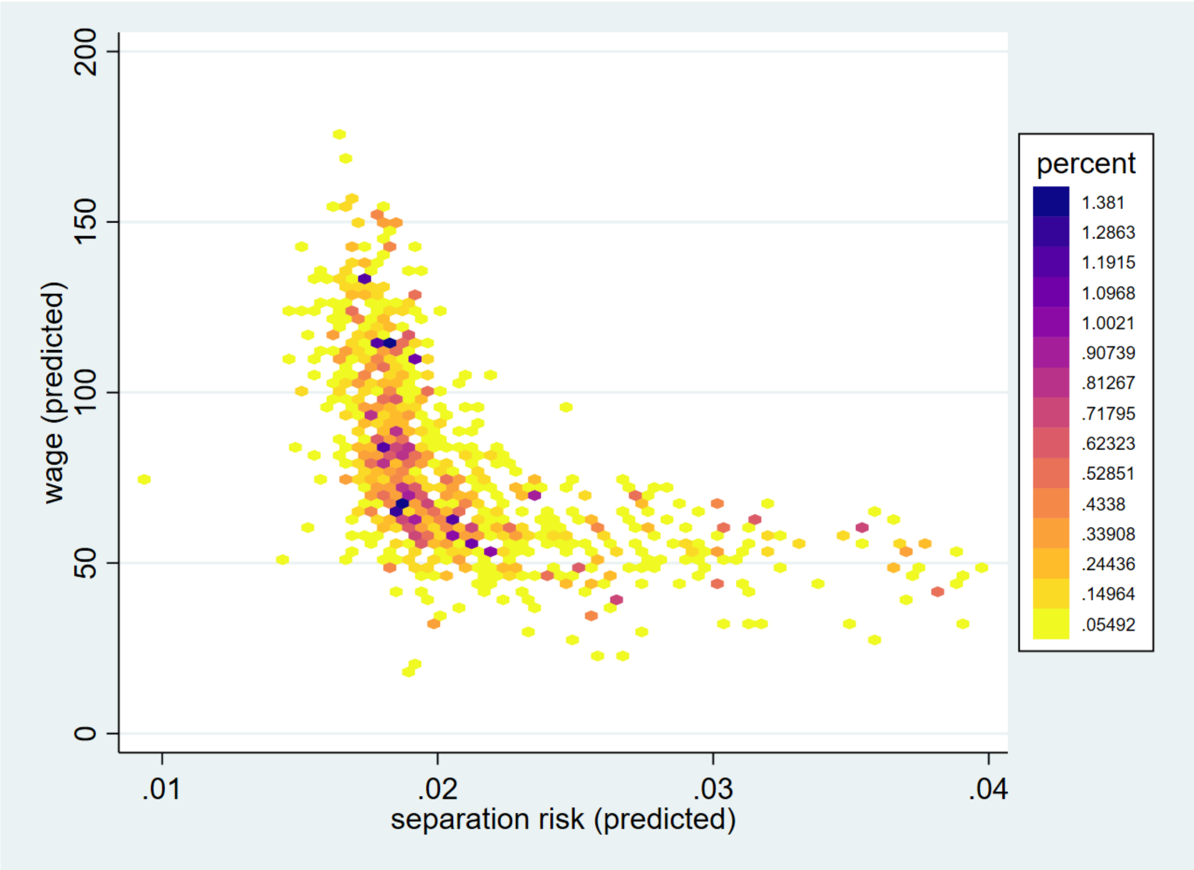

Figure 2. Joint Distribution of Jobs

4 Quantitative Model - Numerical Solution

The model is solved numerically using value function iteration. Before doing so, the utility functions for couples and singles need to be specified, and the state space needs to be discretized.

Utility function specification

Consumption translates into flow utility via a CRRA-utility function.

$$u_s(c) = \frac{c^{1-\iota} - 1}{1 - \iota} \tag{17}$$

For couples, I assume that consumption is evenly split.

$$u_c(c) = \frac{(\frac{1}{2} \cdot c)^{1-\iota} - 1}{1-\iota} \tag{18}$$

Taxes and Unemployment Benefits

I model the German labor income tax system using the two-parameter approach by Heathcote et al. (2017). Under joint taxation for 2-worker households, the disposable (post-tax) labor income ($\tilde{y}$), depending on household labor income y is given by:

$$\tilde{y} = \lambda \cdot y^{1-\tau} \tag{19}$$

The parameters for tax progressivity τ and tax level λ are estimated based on the OECD (2022) Tax Statistics database as described in appendix C.7.1.

The unemployment benefits are modeled in a two-tier system, following the German unemployment system. After being fired from a job, a worker moves into the first tier, where he receives benefits related to his last wage. The replacement rate is denoted by ρ. Thus, the unemployment benefits of a worker with last earned wage w in tier 1 amount to $b(w) = \rho w$.
Unemployed workers in tier 1 move to tier 2 with a monthly rate of $\xi = \frac{1}{12}$. The second tier grants fixed payments b_0.

Job-offer distribution

The two-dimensional job offer distribution $F(w, \delta)$ takes on the following form: The marginal distributions in the wage and the risk dimension follow exponential distributions, truncated at one. The governing parameters will be denoted by λ_w and λ_δ. The dependence structure between the two marginal distributions is described by Frank's copula with copula parameter ρ. These assumptions are made with the objective to allow for a high degree of flexibility in the marginal distributions and the dependence structure, while keeping the number of parameters small.

State space

For the numerical implementation, the state space has to be discretized. First, I discretize the job offer distribution. I use 3 gridpoints for separation risk grid ($\mathcal{R}$) and

7 gridpoints for wages ($\mathcal{W}$), which are equi-logdistantially distributed over the support of the empirical marginal distributions. Furthermore, an unemployment state is added, which naturally has no separation risk. Next, logarithmically spaced asset gridpoints ($\mathcal{A}$) are defined, where the upper limit of the asset grid is chosen sufficiently high in order not to restrict the agents. The Cartesian product constructed as shown below results in the labor market state space grid for singles with 22 points. For couples, the state space needs do be multiplied by the job characteristics for the second worker (blue part in the formula), resulting in 484 labor market grid points. For singles, 200 asset grid points are used, resulting in 4.400 possible states. For couples, 50 asset grid points are used, resulting in 24.200 possible states.

$$\mathcal{G} = \mathcal{A} \times (\mathcal{W} \times \mathcal{R} + \mathcal{U}) \times (\mathcal{W} \times \mathcal{R} + \mathcal{U}) \tag{20}$$

Solution method

The model is solved numerically via value function iteration. The model implies two choices made by the household: the consumption-savings decision and the labor market decision.

Timing within periods

For the numerical solution, workers first choose their consumption level, based on current assets and labor market state, taking into account expectations on labor market events (separations, offers) and optimal response to these events (quits and acceptance of new offers). Then, labor market shocks (separations, job offers) realize, and workers decide whether to accept offers, stay in their current job or quit.

5 Estimation

The quantitative model with the specifications and functional forms chosen in 4 contains the following unknown parameters:

$$\theta_1 = \{\beta, r, \iota, b\} \quad , \quad \theta_2 = \{\lambda_0, \lambda_1, \lambda_w, \lambda_r, \rho\}$$

First, the four parameters of θ_1 are calibrated externally, before using indirect inference for the second set of parameters θ_2, to match the empirical moments.

External Calibration

As the data is converted to a monthly panel, the model will also be calibrated to monthly frequency. The discount rate is consistent with 3.5% annual discounting, and the interest rate matches 2.4% annually. The risk-aversion parameter ι in the CRRA utility function is set to a standard value from the literature of 3, and unemployment benefits are set to 450€, in order to match the monthly payments for long-term unemployed workers in Germany (Hartz IV). This value is clearly not fully representing all possible payments an unemployed worker may receive from the public unemployment insurance system, as they may also include rent assistance, cover heating costs, education and training costs etc. The chosen value is, however a reasonable simplification. Furthermore, the model results are not very sensitive to variations in this parameter. The following table lists all calibrated parameters with their values and sources.

Parameter	Description	Value	Target/Source
β	discount factor	0.997	3.5% annual discounting
r	interest rate	0.002	$\sim$ 2.4% annual interest rate
ι	risk aversion	3	Pilossoph and Wee (2021) Mankart and Oikonomou (2017)
b	non-employment income	0.45	Monthly UI benefits $\sim$ 450€

Table 5. Externally Calibrated Parameters

Indirect Inference

The remaining 5 model parameters need to be chosen to minimize the distance of the model moments to the empirical moments derived in section 3:
The offer rates while employed [unemployed] are informed by the transition rates to a new job coming from employment ($E2ER$) [unemployment (UER)].
The unobserved job offer distribution is set to match the observed distribution of accepted jobs for singles. Specifically, I target mean and variance of both wages and separation risk, as well as their correlation coefficient, of the empirical job distribution for singles. The resulting three parameters of the job offer distribution generate a good fit, indicating that the model is able to generate the empirically observed job distribution. The greatest challenge for the model is to reproduce the mean and standard deviation of the job separation risk distribution. One reason is that the number of separation-risk grid-points is only three. Increasing this number may improve the model fit, but comes at high computational costs. Having targeted the empirical job distribution of singles for estimating the parameters, I use the couples' empirical job distribution in order to evaluate the model fit. Again, the model matches the wage distribution very well, while the separation risk distribution is more challenging. Nonetheless, the model generated moments are close to their empirical counterparts for the non-targeted moments.
Altogether, the model matches the targeted and non-targeted empirical moments well, showing a good model fit.

Parameter	Value	Description	Model	Target	Moment
λ_0	0.22	offer arrival rate unemployed	11.5%	14.6%	UER
λ_1	0.05	offer arrival rate employed	1.58%	1.7%	$E2ER$
		offer distribution			Jobs Singles
λ_w	0.353	wage offer parameter	82.7	77.7	mean $\tilde{w}$
			26.6	26.1	sd $\tilde{w}$
λ_δ	1.806	risk offer parameter	0.042	0.021	mean $\tilde{\delta}$
			0.034	0.005	sd $\tilde{\delta}$
ρ	0.519	Copula Parameter	-0.35	-0.51	Corr$(\tilde{w}, \tilde{\delta})$
					Jobs Couples
			85.9	82.1	mean $\tilde{w}$
			28.5	26.9	sd $\tilde{w}$
			0.05	0.023	mean $\tilde{\delta}$
			0.01	0.005	sd $\tilde{\delta}$

Table 6. Moments and Estimates

6 Results

Using the estimated model, I quantify the labor market effects of the insurance effect arising out of income sharing within couples. I focus on two important variables of interest, the differential in wages between singles and married workers (the marital wage premium), and the differences in precautionary savings.

6.1 Wages

In order to quantify the effects of joint search under separation risk heterogeneity, I simulate the labor market paths of 10.000 households over thirty years. The measured average wage for a single worker is 2.467€ per month, while workers who are part of a couple earn on average 2.576€. Thus the model generates a marital wage premium of $\sim 4.5\%$. This result is net of other potential drivers of the marital wage premium, such as selection, sorting, specialization or job search effort differentials. Thus, up to roughly 80% of the observed, controlled marital wage gap can be explained by joint search and risk sharing.

6.2 Precautionary Savings

In order to study the effects of the insurance mechanism on precautionary savings, 10.000 households of each type are simulated for 30 years. Couples hold on average 1.300 € as precautionary savings, roughly 50% of a married worker average monthly wage. Singles, in contrast hold 17.700 € as precautionary saving, which is about 7 times the average monthly wage of a single worker.

While this result cannot be empirically verified, since there is no empirical way to disentangle savings by different saving motives, it shows the importance of the insurance mechanism of income-sharing within couples. As singles have no way to insure against bad labor market shocks other than self-insure via savings due to incomplete markets, their precautionary savings are about 13 times higher, compared to singles.

The distributions of precautionary savings generated by the model simulations are displayed in the following graphs.

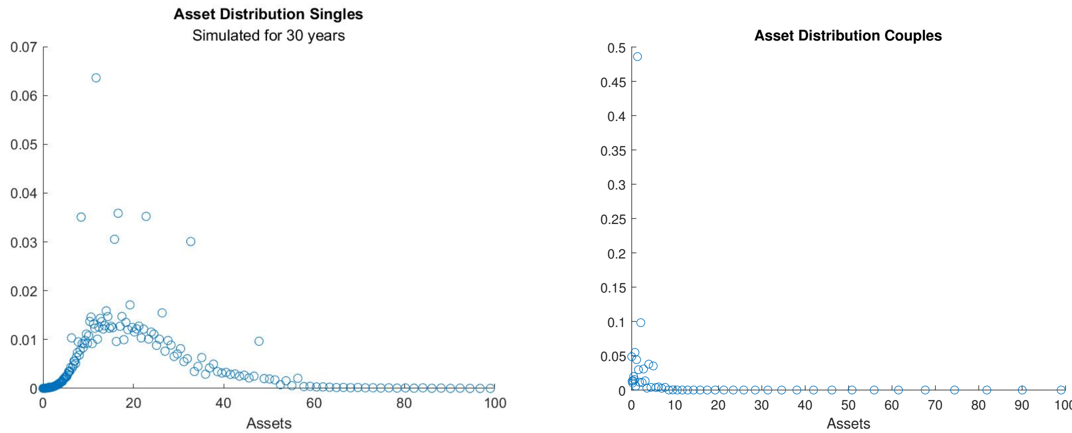

Figure 3. Precautionary Savings in 1.000€

6.3 Comment

The results displayed in Table 6, as well as the results discussed in the current section are results of the estimation of the model without the tax and transfer system. I am currently working on the calibration and estimation of the extended model including the tax and transfer system. I am confident to be able to present the results at the Young Economists' Seminar , as well as policy experiments investigating the effects of moving to separate taxation and/or spouse-independent unemployment payments.

7 Conclusion

The contribution of this paper is twofold. First, I analyze the joint distribution of wages and separation risks inherent to jobs in the German labor market. I document that there is ample dispersion in both dimensions. Furthermore, I show that there is a strong negative correlation between wages and separation risk in the accepted jobs. Second, I present a model of joint search that incorporates separation risk heterogeneity and singles and couples as different household types. The income-sharing feature of couples can generate different labor market outcomes for the household types, which are otherwise ex-ante identical. Thus, I propose a new mechanism that generates important empirical facts such as the marital wage premium. Finally, I quantify the size of this channel. It can generate a marital wage premium of roughly 4.5%, accounting for 80% of the observed, controlled premium in the data. Furthermore, substantial differences in precautionary savings are predicted by the model.
These results imply that the presence of a spouse is a quantitatively important source of insurance against labor income risk. It is a strong substitute for precautionary savings, the other insurance mechanism in the model. Furthermore, income sharing of couples tilts their risk-wage trade-off, so that they tend to accept higher risk - higher wage jobs.

These findings are important for designing public unemployment insurance programs, since some workers already benefit from the insurance mechanism provided by the couple, while single workers do not. More generally my results show that the income sharing effect should be taken into account when modeling decisions under risk, when different household types are of interest.

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A Continuation Value Sets

This section contains the fully written out sets of continuation values that were abbreviated in the main text for equation 5.

$$\Phi_1 = \{UU, EU, UE, EE, UE^*, EE^*\}$$
$$= \{UU(a'), EU(w_1, \delta_1, a')EU(w_2, \delta_2, a'),$$
$$EE(w_1, \delta_1, w_2, \delta_2, a'), EU(w_2^*, \delta_2^*, a'),$$
$$EE(w_1, \delta_1, w_2^*, \delta_2^*, a')\}$$

$$\Phi_2 = \{UU, EU, E'U, UE, EE, E'E\}$$
$$= \{UU(a'), EU(w_1, \delta_1, a'), EU(w_1', \delta_1')EU(w_2, \delta_2, a'),$$
$$EE(w_1, \delta_1, w_2, \delta_2, a'), EE(w_1', \delta_1', w_2, \delta_2, a')\}$$

$$\Phi_3 = \{UU, EU, E'U, UE, EE, E'E, UE^*, EE^*, E'E^*\}$$
$$= \{UU(a'), EU(w_1, \delta_1, a'), EU(w_1', \delta_1')EU(w_2, \delta_2, a'),$$
$$EE(w_1, \delta_1, w_2, \delta_2, a'), EE(w_1', \delta_1', w_2, \delta_2, a'), EU(w_2^*, \delta_2^*, a'),$$
$$EE(w_1, \delta_1, w_2^*, \delta_2^*, a'), EE(w_1', \delta_1', w_2^*, \delta_2^*, a')\}$$

B Derivations

This section shows the details of the derivations of the analytical results discussed in section 2.4. Under optimality assumptions and using Leibnitz' rule, taking the partial derivatives allows to calculate the marginal willingness to pay for job security.

B.1 Trade-off single worker

To characterize the risk-wage trade-off of an employed single worker, I derive how much an employed worker is willing to give up in terms of wage, in order to increase the stability of his job marginally, i.e. the "marginal willingness to pay for job security" ($MWPS$). Simplify equation 2, by ruling out savings.

$$\begin{aligned} E(w,\delta) = u_s(w) &+ \beta\lambda_{e,s}E(w,\delta) \\ &+ \beta\lambda_{e,s}\int_{E'\geq E}\{E(w',\delta') - E(w,\delta)\}\,dF(w',\delta') \\ &+ \beta\delta U \\ &+ \beta(1-\lambda_{e,s}-\delta)E(w,\delta) \end{aligned} \tag{21}$$

Taking the partial derivative w.r.t wages gives the marginal effect of wage changes to the value of the job:

$$\begin{aligned} \frac{\partial E(w,\delta)}{\partial w} = \frac{\partial u_s(w)}{\partial w} &+ \beta\lambda_{e,s}\frac{\partial E(w,\delta)}{\partial w} \\ &- \beta\lambda_{e,s}\frac{\partial E(w,\delta)}{\partial w}(1-F_E) \\ &+ \beta(1-\lambda_{e,s}-\delta)\frac{\partial E(w,\delta)}{\partial w} \end{aligned} \tag{22}$$

Here F_E denotes the cumulative probability mass of the job offer distribution, s.t. the value of the job offer is not greater than the current job:
$F_E(w,\delta) = \int_{(w',\delta')(s.t.)E(w',\delta')\leq E(w,\delta)} 1dF(w',\delta')$
The value of having a marginally higher wage is equal to marginal utility of consumption, a higher continuation value if not fired and no offer received (line 3). If the worker receives an offer in this model, he is not fired, thus the continuation value increases (line 1). At the same time, the mass of acceptable job offers decreases, since

the lower bound of the integral moves up marginally. However, the marginal offers generate zero additional rent, since $E' - E = 0$ if evaluated at E. Finally, the rent gain if finding a better job offer in the future decreases (line 2). Simplifying this term, we see that the marginal wage increase increases the continuation value in case that the worker is not fired and does not receive an acceptable job offer.

$$\frac{\partial E(w,\delta)}{\partial w} = \frac{\frac{\partial u_s(w)}{\partial w}}{1-\beta\left[\lambda_{e,s}\cdot F_E + (1-\delta-\lambda_{e,s})\right]} \tag{23}$$

$$\begin{aligned}\frac{\partial E(w,\delta)}{\partial \delta} =& \beta\lambda_{e,s}\frac{\partial E(w,\delta)}{\partial \delta} \\ &- \beta\lambda_{e,s}\frac{\partial E(w,\delta)}{\partial \delta}(1-F_E) \\ &+ \beta U \\ &+ \beta(1-\lambda_{e,s}-\delta)\frac{\partial E(w,\delta)}{\partial \delta} \\ &- \beta E(w,\delta)\end{aligned} \tag{24}$$

$$\frac{\partial E(w,\delta)}{\partial \delta} = \frac{\beta(U-E(w,\delta))}{1-\beta\left[\lambda_{e,s}\cdot F_E + (1-\delta)(1-\lambda_{e,s})\right]} \tag{25}$$

The marginal willingness to pay for job security is then:

$$MWPS = \left.\frac{dw}{d\delta}\right|_{E\text{ constant}} = -\frac{\frac{\partial E(w,\delta)}{\partial \delta}}{\frac{\partial E(w,\delta)}{\partial w}} = \frac{\beta\left(E(w,\delta)-U\right)}{\frac{\partial u_s(w)}{\partial w}} \tag{26}$$

B.2 Trade-off couple worker

To characterize the risk-wage trade-off of an employed worker with a spouse, I derive how much this employed worker is willing to give up in terms of wage, in order to increase the stability of his job marginally, i.e. the "marginal willingness to pay for job security" ($MWPS$).

Simplify equation 5, by ruling out savings. In order to simplify the notation, the labor market state of the second worker (w_2, δ_2) will be denoted by E. Furthermore, it is assumed that the household previously made optimal decisions, i.e. quitting does not make the household better off.

$$
\begin{aligned}
EE(w_1, \delta_1, w_2, \delta_2) &= u_c(w_1 + w_2) \\
&+ \beta \cdot q_1 \cdot UU \\
&+ \beta \cdot q_2 \cdot EU(w_2, \delta_2) \\
&+ \beta \cdot q_3 \cdot \int \max\{EU(w_2, \delta_2), EU(w_2', \delta_2')\} dF(w_2', \delta_2') \\
&+ \beta \cdot q_4 \cdot EU(w_1, \delta_1) \\
&+ \beta \cdot q_5 \cdot EE(.) \\
&+ \beta \cdot q_6 \cdot \int \max \Phi_1 dF(w_2^*, \delta_2^*) \\
&+ \beta \cdot q_7 \cdot \int \max\{EU(w_1, \delta_1) EU(w_1', \delta_1')\} dF(w_1', \delta_1') \\
&+ \beta \cdot q_8 \cdot \int \max \Phi_2 dF(w_1', \delta_1') \\
&+ \beta \cdot q_9 \cdot \int\int \max \Phi_3(.) dF(w', \delta') dF(w^*, \delta^*)
\end{aligned} \tag{27}
$$

The sets Φ_1, Φ_2 and Φ_3 contain the continuation values of given labor market events: $\Phi_1 = \{EE, UE^*, EE^*\}$ (with * denoting offers for worker 2), $\Phi_2 = \{E'U, EE, E'E\}$ and $\Phi_3 = \{E'U, EE, E'E, UE^*, EE^*, E'E^*\}$.

Taking the partial derivatives w.r.t. wage and separation risk gives the marginal change in value of a given state w.r.t. marginal changes in wage and risk:

$$
\begin{aligned}
\frac{\partial EE}{\partial w_1} &= \frac{\partial u_c(w_1 + w_2)}{\partial w_1} \\
&+ \beta \cdot q_4 \cdot \frac{\partial EU(w_1, \delta_1)}{\partial w_1} \\
&+ \beta \cdot q_5 \cdot \frac{\partial EE}{\partial w_1} \\
&+ \beta \cdot q_6 \cdot \frac{\partial EE}{\partial w_1} \cdot F_{2EE} \\
&+ \beta \cdot q_7 \cdot \frac{\partial EU(w_1, \delta_1)}{\partial w_1} \cdot F_{1EU} \\
&+ \beta \cdot q_8 \cdot \frac{\partial EE}{\partial w_1} \cdot F_{1EE} \\
&+ \beta \cdot q_9 \cdot \frac{\partial EE}{\partial w_1} \cdot F_{1,2,EE}
\end{aligned} \tag{28}
$$

Again, the continuation value is influenced when the first worker is not fired and (if received) job offers are rejected. The F -terms represent the part of the job offer distribution which would be rejected. Re-arranging yields:

$$\frac{\partial EE}{\partial w_1} = \frac{\frac{\partial u_c(w_1+w_2)}{\partial w_1} + \beta \cdot \frac{\partial EU(w_1,\delta_1)}{\partial w_1} \cdot (q_4 + q_7 F_{1EU})}{1 - \beta\left[q_5 + q_6 F_{2,EE} + q_8 F_{1,EE} + q_9 F_{1,2,EE}\right]} \tag{29}$$

For the partial derivative w.r.t. risk, the same logic applies. Additionally, the change in risk changes the probabilities of the continuation cases.

$$\begin{aligned}
\frac{\partial EE}{\partial \delta_1} =& \beta \cdot q_4 \cdot \frac{\partial EU(w_1,\delta_1)}{\partial \delta_1} \\
&+ \beta \cdot q_5 \cdot \frac{\partial EE}{\partial \delta_1} \\
&+ \beta \cdot q_6 \cdot \frac{\partial EE}{\partial \delta_1} \cdot F_{2EE} \\
&+ \beta \cdot q_7 \cdot \frac{\partial EU(w_1,\delta_1)}{\partial \delta_1} \cdot F_{1EU} \\
&+ \beta \cdot q_8 \cdot \frac{\partial EE}{\partial \delta_1} \cdot F_{1EE} \\
&+ \beta \cdot q_9 \cdot \frac{\partial EE}{\partial \delta_1} \cdot F_{1,2,EE} \\
&+ \beta \cdot \delta_2 \cdot UU \\
&+ \beta \cdot (1 - \delta_2 - \lambda_e) \cdot EU(w_2,\delta_2) \\
&+ \beta \cdot \lambda_e \cdot \int \max\{EU(w_2,\delta_2), EU(w_2',\delta_2')\} dF(w_2',\delta_2') \\
&- \beta \cdot \delta_2 \cdot EU(w_1,\delta_1) \\
&- \beta \cdot (1 - \delta_2 - \lambda_e) \cdot EE(.) \\
&- \beta \cdot \lambda_e \cdot \int \max \Phi_1 dF(w_2^*,\delta_2^*)
\end{aligned} \tag{30}$$

Re-arranging yields:

$$\begin{aligned}
\frac{\partial EE}{\partial \delta_1} =& \frac{\beta}{1 - \beta\left[q_5 + q_6 F_{2,EE} + q_8 F_{1,EE} + q_9 F_{1,2,EE}\right]} \\
&\cdot \Bigg[\frac{\partial EU(w_1,\delta_1)}{\partial \delta_1} \cdot (q_4 + q_7 F_{1EU}) \\
&\left.\begin{aligned}
&-\delta_2 \cdot (EU(w_1,\delta_1) - UU) \\
&-(1 - \delta_2 - \lambda_e) \cdot (EE(.) - EU(w_2,\delta_2)) \\
&-\lambda_e \cdot \left(\int \max \Phi_1 dF(w_2^*,\delta_2^*) - \int \max\{EU(w_2,\delta_2), EU(w_2',\delta_2')\} dF(w_2',\delta_2')\right)\Bigg]
\end{aligned}\right\} = -\mathcal{C}
\end{aligned} \tag{31}$$

$$
\begin{aligned}
MWPS = \left.\frac{dw}{d\delta}\right|_{EE \text{ constant}} &= -\frac{\frac{\partial EE}{\partial \delta_1}}{\frac{\partial EE}{\partial w_1}} \\
&= \frac{\beta\left(\mathcal{C} - \frac{\partial EU(w_1,\delta_1)}{\partial \delta_1} \cdot (q_4 + q_7 F_{1EU})\right)}{\frac{\partial u_c(w_1+w_2)}{\partial w_1} + \beta \cdot \frac{\partial EU(w_1,\delta_1)}{\partial w_1} \cdot (q_4 + q_7 F_{1EU})}
\end{aligned} \tag{32}
$$

C Details Empirics

This appendix contains more detailed information on the data, cleaning and sample selection, as well as exact definitions and operationalisations used in section 3 of the main text.

C.1 Data Preparation

I use the SIAB – Version 7519 v1 – provided by the IAB:
Berge, Philipp vom; Frodermann, Corinna; Graf, Tobias; Grießemer, Stephan; Kaimer, Steffen; Köhler, Markus; Lehnert, Claudia; Oertel, Martina; Schmucker, Alexandra; Schneider, Andreas; Seth, Stefan (2021): "Weakly anonymous Version of the Sample of Integrated Labour Market Biographies (SIAB) – Version 7519 v1". Research Data Centre of the Federal Employment Agency (BA) at the Institute for Employment Research (IAB). DOI: 10.5164/IAB.SIAB7519.de.en.v1 The data access was provided via on-site use at the Research Data Centre (FDZ) of the German Federal Employment Agency (BA) at the Institute for Employment Research (IAB) and subsequently remote data access.

Based on the codes by Eberle and Schmucker (2017) and Dauth and Eppelsheimer (2020), a number of preliminary work steps are executed: I merge firm variables from the establishment history panel (BHP). Some educational and occupational classifications are coded. Since top labor income is censored at the contribution limit, I impute the wages above the contribution limit following Gartner (2005). Furthermore, wages are deflated, and marginal and part time employment spells are marked. The spell data is then transformed into a monthly panel, and the main labor market status for each observation-month is identified.

C.2 Sample Selection

The monthly panel data set is restricted in several ways: The sample only contains male prime age workers between 25 and 55 years. Part-time workers are excluded, as well as workers below the marginal workers income threshold. Furthermore, observations with missing information on gender, labor market status etc. are excluded, as well as observations of employees without establishment identifiers. I limit the time-frame to the years 2010 to 2014. The distribution of observations over the years is shown below in table 7. The restricted panel is then used for the empirical analysis in the next steps.

Table 7. Sample by years

Years	freq	pct	cumpct
2010	4760187	19.61	19.61
2011	4809968	19.82	39.43
2012	4866499	20.05	59.48
2013	4899275	20.19	79.67
2014	4935249	20.33	100.00
Total	24271178	100.00	

C.3 Summary Statistics

The following table (8) contains further summary statistics of the selected sample in other dimensions than listed in the main text (3.1.2).

Table 8. Additional Summary statistics

Years	freq	pct	cumpct
2010	4760187	19.61	19.61
2011	4809968	19.82	39.43
2012	4866499	20.05	59.48
2013	4899275	20.19	79.67
2014	4935249	20.33	100.00
Total	24271178	100.00	
Firm size	**freq**	**pct**	**cumpct**
0	495151	2.11	2.11
1-10	5091749	21.66	23.77
11-100	8191043	34.84	58.61
101-1000	7190178	30.58	89.19
more than 1000	2540772	10.81	100.00
Total	23508893		
Education	**freq**	**pct**	**cumpct**
neither vocational training nor univ. degree	1459303	6.29	6.29
vocational training	1.73e+07	74.45	80.74
university degree	4466495	19.26	100.00
Total	23191006		

C.4 Job-type cells

Job-type cells are defined by combining the following categorical variables for each job:

1. industry: defined by 3-digit industry classification (`w93_3`)
2. occupation: defined by 3-digit occupation classification (`beruf2010_3`)
3. firm size: defined by regular full-time employment size bins [1;10], [11;100], [101;1000], [1001;∞)

$$[job\ type] = [industry] \times [occupation] \times [size]$$

This results in a total of 38,864 different cells in the data. For the regressions based on the job-type cells, those type cells containing less than 100 different individuals are dropped, resulting in 1,206 cells containing $\sim$ 35.100.000 observation-months.

C.5 Labor market state transitions

Using the monthly panel of the SIAB data, I identify the relevant labor market transitions of individual workers as follows:

1. U2E: Worker is not employed in the previous and the current month, but employed in the following month.
2. E2U: Worker is employed in the current month, and unemployed in the following two months
3. E2E: Worker is employed in firm x in one month, and employed in firm y in the following month, OR worker is employed in firm x in one month, unemployed in the following month and employed in firm y in the consecutive month.

Here I count E-U-E and E-E transitions as E2E transitions. Thus, short gaps between two employment spells are interpreted as if the worker would directly move to the new employer.

Table 9. Transition Definitions

	Month			
Type	-1	0	+1	+2
U2E	U	U	E	
E2U		E	U	U
E-E		E	E'	
E-U-E		E	U	E'

C.6 Regressions and predictions

C.6.1 Regressions

The following table contains the regression results from the regressions described in section 3.2.1. Note that the small R^2 values are not of concern, since we do not attempt to predict exactly which worker transitions at what point in time, but rather want to partial out structural effects of age, tenure and education.

Table 10. Regression Results

	E2E	U2E
	b/se	b/se
age	-.0003951	-.0042066
	.0000295	.0006796
age^2	3.24e-06	.0000253
	3.63e-07	8.47e-06
2.ausbildung2	.0013965	.0658461
	.0001176	.0023268
3.ausbildung2	-.0018923	-.0079304
	.0002925	.0065124
4.ausbildung2	.0014786	.0512934
	.0001346	.0028532
5.ausbildung2	.0011241	.0452848
	.0001924	.0044652
6.ausbildung2	.0009681	.0499089
	.000127	.0028403
ln(tenure)	-.0039722	
	.0000192	
cons	.04642	.2077283
	.0005848	.0129863
r2	.0044485	.0050855
N	1.28e+07	337138

C.6.2 Predictions

The predictions are performed to partial-out between-worker heterogeneity based on observable worker characteristics. Therefore, I use the predicted values for a generic worker: 40 year old male, in West-Germany, with vocational training and a tenure at the firm set to the sample mean.

C.7 Taxes, Transfers and Social Security

This section of the appendix describes the approximation of the German system of taxes and transfers, which will be used in the quantitative model. I first estimate a labor income tax function, including employee contributions to social security. However, I leave out unemployment insurance payments and other transfers at the lower end of the income distribution, and approximate them separately. This allows for policy experiments, where parts of the tax system or the social security system are altered independently.

C.7.1 Estimation of the German Income Tax schedule

I estimate the two-parameter tax system approximation proposed by Benabou (2000), Heathcote et al. (2017) and others. In this approximation, post-tax income ($\tilde{y_i}$) is calculated from pre-tax income (y_i) as follows:

$$\tilde{y_i} = \lambda \cdot y_i^{1-\tau} \tag{33}$$

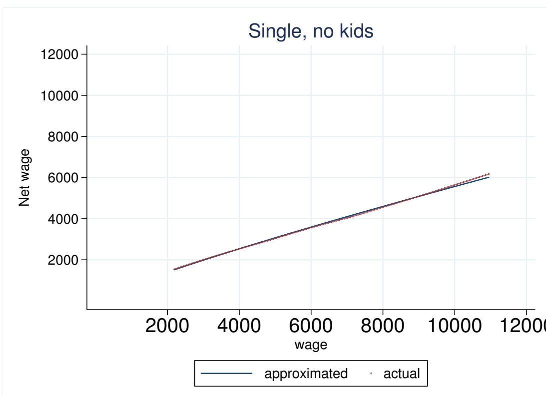
The parameters λ and τ can be interpreted as the level and and the progressivity of the tax system. Rewriting equation 33 in logarithms implies in the following regression:

$$\log(\tilde{y_i}) = \log(\lambda) + (1-\tau) \cdot \log(y_i) + \epsilon_i \tag{34}$$

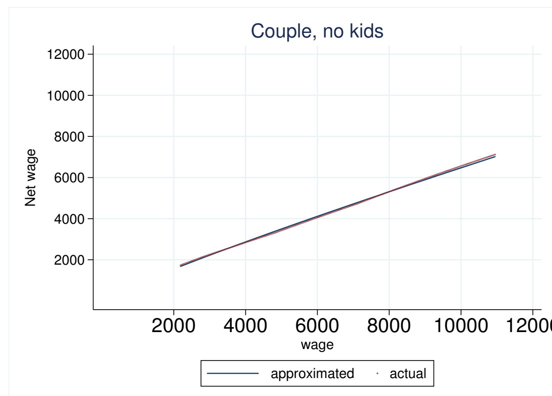
I use the OECD (2022) Tax Data Set for the estimation. This dataset contains the Taxing Wages Database, which lists the statuary gross- and net wage earnings for different household types. The values are documented for annual labor incomes ranging from 50% (26,278 €) to 250% (131,389 €) of average annual earnings, in 1%-point steps. The net wage earnings take into account employee-contributions to the social security system (health insurance, unemployment insurance etc.). This procedure results in a realistic approximation of the net labor income after taxes and contributions, except for low income households. As these low income households are more likely to be social security payment or transfer recipients, their net income will largely be determined by social security payments, which will be discussed in the next subsection. For Germany, the data is only available for the year 2021, which will be used for the estimation. The fit of the tax function approximation to the actual values is very accurate, as shown in figure 4.

The regression results for the four available household types are shown in table 11. Transforming the coefficients back into the Benabou-parameters results in the following estimates. The post tax income for households is then calculated as $y_{post} = \hat{\lambda_h} \cdot y^{1-\tau_h}$, where h is the household type and y is the total household wage income.

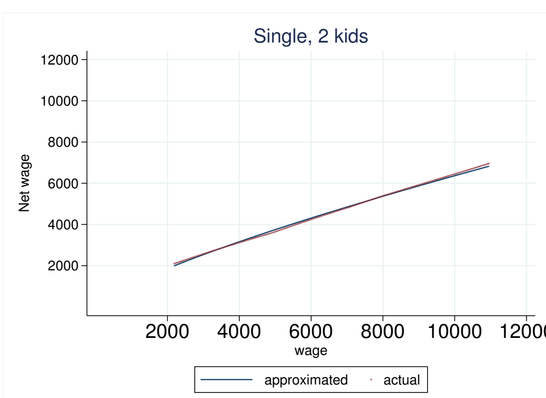
	Tax-Parameters	
	λ	τ
Single, no kids	2.073894	.1428291
Couple, no kids	1.824459	.1125031
Single, 2 kids	5.602858	.2361501
Couple, 2 kids	4.697109	.2075976



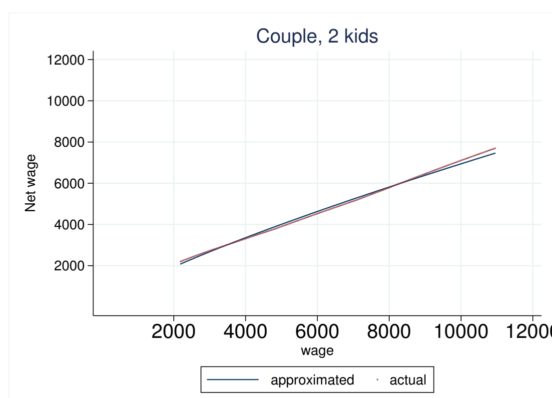
(a) Single, no kids



(b) Couple, no kids



(c) Single, 2 kids



(d) Couple, 2 kids

Figure 4. Actual and approximated net incomes

Table 11. Income Tax System Regression

	(1) single, no kids	(2) couple, no kids	(3) single, 2 kids	(4) couple, 2 kids
logwage	0.857***	0.887***	0.764***	0.792***
	(0.000)	(0.000)	(0.000)	(0.000)
_cons	0.729***	0.601***	1.723***	1.547***
	(0.000)	(0.000)	(0.000)	(0.000)
N	201	201	201	201
F	234730.0	149424.0	80816.8	49596.8
r2	0.999	0.999	0.998	0.996

p-values in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

C.7.2 Social Security Payments

The German Unemployment Insurance system consists of two tiers:
The first tier, also called Unemployment Insurance (UI), provides earnings-related benefits for a limited duration. It is generally paid for up to 12 months of unemployment, irrespective of need. The replacement rate ρ is currently 60% (65%) of net assessed earnings, which in turn are calculated as 80% of the post tax income of the 12-month average earnings prior to the beginning of the unemployment spell.
The second tier, also called Unemployment Assistance (UA), is means-tested and consists of a fixed payment, independent of previous wage earnings.

I approximate the UI payments b for workers with their last pre-unemployment wage w as the replacement rate times the predicted statutory income after taxes and transfers, using the estimation results from the previous section:

$$b_w = \rho \cdot y_{post}(w) \tag{35}$$

With probability $\xi = \frac{1}{12}$, workers move from UI to UA. The UA payments b_0 are set to the standard of 450€.
For couples, the UA payments are conditional on the spouse's income. If the income of the spouse is sufficient to support the partner, their UA payments are reduced or stopped completely.