Keldenich, Carina; Knabe, Andreas

Article — Published Version

Women's Labor Market Responses to Their Partners' Unemployment and Low-Pay Employment

Journal of Labor Research

Provided in Cooperation with:
Springer Nature

Suggested Citation: Keldenich, Carina; Knabe, Andreas (2022) : Women's Labor Market Responses to Their Partners' Unemployment and Low-Pay Employment, Journal of Labor Research, ISSN 1936-4768, Springer US, New York, NY, Vol. 43, Iss. 1, pp. 134-162, https://doi.org/10.1007/s12122-022-09327-0

This Version is available at:
https://hdl.handle.net/10419/309935

Journal of Labor Research (2022) 43:134–162
https://doi.org/10.1007/s12122-022-09327-0

Women's Labor Market Responses to Their Partners' Unemployment and Low-Pay Employment

Carina Keldenich[1] · **Andreas Knabe**[1,2]

Accepted: 14 January 2022 /Published online: 26 January 2022

Abstract
Using bivariate random-effects probit estimation on data from the German Socio-Economic Panel we show that women respond to their partners' unemployment with an increase in labor market participation, which also leads to an increase in their employment probability. Our analysis considers within and between effects separately, revealing differences in the relationships between women's labor market statuses and their partners' unemployment in the previous period (within effect) and their partners' overall probability of being unemployed (between effect). Furthermore, we contribute to the literature by demonstrating that a partner's employment in a low-paid job has an effect on women's labor market choices and outcomes similar to that of his unemployment.

Keywords Added worker effect · Labor supply · Family economics · Unemployment · Low-pay employment

JEL Classification Codes D12 · D13 · J22

Introduction

Many important decisions in an individual's life are made within the context of a couple/nuclear family or are, at least partially, driven by considerations for the family as a whole. Living with a partner (potentially) allows for specialization, insurance mechanisms and economies of scale in consumption within the family. Given this prominent role of the family a growing body of the economic literature is devoted

✉ Carina Keldenich
Carina.Keldenich@ovgu.de

Andreas Knabe
Andreas.Knabe@ovgu.de

[1] Faculty of Economics and Management, Otto von Guericke University Magdeburg, P.O. Box 4120, 39016 Magdeburg, Germany

[2] Otto von Guericke University Magdeburg, Magdeburg, Germany

to analyzing intrafamilial decision-making, family formation and the consequences for society, both theoretically and empirically (see e.g. Becker 1991, and Browning et al. 2014). Unemployment of one family member, particularly the primary earner, affects everyone living in the household, at the very least due to a short-term, and potentially also long-term, reduction in household income. One possible response of the family to the job loss of the primary earner could be an increase in the labor supply of the other partner. The concept of "additional workers" entering the labor market due to their partners' unemployment was already analyzed by Woytinsky (1942), who focuses primarily on the inflow of these workers into the labor market during a depression, resulting in an even higher unemployment rate than would be observed otherwise. While the *added worker effect*, defined by Lundberg (1985, p.11) as "a temporary increase in the labor supply of married women whose husbands have become unemployed", has been investigated by several empirical studies, the evidence is not conclusive, particularly when considering responses at the extensive margin (see for example Lundberg 1985; Maloney 1991; Stephens 2002; Kohara 2010; Triebe 2015). Variations in findings could be explained by differences in the definition of the added worker effect and estimation technique as well as differences across countries and time periods.

As noted by Maloney (1991), the concept of the added worker effect typically builds on the idea that men are frequently the primary earners of the family and tend to be closely attached to the labor market, such that their employment decisions are largely independent of the wife's choices. On the other hand, as long as the husband is employed the wife is assumed to either not participate in the labor market or to be a secondary earner, who has the capability to increase working hours. This leaves room for the wives to adjust their labor market participation or working hours depending on their partner's labor market status or the financial situation of the household more generally. While some studies (e.g. Triebe 2015) have, in the light of increased female labor market participation and shifting gender norms, extended this definition to also include the response of men to their partners' unemployment, this remains the exception. In line with most previous studies and for ease of exposition, we will focus on men as primary earners and women as secondary earners throughout this paper and estimate the added worker effect only for women.[1]

The purpose of this study is twofold. Firstly, we want to investigate whether there is evidence for the added worker effect in Germany, using data from the German Socio-Economic Panel (SOEP), and estimate its magnitude. We explicitly focus on whether the probability of participating in the labor market increases following the partner's unemployment. Thus, we focus on outcomes at the extensive rather than the intensive margin. In addition to the participation decision, we also consider the

[1] It should be noted that, from a theoretical standpoint, the analysis of specialization on either market work or household production is a priori gender neutral and typically depends on market wages and productivity in the household sector. Any comparative advantage can then be reinforced by, or indeed arise only because of, the process of specialization e.g. in terms of human capital accumulation. The typical label of "man" and "woman" arise due to what is typically observed in society and the resulting gender norms, though some biological arguments for why the respective specializations arise have also been brought forward (see e.g. Becker 1991, for a helpful exposition of this argument).

employment status. An increase in the employment probability due to the unemployment of a partner can arise via several channels. If there is the aforementioned increase in participation, some of the women who newly enter the labor market will find employment. Additionally, women who already participate in the labor market, but are unemployed and searching for a job, might increase their search intensity and/or start accepting less favorable job offers, and thus increase their employment probability. Lastly, women who already hold a job might become less likely to terminate the employment relationship.

Secondly, we contribute to the existing literature by incorporating the impact of low-pay employment of the man on his partner's labor market status into the analysis, which, to the best of our knowledge, has not been considered in previous studies on the topic. Failing to obtain high-paid employment may cause sufficient financial hardship for the family to warrant a similar compensatory response as the primary earner's unemployment. Thus, we interpret such a response also as a form of added worker effect. However, an important difference between unemployment and low-pay employment is that only the former increases the man's available time and allows the substitution of the partner's time in household production. Hence, one would expect a smaller response of the woman's labor supply to low-pay employment than to unemployment of her partner.

We estimate a dynamic bivariate random effects probit model to capture state dependence in the labor market position and to allow the unobserved heterogeneity to be correlated across outcome variables. We apply a Mundlak correction to model both the within effects, which correspond to the estimates of a fixed-effects regression, and between effects of a partner's unemployment and low-pay employment into account explicitly. This takes up the idea by Maloney (1991) who considers the temporary and permanent component of the partner's unemployment in a cross-section of married couples with information on past unemployment experiences. Similarly, Hyslop's (1999) analysis of female labor market participation, which applies a dynamic random effects model, incorporates both a transitory and a permanent component of non-labor income as explanatory variables. Both studies highlight the importance of heterogeneity in the analysis of female labor supply in general and the estimation of the added worker effect in particular.

Our results suggest that women do respond to the within component of their partner's unemployment as well as low-wage employment by increasing labor market participation. Along with the increased participation of these women, we also observe a higher probability of being employed. We interpret this within effect of the man's unemployment/low-wage employment as evidence of the added worker effect. Furthermore, we find that women whose partners are frequently unemployed or in low-wage employment also have higher participation rates. However, this higher participation rate is only associated with a higher probability that these women are unemployed themselves, but we do not find a significantly higher employment probability. These between effects should not be interpreted as an added worker effect for two reasons. First, they are not short-term responses to a current spell of unemployment of the partner. Second, it is not clear whether the observed relationship can be interpreted as causal, as the results could also be indicative of assortative matching in the marriage market. While we also report results for the man's non-participation

in the labor market, these should be interpreted with caution as the group of non-participating men is very small.

An important caveat to our analysis concerns the question of causality. Several recent studies have placed emphasis on identifying the added worker effect by only considering the influence of a partner's exogenous job loss, typically defined as resulting from a plant closure or dismissal (see for example Stephens 2002, and, Kohara 2010), to ensure that the identified effect is causal. Since there is no convincing way to model an exogenous switch to low-pay employment from high-pay employment in a similar fashion, we instead take great care in our model set-up to address this issue. We decompose the partner's employment status variables into a between and a within component, thereby addressing the potential influence of time-invariant factors influencing both partners (e.g. assortative matching in the marriage market). However, these adjustments do not rule out that there are some time-varying factors influencing both partners' labor supplies, which lead to a correlation between the woman's labor market status and that of her partner in the previous period. As long as these shocks affect both partners in the same direction, as would be the case for most macroeconomic and other labor market shocks, this correlation would cause an underestimation of the added worker effect. In that sense, our estimates constitute lower bounds. However, we mitigate these influences by including lags of the women's own employment status alongside the lag of her partner's labor market status as well as time fixed effects. There is also the possibility that the two partners voluntarily decide to "switch roles", i.e. the woman becomes the breadwinner while her partner stays at home. The aforementioned lag structure would also partly deal with this issue. However, it will not be able to capture all conceivable sequences of events, e.g. the man quits his job anticipating that his wife will take up a new job in the future. This would cause an overestimation of the added worker effect. Even though there is, thus, no guarantee that the estimated within effects truly correspond to the impact that a fully exogenous, unanticipated job loss would have, we believe that our model addresses the most critical issues concerning causality.

The remainder of the paper is structured as follows. Section 2 reviews the existing literature on the added worker effect and the estimation technique. The econometric model and the data are introduced in section 3 and 4, respectively. Section 5 reports the key results, while robustness checks and limitations are discussed in section 6 and 7 respectively. Section 8 concludes.

Theoretical Background and Related Literature

A number of studies have provided a theoretical rationale for the existence of an added worker effect, both related to unemployment as well as low wage rates of one household member. Imperfect credit markets are a common explanation, since an unemployment spell of the (otherwise) primary earner results in a temporary reduction in household income, which induces an increase in labor supply of the partner if leisure is a normal good. A transitory increase in labor supply by the wife can act as a family consumption smoothing or insurance mechanism when alternatives are not available or costly (Mincer 1962, and Lundberg 1985). However, as Stephens

(2002) has argued, even with well-functioning credit markets the shock to the permanent earnings of the family due to worker displacement may be sufficiently large to warrant a partner's response, since worker displacement has been shown to have a substantial impact on earnings, both in terms of an immediate loss of income as well as lower wages years after the initial job loss (see e.g. Fallick 1996, and Couch and Placzek 2010, and the literature mentioned therein). In a life-cycle model, this reduction in expected lifetime earnings of the husband also results in a permanent increase in (desired) female labor supply if leisure is a normal good. Even though this change would clearly be considered a labor market response by the woman, whether it should be considered an added worker effect depends on whether permanent responses are also included in the definition.

In addition to the potential for credit constraints another important aspect to consider when thinking about transitory changes in female labor supply directly related to periods of unemployment of the husband is the substitutability in the two partners' nonmarket/leisure times. For example, Ashenfelter (1980) showed in his theoretical model of household utility maximization which treats unemployment of family members as a constraint in optimization that an exogenous unemployment spell of one partner will increase (decrease) the labor supply of the other partner if the nonmarket time of the two partners are substitutes (complements). Assuming that nonmarket times of the two partners are indeed substitutes, this substitution effect would explain part of the added worker effect. Lundberg (1985) also arrives at the conclusion that, if the husband's and wife's leisure times are substitutes, an increase in the husband's wage will increase the reservation wages of the wife and, as a result, make her less likely to participate in the labor market or accept a job offer if she is currently unemployed. The husband's unemployment has the converse effect. The model also includes credit constraints, however, even in this case strong complementarities in leisure times could make the direction of the labor market response by the woman ambiguous. In this context it should also be noted that even though Lundberg refers to *leisure* times she also states that leisure could be interpreted as time devoted to household production, which makes the assumption of substitutability more credible.

Lundberg (1985) also provides an empirical test of her aforementioned theoretical model. Using data from the Seattle and Denver Income Maintenance Experiments (SIME/DIME), she estimates transition matrices for wives with employed and unemployed husbands. Wives with unemployed husbands are more likely to start participating in the labor market and less likely to give up their employment than wives with employed husbands. However, transitioning from unemployment to employment actually becomes less likely, which is at odds with the theoretical predictions. In order to determine the overall magnitude of the impact of an increase in the unemployment rate of husbands on the steady-state distributions of labor market outcomes of wives, i.e. the strength of the added worker effect, Lundberg utilizes simulations based on the estimated transition probabilities. She finds evidence for a small added worker effect among white families, where the loss of employment of 100 men leads to three additional women participating in the labor market and two successfully finding employment. There is, however, no evidence in favor of an added worker effect for black married women, instead the measured effect goes in

the opposite direction. Thus, the evidence presented by Lundberg is rather mixed. Lundberg notes that conclusions about the existence of an added worker effect may differ across studies due to differences in the measurement of labor supply.

Maloney (1991) finds no evidence for the added worker effect at the extensive margin in the Panel Study of Income Dynamics (PSID). The study, using a double selection model, suggests that women respond not to the "transitory component of husband's unemployment", but rather to the spouse's long-term unemployment probability, which he terms the "permanent component of husband's unemployment". Women whose husbands have a high probability of being unemployed are shown to have lower reservation wages, but to also face lower market wages and a higher unemployment probability. In this context, Maloney also notes that taking unobserved heterogeneity into account in the estimation is key, as e.g. assortative matching in the marriage market could otherwise bias the results. Also using the PSID, Hyslop (1999) applies a variety of models, including a dynamic random effects probit model, to analyze female labor market participation. His results indicate that the relationship between the woman's participation and current non-labor income, as measured by the husband's earnings, is small but negative. The relationship is stronger when considering the permanent non-labor income. The results are neither evidence for nor against the added worker effect as related to unemployment of the partner, as the sample is restricted to women whose partners reported positive hours worked as well as annual earnings in each year. However, they are some indication of an added worker effect related to low-pay employment.

Cullen and Gruber (2000) utilize U.S. data from the Survey of Income and Program Participation and information on each state's unemployment insurance system to show that the added worker effect is at least partially crowded out by unemployment insurance. They find that women whose partners are unemployed would work 30% more hours in the absence of unemployment insurance, while the non-employment rate would be 45% lower.

Stephens (2002) analyzes the impact of the husband's job displacement, rather than any kind of current unemployment experience, on the wife's labor supply, using PSID data. Displaced workers are identified as those workers who lost their job due to plant closure or being fired. As a result, Stephens is able to measure the effect of involuntary job loss instead of potentially voluntary or seasonal unemployment, which may not affect expected permanent earnings of the household. By including a series of lags and leads of the displacement variable, Stephens is able to analyze the timing of the women's reaction to the husband's job loss. He finds that women significantly increase their work hours in the periods following the husband's job displacement and that this effect is fairly stable over time. There are no significant anticipation effects. Using data from the Japanese Panel Survey of Consumers (JPSC), Kohara (2010) shows that Japanese wives adjust their labor supply both at the extensive and at the intensive margin in response to their husband's involuntary job loss, defined as being laid off or experiencing a displacement due to plant closure/bankruptcy. The effect is present in a variety of fixed-effects, random-effects and Arellano-Bond GMM specifications. Hardoy and Schøne (2014) also focus on the impact of the husband's job displacement but use data from Norway, a country with high female labor market participation and a generous welfare state, and

find no evidence of an added worker effect in the full sample. On the contrary, the employment probability is actually reduced in the periods of and following the displacement. However, when restricting the sample to only women who have not worked full-time prior to the displacement, i.e. those that have more scope to adjust labor supply, an added worker effect in terms of the woman's earnings is found. Triebe (2015) analyzes data from the German Socio-Economic Panel (SOEP) and finds that both men and women respond to their partner's involuntary job loss. In her estimation, the effect occurs primarily through an increase in working hours, rather than a fundamental change in labor market status. Cardona-Sosa et al. (2018) find a substantial added worker effect in Colombia, a country with a comparatively weak social safety net. Interestingly they also find a reduction in tertiary education enrollment in favor of an increased labor market participation for other household members aged between 18 and 25. Using an instrumental variable approach on Turkish panel data, Ayhan (2018) also finds an added worker effect. However, the response is quite short-lived.

Bredtmann et al. (2018) explicitly focus on comparing the added worker effect across 28 European countries. They estimate several probit models to capture five different labor market transitions of women using data from the European Union Statistics on Income and Living Conditions (EU-SILC) survey. The results are generally in favor of an added worker effect at the intensive margin and in terms of an increase in labor market participation. However, women whose husbands became unemployed are not more likely to become employed themselves. Furthermore, results vary depending on the macroeconomic conditions as well as welfare regimes. For example, in Continental Europe (Austria, Belgium, Germany, France, Luxembourg, and the Netherlands) an added worker effect is only found at the intensive margin.

All the aforementioned studies use individual-level data to study the wife's response to the husband's job loss or unemployment, because the added worker effect represents a within-family response to individual hardship, rather than an adjustment to higher unemployment rates within the society. Local labor market conditions should, thus, not be used as a key explanatory variable to proxy for individual unemployment when attempting to identify the added worker effect. Indeed, poor labor market conditions may cause wives to not search for a job or even stop searching because they are not optimistic about being able to find employment. This "discouraged worker effect" on secondary workers clearly captures a different process and acts in the opposite direction of the added worker effect (see e.g. Lundberg 1985, and Benati 2001). Maloney (1991) also notes that the discouraged worker effect could potentially reduce the estimated added worker effect or mask the effect completely, even in studies using individual displacement or unemployment experiences. This is the case if individual displacement/unemployment experiences are correlated with overall worse local labor market conditions, if these are not controlled for separately in the estimation.

The dynamic bivariate random effects probit model used in this investigation has been applied in a number of studies outside the added worker literature. Alessie et al. (2004) originally introduced the model in the context of their analysis of ownership dynamics of stocks and mutual funds. The model has been taken up by the literature

on labor market dynamics. Stewart (2007) shows that low-wage employment has a negative effect on future employment prospect which is not significantly different from the impact of unemployment. His empirical investigation is based on BHPS data and uses a variety of specifications including a modification of the model by Alessie et al. (2004). Using the same estimation method on SOEP data, Knabe and Plum (2013) find, contrariwise, that low-paid employment can serve as a stepping stone to obtaining a high-paid job in the future. These studies have in common that they require the simultaneous analysis of two dynamic outcome variables, because their state-dependent evolutionary processes are potentially related to one another.

Econometric Model

This section introduces the econometric model and describes how the estimation results may be interpreted in order to draw conclusions about the presence of an added worker effect. We apply a dynamic bivariate random effects probit model. The model set-up and exposition draws on previous studies by Alessie et al. (2004), Knabe and Plum (2013)[2] and Stewart (2007) as well as arguments put forward by Bell and Jones (2015) and Rabe-Hesketh and Skrondal (2013). For ease of exposition, we initially introduce a simplified version of our model to establish the bivariate random-effects estimator applied in this study. Additional elements necessary to address issues arising due to the random-effects assumption are incorporated later to complete the model set-up. Only the final version is estimated.

The model assumes that each individual $i \in \{1, \ldots, N\}$ can be in three different mutually exclusive and exhaustive states in time period $t \in \{1, \ldots, T\}$. In our case, these states describe the labor market position of the woman. In particular, each woman can be outside of the labor force, unemployed or employed. These three labor market positions can be described by two dummy variables y_{1it} and y_{2it} defined as follows:

$$y_{1it} = \begin{cases} 1 & \text{if the person does not participate in the labour market} \\ 0 & \text{otherwise} \end{cases}, \tag{1}$$

and

$$y_{2it} = \begin{cases} 1 & \text{if the person participates in the labor market, but is unemployed} \\ 0 & \text{otherwise} \end{cases} \tag{2}$$

Thus, the individual is employed if $y_{1it} = y_{2it} = 0$. In this way, the model can incorporate the participation decision as well as provide information about whether a decision to participate actually results in employment, based on two dependent

[2] For ease of comparison the mathematical notation is, wherever possible, identical to Knabe and Plum (2013).

variables. In this way we aim to represent the idea that an individual can freely choose whether to participate in the labor market or not (at any point in time) and will do so if the expected utility of labor market participation is higher than the utility of non-participation. Intuitively, eqs. (1) and (2) can be seen as a sequential process. In the first stage, people decide whether to participate in the labor market or not. In the second stage, they will then either be unemployed, looking for a job and deciding when to accept a job offer, or they will be employed until they quit or are laid off. Though finding as well as quitting a job might take some time due to search frictions and notice periods, transitions between unemployment and non-participation can be immediate. Once the decision to participate in the labor market is made the employment probability can be affected by the individual in several ways. Firstly, individuals can increase their search intensity and accept lower wage offers or worse non-monetary job characteristics. Secondly, individuals can exert more effort at work to prevent job loss. Thirdly, individuals abstain from voluntary terminations of their current job.

We further assume that the labor market positions follow a first-order Markov process, implying that the current labor market position depends on the labor market position in the previous period, but conditional on the labor market position in the previous period it is independent of all earlier labor market positions.[3] This introduces state dependence in the dependent variables of the model.

The two dichotomous dependent variables y_{1it} and y_{2it} are assumed to depend on two underlying continuous variables $\tilde{y}_{1it}$ and $\tilde{y}_{2it}$ via the following relationship:

$$y_{jit} = \begin{cases} 1 & \text{if } \tilde{y}_{jit} > 0 \\ 0 & \text{if } \tilde{y}_{jit} \leq 0, \end{cases} \tag{3}$$

where $j = \{1, 2\}$ refers to the dependent variable being considered.

Furthermore, we assume that $\tilde{y}_{1it}$ and $\tilde{y}_{2it}$ may be described by the following linear functions of the explanatory variables, including lagged values of the dependent variables:

$$\tilde{y}_{1it} = \alpha_1 + \gamma_{11} y_{1it-1} + \gamma_{12} y_{2it-1} + \varphi_{11} olf^{par}_{it-1} + \varphi_{12} ue^{par}_{it-1} + \varphi_{13} lp^{par}_{it-1} + \boldsymbol{x}'_{1it}\boldsymbol{\beta}_1 + \tau_{1t} + \varepsilon_{1i} + u_{1it} \tag{4}$$

and

$$\tilde{y}_{2it} = \alpha_2 + \gamma_{21} y_{1it-1} + \gamma_{22} y_{2it-1} + \varphi_{21} olf^{par}_{it-1} + \varphi_{22} ue^{par}_{it-1} + \varphi_{23} lp^{par}_{it-1} + \boldsymbol{x}'_{2it}\boldsymbol{\beta}_2 + \tau_{2t} + \varepsilon_{2i} + u_{2it}, \tag{5}$$

where y_{jit-1} is the dichotomous dependent variable in period $t-1$, i.e. lagged by one period. olf^{par}_{it-1} is a dummy variable equal to 1 if the partner did not participate in the labor force in the previous period and 0 otherwise. ue^{par}_{it-1} is a dummy variable equal to 1 if the partner was unemployed in the previous period and 0 otherwise. lp^{par}_{it-1} is a

[3] This assumption follows Stewart's (2007) analysis of labor market dynamics. As a tentative investigation into the sensitivity of our findings, we also estimated our analyses with first and second lags of the dependent variable (second-order Markov process). The results are similar both in sign and magnitude. However, the significance level is reduced in some cases. Results are available upon request.

dummy variable equal to 1 if the partner was low-paid in the previous period and 0 otherwise. Thus, the default category captures individuals whose partners were high-paid in the previous period. $\boldsymbol{x}_{jit}$ is a vector of exogenous control variables of person i in period t for estimating equation j. $\boldsymbol{x}_{jit}$ also includes further partner characteristics (other than the labor market status in the previous period). To account for changes in the economic conditions as well as time trends, e.g. in female labor market participation, we also include a full set of year dummy variables, represented by the year fixed effect τ_{jt}. (u_{1it}, u_{2it}) are time-specific idiosyncratic shocks, which are assumed to be independent over time and to follow a bivariate normal distribution with mean zero, unit variance and correlation ρ_u across the two estimating equations. $(\varepsilon_{1i}, \varepsilon_{2i})$ are individual-specific time-invariant effects, assumed to follow a bivariate normal distribution, with mean zero, variance $\sigma^2_{\varepsilon_j}$ and correlation coefficient ρ_ε across the two estimating equations. These will be treated as random effects in the estimation. The variance-covariance matrix of these random effects is, thus, given by:

$$\sum\nolimits_{\varepsilon} = \begin{pmatrix} \sigma^2_{\varepsilon_1} & \rho_\varepsilon \sigma_{\varepsilon_1} \sigma_{\varepsilon_2} \\ \rho_\varepsilon \sigma_{\varepsilon_1} \sigma_{\varepsilon_2} & \sigma^2_{\varepsilon_2} \end{pmatrix}. \tag{6}$$

The individual-specific time-invariant effects lead to serial correlation in the composite error term $v_{jit} = \varepsilon_{ji} + u_{jit}$, even though the u_{jit}'s are independent over time. In particular, the correlation between any two composite errors terms v_{jit} and v_{jis}, where $t \neq s$, is given by:

$$\lambda_j = \frac{\sigma^2_{\varepsilon_j}}{\sigma^2_{\varepsilon_j} + \sigma^2_{u_j}} = \frac{\sigma^2_{\varepsilon_j}}{\sigma^2_{\varepsilon_j} + 1}. \tag{7}$$

In dynamic models it is important to take individual-specific heterogeneity into account explicitly and to address the issues arising due to unobserved heterogeneity, as discussed below. Since the start of the data-generating process is not observed in our case, this serial correlation would otherwise lead to biased estimates (Heckman 1981a, b, and Baltagi 2008). In this context, Heckman (1981a) emphasizes the importance of distinguishing between true and spurious state dependence.

The variance of the composite error term is then given by:

$$\sigma^2_{v_j} = \sigma^2_{\varepsilon_j} + 1 = \frac{1}{1 - \lambda_j}. \tag{8}$$

The assumptions outlined above lead to a bivariate random-effects probit model. The probability of the observed labor market state of individual i for $t > 1$, given the values of all observed explanatory variables and one specific realization of the random effect, is given by:

$$P_{it}\left(\varepsilon_1^*, \varepsilon_2^*\right) = y_{1it} \boldsymbol{\Phi}\left(\mu_{1it}\right) + \left(1 - y_{1it}\right) \boldsymbol{\Phi}_2\left(-\mu_{1it}, \left(2y_{2it} - 1\right)\mu_{2it}, -\left(2y_{2it} - 1\right)\rho_u\right), \tag{9}$$

where $\Phi(.)$ is the cumulative univariate standard normal distribution function and $\Phi_2(.)$ refers to the bivariate cumulative normal distribution function and

$$\mu_{jit} = \alpha_j + \gamma_{j1} y_{jit-1} + \gamma_{j2} y_{jit-1} + \varphi_{j1} olf^{par}_{it-1} + \varphi_{j2} ue^{par}_{it-1} + \varphi_{j3} lp^{par}_{it-1} + \boldsymbol{x}'_{jit}\boldsymbol{\beta}_1 + \tau_{jt} + \varepsilon^*_{ji}, \tag{10}$$

where $\varepsilon^*_{ji} = \varepsilon_{ji}/\sigma_{\varepsilon_j}$ and $\sigma_{\varepsilon_j} = \sqrt{\lambda_j/(1-\lambda_j)}$.

The likelihood function is then given by (see Stewart 2007, and Knabe and Plum 2013):

$$L = \prod_{i=1}^{N} \int_{\varepsilon^*_1} \int_{\varepsilon^*_2} \left\{ \prod_{t=2}^{T} P_{it}\left(\varepsilon^*_1, \varepsilon^*_2\right) \right\} f_2\left(\varepsilon^*_1, \varepsilon^*_2, \Sigma_{\varepsilon^*}\right) d\varepsilon^*_1 d\varepsilon^*_2, \tag{11}$$

where f_2 denotes the bivariate normal density function, which captures the probability that a certain combination of the two random effects ε^*_1 and ε^*_2 occurs. The integral over the random effects necessitates the use of maximum simulated likelihood (MSL) which, in our case, is implemented using Halton draws (Plum 2016).

Following suggestions by Bell and Jones (2015) and Rabe-Hesketh and Skrondal (2013), we extend this basic bivariate random-effects probit model in order to address a number of econometric issues related to the presence of unobserved heterogeneity in the model. The arguments by Bell and Jones (2015) and Rabe-Hesketh and Skrondal (2013) are based on a line of research interested in solving the 'endogenous covariates' and 'initial conditions' problem, most notably Mundlak (1978), Heckman (1981a, b) and Wooldridge (2005). Mundlak (1978) argues that the problem of 'endogenous covariates' or 'heterogeneity bias'[4] should be addressed by explicitly modelling the between component of each time-varying covariate via the inclusion of the within-subject means of these variables in the estimating equation. Hence, the results can be interpreted as a decomposition of the added worker effect into a within and a between component. In a correctly specified model, the random-effects estimator is identical to the fixed-effects estimator, unifying the two approaches (Mundlak 1978, and Bell and Jones 2015). Wooldridge (2005) proposes to solve the 'initial conditions'[5] problem by including the values of the dependent variable(s) in the initial period and values of the time-varying covariates in every period in

[4] If the within and between component of a time-varying explanatory variable affects the dependent variables differently, then the coefficient on the respective covariate cannot capture either of these effects correctly. Since the variance left unexplained enters the error term, the random-effects assumption of no correlation between the unobserved heterogeneity and the explanatory variables will be violated, leading to the problem of 'endogenous covariates' or 'heterogeneity bias' (see Bell and Jones 2015, and the literature mentioned therein).

[5] The econometric literature on the 'initial conditions' problem goes back to Heckman (1981a, b). The problem arises because the initial observation in a sample taken from an already ongoing process is not exogenous. The endogeneity occurs because the initial observation in the sample is determined via the same process as later observations, including the influence of the unobserved heterogeneity and the dependent variable in the previous period (which is not observed), but cannot be modelled correctly as the required data is not available. Several solutions to the initial conditions problem have been suggested (for a review see Skrondal and Rabe-Hesketh 2014). However, we only discuss those immediately relevant to the present study.

the estimating eq. A constrained version of this estimator includes the dependent variable(s) in the initial period in addition to the within-subject means. Rabe-Hesketh and Skrondal (2013) argue that it is also necessary to include the starting values of all time-varying control variables and to exclude this initial period from the calculation of the within-subject means to avoid bias in the constrained Wooldridge (2005) estimator. This is the version implemented in our study.

The complete underlying linear estimating equations are thus given by:

$$\begin{aligned}\tilde{y}_{1it} =& \alpha_1 + \gamma_{11} y_{1it-1} + \gamma_{12} y_{2it-1} + \varphi_{11}\left(olf^{par}_{it-1} - \overline{olf}^{par}_{i}\right) \\ &+ \varphi_{12}\left(ue^{par}_{it-1} - \overline{ue}^{par}_{i}\right) + \varphi_{13}\left(lp^{par}_{it-1} - \overline{lp}^{par}_{i}\right) \\ &+ \left(\boldsymbol{x}_{1it} - \bar{\boldsymbol{x}}_{1i}\right)'\boldsymbol{\beta}_1 + \phi_{11}\overline{olf}^{par}_{i} + \phi_{12}\overline{ue}^{par}_{i} + \phi_{13}\overline{lp}^{par}_{i} \\ &+ \bar{\boldsymbol{x}}'_{1i}\boldsymbol{\delta}_1 + \boldsymbol{z}'_{1i}\boldsymbol{\eta}_1 + \psi_{11} y_{1i1} + \psi_{12} y_{2i1} + \psi_{13} olf^{par}_{i1} + \psi_{14} ue^{par}_{i1} \\ &+ \psi_{15} lp^{par}_{i1} + \boldsymbol{x}'_{1i1}\boldsymbol{\psi}_1 + \tau_{1t} + \varepsilon_{1i} + u_{1it}\end{aligned} \tag{12}$$

and

$$\begin{aligned}\tilde{y}_{2it} =& \alpha_2 + \gamma_{21} y_{1it-1} + \gamma_{22} y_{2it-1} + \varphi_{21}\left(olf^{par}_{it-1} - \overline{olf}^{par}_{i}\right) \\ &+ \varphi_{22}\left(ue^{par}_{it-1} - \overline{ue}^{par}_{i}\right) + \varphi_{23}\left(lp^{par}_{it-1} - \overline{lp}^{par}_{i}\right) \\ &+ \left(\boldsymbol{x}_{2it} - \bar{\boldsymbol{x}}_{2i}\right)'\boldsymbol{\beta}_2 + \phi_{21}\overline{olf}^{par}_{i} + \phi_{22}\overline{ue}^{par}_{i} + \phi_{23}\overline{lp}^{par}_{i} \\ &+ \bar{\boldsymbol{x}}'_{2i}\boldsymbol{\delta}_2 + \boldsymbol{z}'_{2i}\boldsymbol{\eta}_2 + \psi_{21} y_{1i1} + \psi_{22} y_{2i1} \\ &+ \psi_{23} olf^{par}_{i1} + \psi_{24} ue^{par}_{i1} + \psi_{25} lp^{par}_{i1} + \boldsymbol{x}'_{2i1}\boldsymbol{\psi}_2 + \tau_{2t} + \varepsilon_{2i} + u_{2it},\end{aligned} \tag{13}$$

where $\bar{x}_i$ denotes the within-subject mean of variable x_{it}. In this specification, $\boldsymbol{x}_{jit}$ denotes a vector of time-varying control variables in estimating equation j for individual i at time t. $\boldsymbol{z}_{ji}$ denotes a vector of time-invariant control variables in estimating equation j for individual i. In our case, both estimating equations contain the same set of control variables, such that $\boldsymbol{x}_{1it}=\boldsymbol{x}_{2it}$ and $\boldsymbol{z}_{1i}=\boldsymbol{z}_{2i}$. Although it is not necessary to subtract the mean from the time-varying explanatory variables to obtain unbiased estimates of the within and between effects from the estimated coefficients, this specification was chosen for our key explanatory variables because then the within and between effects (in the underlying linear functions) are estimated directly via the φ and ϕ coefficients, respectively (Bell and Jones 2015).

φ_{12} represents the added worker effect in its strict sense, i.e. the within effect of the man's unemployment in the previous period on the probability of labor market (non-) participation of the woman, controlling for the share of periods in which the man was unemployed, i.e. the within-subject mean. We interpret this latter variable as the man's overall unemployment propensity. However, the between effect ϕ_{12} itself may also be of interest, since the woman may change her labor supply decision in response to her partner's overall increased probability of being unemployed over the lifetime. This is a point supported by Maloney (1991, p. 173) who finds that "labour supply behaviour of married women is influenced by the permanent, and not the transitory, nature of their spouses' unemployment". This latter effect is arguably not an added worker effect, as it is typically understood, but certainly interesting in regard to the labor supply decisions

made within the household. However, it is not clear whether the estimated between effect should be interpreted as causal, as we will discuss in more detail in section 5. The woman's response to her partner's low-pay employment or non-participation may also be of interest, since both can put sufficient financial strain on the household to warrant a labor supply response of the woman. The within and between components of these two labor market statuses are also modelled explicitly and the respective coefficients can be interpreted analogously to the case of unemployment. Whether these should also be interpreted as an added worker effect depends on the normative judgement of what exactly constitutes an "added worker effect". Estimating eq. (13) captures the probability of being unemployed rather than employed. The coefficients in this equation cannot be directly interpreted in terms of the added worker effect, because the final outcome also depends on the participation decision modeled in eq. (12). To facilitate the interpretation of the results, we calculate average partial effects (see the discussion below and Appendix 1).

Due to the bivariate probit specification of the model, it is not possible to fully interpret the estimated coefficients without further mathematical manipulation. In some cases, particularly in the first estimating equation, the sign of the estimated coefficients can give an indication of the direction of the effect, but the magnitude cannot be interpreted directly. Furthermore, not even the direction of the effect is clear for all outcomes. If, for example, the estimates indicate both an increase in the probability of participation and unemployment, the direction of the effect on the employment probability is not clear based only on the estimation results. In addition, the size of the added worker effect in terms of a change in the probability of being in a particular labor market status depends on the values of all control variables. Thus, in order to evaluate the magnitude of the added worker effect we calculate the average partial effects (APEs) of the key explanatory variables (cf. Stewart 2007). For example, the partial effect of the within component of a partner's unemployment in the previous period for a particular individual at a particular point in time is given by the difference in the counterfactual outcome probabilities when the partner was unemployed in the previous period $\left(ue^{par}_{it-1} = 1, olf^{par}_{it-1} = 0, lp^{par}_{it-1} = 0\right)$ rather than employed in the high-paid sector in the previous period $\left(ue^{par}_{it-1} = 0, olf^{par}_{it-1} = 0, lp^{par}_{it-1} = 0\right)$, where each probability is calculated using the actual values of all other variables, including the within-subject means. Three example equations, one for each outcome state, are provided in Appendix 1. The average partial effect is given by the average of all the partial effects over individuals and time periods. The average partial effect of the between effect is also calculated based on counterfactual outcome probabilities and, for example, represents the change in the probability of being in a particular labor market position when the partner is always unemployed rather than always high-paid, where each probability is still calculated at the actual values of all other variables. The partial effects for the partner's other labor market outcomes are calculated analogously. High-paid employment of the partner is always taken to be the default category.

Data

We use data from the 1984 to 2019 waves of the German Socio-Economic Panel (SOEP). The SOEP is a representative annual household survey of German households conducted by the German Institute for Economic Research (DIW).[6] In recent years, about 30,000 individuals living in almost 15,000 households are interviewed. Since the same individuals are interviewed repeatedly it is possible to apply the random effects model outlined in section 3. The SOEP contains data on a large number of socio-economic variables, including the labor market status, individual earnings, household income, household structure, education and subjective measures of individual well-being. Some questions are answered by each individual aged 17 or above living in the household while questions related to the household as a whole are answered only by the head of household. Due to the structure of the SOEP, it is possible to clearly identify couples and to obtain information on the characteristics of the respective partner.

We are interested in analyzing labor supply choices by prime-age individuals who have completed their schooling and could be available for dependent employment. Thus, we restrict the sample to individuals between the age of 25 and 60 years, who are not currently in education, occupational training or (compulsory) military or alternative civilian service. Furthermore, all self-employed individuals and pensioners are dropped from the sample.[7]

A key point of our study is to explicitly analyze the participation decisions independently of whether the individual actually obtains a job. It is thus necessary to clearly distinguish between an unemployed individual and an individual that is not participating in the labor market. We categorize respondents in the SOEP as unemployed if they stated that they are officially registered as unemployed. They are also defined as unemployed if they are currently not in employment (and do not preclude taking up employment in the future), but have been actively searching in the last 4 weeks prior to the interview and/or could start working immediately if a suitable job was offered. The remaining individuals which are not in employment, based on information about their specific occupational position, are defined as not participating in the labor market.

Since we are not only interested in the added worker effect as it is typically defined but also in whether non-participation and low-wage employment by a partner impacts an individual's labor market choices and outcomes, we need to define a low-wage threshold. The low-wage threshold is calculated based on 268,516 person-year observations which were not excluded based on the sample restrictions above and for which data on monthly gross labor income (including overtime pay) and actual weekly working hours was available. The hourly wage of individual i in year t is calculated as:

[6] A general introduction to the dataset is provided by Goebel et al. (2019).

[7] The key results remain unchanged when also including the self-employed in the analysis. Detailed results are available upon request.

$$wage_{it} = \frac{monthly\ gross\ labour\ income_{it}}{4.345 \times actual\ weekly\ working\ hours_{it}} \tag{14}$$

This definition was chosen because it most closely resembles the actual characteristics of the individual's job rather than also incorporating the peculiarities of the tax system (as would be the case when looking at net wages) or focusing on an hourly wage which only exists on paper (if looking at contractual hours instead of actual hours). Following the standard OECD definition, the low-wage threshold is chosen to be equal to 2/3 of the median hourly wage in each year. All individuals who do not fall below this low-wage threshold are referred to as "high-paid".

To identify the added worker effect we require information about the partner's labor market status. Thus, the sample is further restricted to contain only couples where the relevant information is available for both partners. The sample includes both married and cohabiting couples, but excludes those saying they are married but separated from their spouse, even if they are already living with a new partner. Furthermore, same-sex couples are excluded since in line with most previous studies we restrict our attention to the reactions of women to changes in their male partner's labor market status.[8] It should be noted that the low-wage threshold was deliberately calculated before restricting the sample according to household structure, because the wage comparison should be made relative to a representative sample of all prime-age workers, not just relative to the subpopulation of couples.

Due to the dynamic nature of the model we use a panel that does not contain any gaps, thus, all observations following a gap in the dependent or in any of the explanatory variables are dropped from the sample. The first observation for each individual is also lost due to the lag-structure of the model, but information from this period is used in the construction of the initial conditions. As noted above, we focus on the response by women to their partner's labor market status rather than the other way around. Restricting the analysis to women results in 55,379 usable person-year observations in the sample.

Table 1 reports sample means of the dependent as well as key explanatory variables.

Table 2 reports the fraction of women in each of the three potential labor market states, conditional on their partner's labor market state in the previous period. Interpreting the shares as the likelihood to be in each labor market state, the table suggests that women whose partners were unemployed in the previous period are less likely to be employed, more likely to be unemployed and less likely to be out of the labor force than women whose partners were high-paid. This descriptive evidence is consistent with the existence of an added worker effect in terms of labor market participation. However, the employment probability changes in the opposite direction of what the added worker effect would predict. Women whose partners were low-paid have the highest labor market participation rate out of all the presented subgroups. These women are also more likely to be employed than

[8] Unfortunately, there is not sufficient data available to include same-sex couples separately in the analysis.

Table 1 Summary statistics

Variable	Summary Statistics	
Labor market status (women):	*Shares*	
unemployed	11.9%	
employed	67.7%	
out of labor force	20.4%	
Labor market status (men):	*Shares*	
unemployed	7.5%	
out of labor force	0.8%	
employed *of which*	91.7%	
low-pay	8.0%	
high-pay	83.7%	
Control variables (dummies):	*Shares*	
married	90.7%	
migrant	19.3%	
West Germany	79.3%	
homeowner	54.4%	
Control variables (other):	*Mean*	*Standard deviation*
age (women)	40.96	8.49
age (men)	43.53	8.58
years of education (women)	12.11	2.53
years of education (men)	12.38	2.71
number of children	1.17	1.14

Source: SOEP waves 1984–2019, own calculations, N = 55,379

Table 2 Fraction of women in each labor market status

	Labor market status of the man in t-1				
	High-pay (N = 46,238)	Low-pay (N = 4844)	Unemployed (N = 3943)	Out of labor force (N = 354)	Full Sample (N = 55,379)
Employed	0.688	0.709	0.505	0.768	0.677
Unemployed	0.093	0.186	0.342	0.119	0.119
Out of labor force	0.219	0.105	0.153	0.113	0.204

Source: SOEP waves 1984–2019, own calculations

women whose partners were high-paid. On the other hand, they are also more likely to be unemployed themselves. This would be consistent with an added worker effect of low-pay employment both in term of participation and employment. However, this is clearly not conclusive evidence in favor of or against the added worker effect since the table only captures correlations between the two

partners' labor market outcomes, which may also be explained by a variety of processes including assortative matching. Thus, in Section 5 we will turn to the estimation results of the model presented in Section 3 to obtain more reliable estimates of the added worker effect as it is typically defined as well as further insights into the processes determining labor market outcomes in couples.

Results

Table 3 reports the estimation results for our main specification. As noted in Section 3, we calculate average partial effects to fully interpret the estimation results regarding the relationship between the man's and the woman's labor market states. However, it is also possible to draw some conclusions directly from the estimation results.

The random effects are positively correlated with $\hat{\rho}_{\epsilon} = 0.530$ (std. err. 0.040). Thus, an individual who is more likely to not participate in the labor market due to his or her unobserved time-invariant characteristics also has a higher propensity to be unemployed due to these characteristics.

$\hat{\rho}_{\epsilon}$ is significantly different from zero, indicating that it is necessary to estimate a bivariate rather than a univariate model (see Plum 2016). The estimated variances of the random effects $\hat{\sigma}^2_{\varepsilon_j}$ indicates that roughly 40% of the overall error variance $\hat{\sigma}^2_{v_j}$ can be attributed to variation in the random effects in each estimating equation. In particular, the estimates imply that the intertemporal correlations of the composite error terms are $\hat{\lambda}_1 = 0.381$ (std. err. 0.014) and $\hat{\lambda}_2 = 0.407$ (std. err. 0.019).

There is also evidence in favor of state dependence. Individuals who did not participate in the labor market in the previous period have a significantly higher probability of currently not participating, compared to previously employed individuals. A similar relationship is present in the case of unemployment. The signs of the estimated coefficients of control variables are generally in line with economic intuition.

Table 4 presents the average partial effects for the key explanatory variables, calculated according to the description in Section 3. The entries in the first row of Table 4, the within effects of the partner's unemployment in the previous period, represent the added worker effect in the strict sense. A woman whose partner was unemployed in the previous period is 2.7 percentage points more likely to participate in the labor market and 2.0 percentage points more likely to be currently employed than a woman whose partner was high-paid. Both results are significantly different from zero at least at the 5% level. The increase in the unemployment probability of 0.7 percentage points makes up for the difference in the estimates, but is not statistically significantly different from zero itself. This evidence supports the existence of an added worker effect at the extensive margin. It should be kept in mind that an increase in the likelihood to be in a specific labor market state can be brought about by more women entering that state or by some, who would have otherwise left, remaining in that state.

The partner's low-pay compared to high-pay employment in the previous period has a similar effect on the woman's labor market outcome. In this case, the woman is

Table 3 Results

	Labor market outcome of the woman	
	(1)	(2)
Variables	Out of labor force	Unemployed
Lagged dependent variables:		
out of labor force	1.200***	1.306***
	(0.029)	(0.072)
unemployed	0.390***	1.293***
	(0.036)	(0.036)
Within component of man's employment status in t-1:		
unemployed	−0.192***	−0.019
	(0.060)	(0.060)
out of labor force	−0.620***	0.032
	(0.170)	(0.179)
low-pay	−0.158***	−0.003
	(0.055)	(0.052)
Between component of man's employment status:		
unemployed	−0.679***	0.728***
	(0.085)	(0.084)
out of labor force	−0.417*	−0.519*
	(0.235)	(0.275)
low-pay	−0.265***	0.232***
	(0.084)	(0.081)
Time-varying control variables:		
age	−0.348***	−0.152**
	(0.0580)	(0.0775)
age squared	0.004***	0.002***
	(0.000)	(0.001)
number of children	0.476***	0.242***
	(0.023)	(0.030)
homeowner	−0.049	−0.009
	(0.047)	(0.062)
West Germany	0.053	−0.205
	(0.227)	(0.224)
married	0.565***	0.338***
	(0.082)	(0.107)
constant	3.266***	−0.048
	(0.617)	(0.711)
time-invariant control variables	yes	yes
partner control variables	yes	yes
full set of year dummies	yes	yes
means of time-varying control variables	yes	yes
full set of initial conditions	yes	yes

Table 3 (continued)

	Labor market outcome of the woman	
	(1)	(2)
Variables	Out of labor force	Unemployed
$\hat{\sigma}^2_{\epsilon_j}$	0.616***	0.686***
	(0.036)	(0.055)
$\hat{\rho}_{\epsilon}$	0.530***	
	(0.040)	
$\hat{\rho}_{u}$	−0.102	
	(0.099)	
observations	55,379	
log-likelihood	−25,296.245	

Source: SOEP waves 1984–2019, own calculations; partner control variables: age, age squared, migrant, education, education squared; time-invariant controls variables: migrant, education (in years), education squared; standard errors in parentheses; *** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 4 Average partial effects

	Labor market outcome of the woman		
	(1)	(2)	(3)
Variables	Out of labor force	Unemployed	Employed
Within effects of the man's employment status in t-1:			
unemployed	−0.027***	0.007	0.020**
	(0.008)	(0.007)	(0.008)
out of labor force	−0.086***	0.031	0.055
	(0.024)	(0.021)	(0.024)
low-pay	−0.022***	0.007	0.015**
	(0.008)	(0.006)	(0.007)
Between effects of the man's employment status:			
unemployed	−0.096***	0.101***	−0.005
	(0.012)	(0.008)	(0.013)
out of labor force	−0.059	−0.033	0.092**
	(0.033)	(0.028)	(0.038)
low-pay	−0.037***	0.034***	0.003
	(0.012)	(0.008)	(0.012)

Source: SOEP waves 1984–2019, own calculations, *** $p<0.01$, ** $p<0.05$, * $p<0.1$

2.2 percentage points more likely to participate in the labor market and 1.5 percentage points more likely to be employed. This suggests that low-pay employment by the primary earner creates a sufficiently strong financial strain for the family to also warrant a response by the secondary earner.

There is also a statistically significant effect of the within component of the man's non-participation compared to high-paid employment on the woman's participation in the labor market, with a comparatively large estimated average partial effect of 0.086. However, the estimated effects on the unemployment and employment probabilities are statistically insignificant. The standard errors are comparatively large due to the small number of men not participating in the labor market.

The between effects show, for example, how the man's unemployment propensity, modelled as the fraction of periods spent in unemployment during the observation period, is correlated with the woman's probability of being in a particular labor market state in each period. If there is a correlation, it may be due to a causal relationship, with the woman responding to her partner's participation and employment probability. This could constitute another type of added worker effect. Alternatively, a correlation may arise for other reasons, e.g. the matching process in the marriage market where individuals with certain characteristics, which are unobservable in the SOEP but affect the propensity to be in each labor market status, get together. In this case, there would be no causal relationship between the two partners' labor market outcomes and the results should not be interpreted as an added worker effect.

Women with frequently unemployed partners are significantly more likely to participate in the labor market. However, the increase in participation is entirely attributable to an increase in unemployment since the change in the employment probability is small, negative and not statistically significant. It was already noted above that these between effects do not necessarily represent a causal effect and could also be caused by unobserved heterogeneity, e.g. via assortative matching. Shifts from non-participation to unemployment may also be partially explained by the German welfare system, where basic welfare benefits are means-tested based on a household's total disposable income and wealth. If a household receives basic welfare benefits, all able adult household members are automatically registered as unemployed (and are then required to search for employment by law). Thus, some women who would otherwise not participate may be considered unemployed because the household drops below the income/ wealth threshold due to the partner's frequent unemployment or low-pay employment. Switching from non-participation to unemployment could then simply reflect legal requirements of the welfare system rather than indicating an increased desire to work. This latter point could also be made about the within effect. However, since the increase in participation actually results in an increase in employment, which presumably requires at least some real interest in obtaining a job, this explanation appears unlikely in the case of the within effect. To further alleviate this concern, we also conduct a number of robustness checks, using a variety of unemployment definitions in Section 6.

Frequent employment of the man in the low-pay sector leads to qualitatively similar results, though the size of the estimated between effects on participation and unemployment is smaller. Just as in the case of the man's unemployment, there is no significant change in the employment probability of the woman.

In contrast, women with partners who are frequently outside of the labor force are significantly more likely to be employed. This correlation may arise because non-participation is only an option if the couple is sufficiently financially secure. Thus, there might be an issue with reverse causality when interpreting this result.

Robustness Checks

One potential objection to the estimation results presented in Section 5 is that the distinction between who is unemployed and who is not participating in the labor market depends on some normative choices regarding the definition of the two categories. To alleviate this concern, we re-estimate the model based on four additional definitions of unemployment. Table 5 reports the respective average partial effects. Specification (A) defines individuals as unemployed if they are officially registered as unemployed and/or do not hold a job, but state that they have been actively searching for a job in the four weeks prior to the interview *and* could start working immediately.

Specification (B) is the same as Specification (A), but defines everyone as employed if the employment status variable generated in the SOEP assigns employment in any of the occupational categories to the individual, even if they would be unemployed by the definition in specification (A). Specification (C) is based completely on the employment status variable generated in the SOEP, which also distinguishes between employment (in a variety of sectors), unemployment and non-participation. Specification (D) defines only individuals that are not currently employed in any sector, but state that they have been actively searching for a job in the four weeks prior to the interview or could start working immediately, as unemployed, irrespective of whether they are registered as unemployed or not. In each case the change in the definition of unemployment is applied to both partners.

Overall the results are robust to changing the exact definition of unemployment and non-participation in the sample. In most cases, the point estimates and significance levels are similar across specifications, though some changes do occur. Comparing the robustness checks to our baseline estimates in Table 4, we do not find cases where the estimated coefficients change signs in a statistically significant way. Considering all variables for which we find statistically significant average partial effects in any specification of the robustness checks, the sign of the point estimates is identical across specifications with only three exceptions. In all three cases, only one of the estimates is statistically significant. The between effect of the man's unemployment on the woman's employment probability has a significant positive point estimate in specification (C), but is negative but insignificant in Table 4 and in specification (D). The between effect of the man's non-participation on the woman's non-participation is negative whenever it is significant, but positive and insignificant in specification (D) while the converse is true for the woman's employment probability.

We also re-estimated our model's parameters using a linear probability model (LPM), which also allows us to consider a fixed effects specification in addition to the random effects specification. The results in the top section of Table 6 represent an LPM version of the baseline estimating equation with correlated random effects implemented using the CMP command (Roodman 2011). The estimating equations used in this section are specified analogously to those used in the bivariate random effects probit model, i.e. they include the within transformation, the Mundlak terms as well as the initial conditions for all time-varying explanatory variables. The lower section of Table 6 reports results from a fixed-effects regression using

Table 5 Average Partial Effects – Various Definitions of Unemployment

	(A)			(B)			(C)			(D)		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
Variables	OLF	UE	EMP	OLF	UE	EMP	OLF	UE	EMP	OLF	UE	EMP
Within effects of the man's employment status in t-1:												
unemployed	−0.022***	0.006	0.016*	−0.021**	0.002	0.019**	−0.024***	0.004	0.021**	−0.014*	−0.007	0.021**
	(0.009	(0.005)	(0.008)	(0.009)	(0.005)	(0.009)	(0.009)	(0.005)	(0.009)	(0.009)	(0.007)	(0.009)
out of labor force	−0.083***	0.027**	0.055**	−0.079***	0.028**	0.051***	−0.054***	0.007	0.047***	−0.031**	−0.009	0.040***
	(0.019)	(0.013)	(0.019)	(0.019)	(0.013)	(0.019)	(0.017)	(0.010)	(0.017)	(0.014)	(0.012)	(0.015)
low-pay	−0.017**	0.003	0.015**	−0.016**	0.003	0.013*	−0.014*	0.002	0.012	−0.015**	0.005	0.009
	(0.008)	(0.005)	(0.007)	(0.008)	(0.004)	(0.007)	(0.008)	(0.004)	(0.007)	(0.007)	(0.006)	(0.007)
Between effects of the man's employment status:												
unemployed	−0.091***	0.083***	0.008	−0.089***	0.070***	0.019	−0.099***	0.064***	0.035***	−0.045***	0.061***	−0.017
	(0.013)	(0.006)	(0.013)	(0.013)	(0.006)	(0.013)	(0.014)	(0.005)	(0.013)	(0.013)	(0.008)	(0.013)
out of labor force	−0.084***	−0.018	0.102***	−0.077***	−0.019	0.096***	−0.061**	−0.006	0.067**	0.017	0.002	−0.019
	(0.029)	(0.019)	(0.031)	(0.028)	(0.018)	(0.031)	(0.027)	(0.014)	(0.028)	(0.019)	(0.015)	(0.021)
low-pay	−0.030**	0.026***	0.004	−0.036***	0.024***	0.012	−0.037***	0.024***	0.013	−0.018	0.018**	0.000
	(0.012)	(0.006)	(0.012)	(0.012)	(0.006)	(0.012)	(0.012)	(0.005)	(0.012)	(0.011)	(0.007)	(0.012)

Source: SOEP waves 1984–2019, own calculations, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 6 Linear probability model

	Labor market outcome of the woman		
	(1)	(2)	(3)
Variables	Out of labor force	Unemployed	Employed
CMP, Random Effects (N = 55,379)			
Within effects of the man's employment status in t-1:			
unemployed	−0.024***	0.012*	0.012
	(0.007)	(0.007)	(0.008)
out of labor force	−0.079***	0.029	0.049**
	(0.020)	(0.019)	(0.021)
low-pay	−0.020***	0.006	0.013**
	(0.006)	(0.006)	(0.007)
Between effects of the man's employment status:			
unemployed	−0.088***	0.171***	−0.084***
	(0.011)	(0.010)	(0.018)
out of labor force	−0.053*	−0.032	0.086***
	(0.030)	(0.028)	(0.032)
low-pay	−0.033***	0.037***	−0.004
	(0.010)	(0.010)	(0.011)
Fixed Effects, Arellano-Bond Difference GMM (N = 44,135)			
Within effects of man's employment status in t-1:			
unemployed	−0.032**	−0.004	0.036**
	(0.014)	(0.015)	(0.015)
out of labor force	−0.059**	0.008	0.051
	(0.028)	(0.034)	(0.036)
low-pay	−0.023**	−0.005	0.027**
	(0.009)	(0.010)	(0.011)

Source: SOEP waves 1984–2019, own calculations, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

the Arellano-Bond difference GMM approach. Since this model eliminates the time-invariant individual-specific effects as well as all time-invariant explanatory variables, only the time-varying (lagged) explanatory variables were included. This also implies that no between effects can be estimated.

Compared to Table 4, some point estimates and significance levels have changed. However, the within effects are generally of a similar magnitude and the sign remains unchanged for all significant point estimates. The Arellano-Bond estimation suggests slightly larger effect sizes. Overall, the key results are confirmed.. However, it should be noted that the results in Table 6 have to be interpreted with caution. The linear probability model does not take into account that the dependent variable is binary. For these reasons, we prefer to apply the probit model presented in the main body of this study.

Table 7 Average partial effect controlling for local unemployment rate

	Labor market outcome of the woman		
	(1)	(2)	(3)
Variables	Out of labor force	Unemployed	Employed
Within effects of the man's employment status in t-1:			
unemployed	−0.027**	0.006	0.021**
	(0.008)	(0.007)	(0.008)
out of labor force	−0.085**	0.029	0.056**
	(0.023)	(0.020)	(0.024)
low-pay	−0.023**	0.007	0.016**
	(0.008)	(0.006)	(0.007)
Between effects of the man's employment status:			
unemployed	−0.091***	0.098***	−0.007
	(0.012)	(0.008)	(0.013)
out of labor force	−0.057*	−0.030	0.087**
	(0.033)	(0.028)	(0.037)
low-pay	−0.037***	0.033***	0.004
	(0.012)	(0.008)	(0.012)

Sources: SOEP waves 1984–2019, Federal Employment Agency (2021), own calculations, *** $p<0.01$, ** $p<0.05$, * $p<0.1$

In Table 7, we re-estimate the results from Table 4 but include the unemployment rate in the federal state in the respective year as an additional control variable. This is meant to address concerns about the unemployment experience of the man signaling local labor market conditions, which could be associated with a discouraged worker effect. For this robustness test, unemployment statistics for each state and year from the Federal Employment Agency (2021) were merged with the SOEP. In comparison to Table 4, the estimates remain largely unchanged. The sign is identical in all cases and many point estimates are remarkably close to those reported in Table 4.

Limitations

Finally, we want to address some limitations of our analysis. Our results imply that there is a response by the woman to her partner's labor market status in the previous period, even after conditioning on the woman's own labor market status in the previous period. We believe that it is reasonable to assume that there is some lag in the response of the woman. Nonetheless, it should be acknowledged that the specification places some restrictions on the timing of the response. In particular, a contemporaneous adjustment of the woman to the man's labor market status would be absorbed by the conditioning on the own labor market status in the previous period. Testing for a contemporaneous effect by including the current labor market position

is also problematic due to the potential for reverse causality. Assuming the direction of a contemporaneous response, if at all present, is in the same direction, the total effect of the man's unemployment/low-pay employment would be larger than the effect estimated in this study since there is a positive correlation in the woman's labor market status over time. This does not invalidate the estimated conditional responses but one should be cautious about interpreting our results as the "full" response. It would also be interesting to analyze a longer lag structure. However, this is not the key focus of this study and would result in a further reduction of the usable sample size.

Several recent studies have placed emphasis on identifying the added worker effect by only considering the influence of a partner's exogenous job loss, typically defined as resulting from a plant closure or dismissal (see for example Stephens 2002, and, Kohara 2010), to ensure that the identified effect is causal. Since there is no convincing way to model an exogenous switch to low-pay employment from high-pay employment in a similar fashion, we have instead taken great care in our model set-up to address this issue. We have decomposed the partner's employment status variables into a between and a within component. The within component is constructed based on the lag of the partner's employment status and the time-invariant individual-specific error terms are explicitly modelled. However, these adjustments do not rule out that there are some time-varying factors influencing both partners' labor supplies, which lead to a correlation between the woman's labor market status and that of her partner in the previous period. Thus, there is no guarantee that the estimated within effects truly correspond to the impact that a fully exogenous, unanticipated job loss would have.

In addition, one might be concerned about the type of transitions between high-pay and low-pay employment which are captured by the model. When considering the added worker effect in the traditional sense one would be particularly interested in identifying the effect for individuals who have suddenly experienced a sharp reduction in their income. For example, a man might have lost a high-paid job and was forced to accept a low-paid job to prevent a period of unemployment, which could then elicit a change in the labor supply of his partner while the man is still low-paid. Our model assumes symmetry and, thus, also captures the converse case, i.e. a man climbing the career ladder and moving from a low-paid job to a high-paid one and his partner responding with a reduction in own labor supply. Whether the woman's previously higher probability of participating in the labor market should be referred to as an "added worker effect" is a matter of definition. In any case, a positive within effect of low-pay employment tells us something about the relationship between the two partners' labor supplies. In addition, one might be concerned that, in many cases, people might expect some episodes of being low-paid, particularly during qualification phases, with a subsequent (also expected) transition to high-pay employment. If an expected period of low-pay employment has a lower or no impact on the partner's labor supply, then our estimates would underestimate the impact an unexpected fully exogenous shift to low-pay employment would have. Lastly, one might be concerned that shifts between high-pay and low-pay employment are largely just small shifts around the low-pay threshold, without any noticeable consequences for the individual. In these cases, we would not expect any response by the

partner. Given that we do find a significant within effect of low-pay employment, this could be seen as a lower bound because the effect would be even larger if we excluded these smaller fluctuations around the threshold.

Lastly, one could be concerned that unemployment or low-pay employment might induce the separation of couples. Couples who separate due to unemployment or low-pay employment of the husband might show systematically different responses if they were forced to remain together than those who actually remain together. In this case, the added worker effects estimated in this study may yield a biased representation of the effect for the entire population (Charles and Stephens 2004). Also using the SOEP data, Keldenich and Luecke (2020) find that the husband's employment termination is indeed associated with an increase in the probability of divorce. However, when the husband is dismissed from his job, the relative risk of divorce will be lower if the woman takes up a new job instead of remaining unemployed (while there is no significant difference for other types of job losses). It is generally conceivable that couples are more likely to remain together if they are able to buffer negative shocks to the husband's income via employment of the woman. This implies that the estimated effects are larger than they would be if separation was impossible. However, it is not clear what women would have done if they did not have the option to separate. One could also think of scenarios where the selection bias causes an underestimation of the true effect. In the present study, we are only interested in the relationship for couples who remain together. It must be acknowledged, however, that our estimates are only representative for this group.

Conclusions

The evidence presented in this paper suggests that there is an added worker effect at the extensive margin. If a woman's partner was unemployed in the previous period she is about three percentage points more likely to participate in the labor market than if the partner was high-paid. The probability of being employed also increases by about two percentage points. We also show that the man's low-pay employment in the previous period has a similar, though somewhat smaller, effect on his partner's labor market status as his unemployment. In particular, the participation and employment probabilities increase by 2.2 and 1.5 percentage points, respectively. The estimated between effects could be interpreted as the woman's response to her partner's overall propensity to be in a particular labor market state or as evidence for assortative matching in the marriage market. A woman whose partner is frequently unemployed is significantly more likely to participate in the labor market. However, she is not more likely to be employed.

Our results may differ from those of earlier studies that did not find an added worker effect at the extensive margin due to differences in the estimating procedure and in the dataset. Considering the results of this study, it should be noted that our reference group consists only of women whose partners were high-paid. We have chosen this specification for two reasons. Firstly, we are specifically interested in also analyzing the impact of low-paid employment of the man on the woman's labor market outcomes. Secondly, the added worker effect is often defined as a response

to the loss of employment, and thus income, of the breadwinner. Thus, it might be argued that – while employed – the breadwinner's income is generally assumed to be high enough to support the family, even without any additional income from the secondary earner or at least without the secondary earner contributing a significant share to the household income. If both partners are low-paid and are, thus, required to work full-time in order to support the family (which is precisely the effect we also address in our study), there is not much (if any) room for an additional increase in labor supply. This is certainly the case when considering the extensive margin. Thus, we would argue that in many definitions of the added worker effect the lost job is implicitly assumed to have been high-paid. This second point is of course debatable. The definition of the added worker effect is already not clear cut and may be subject to change as the labor market changes over time. Particularly in the light of changing gender roles, another interesting extension could be to estimate the added worker effect separately in each decade to see whether the effect has changed over time. This is left for further research.

Appendix 1: Partial Effects

Partial effect of the within component of a partner's unemployment in the previous period on …

1) the woman's unemployment probability at a particular point in time

$$\begin{aligned}\hat{PE}_{it}^{UE} =& \boldsymbol{\Phi}_2\Big(-\Big(\hat{\gamma}_{11}y_{1it-1}+\hat{\gamma}_{12}y_{2it-1}+\hat{\varphi}_{11}\Big(0-\overline{olf}_i^{par}\Big)+\hat{\varphi}_{12}\big(1-\overline{ue}_i^{par}\big)+\hat{\varphi}_{13}\Big(0-\overline{lp}_i^{par}\Big)+\boldsymbol{X}'_{1it}\hat{\boldsymbol{B}}_1\Big)\\ &\sqrt{1-\hat{\lambda}_1},\ \Big(\hat{\gamma}_{21}y_{1it-1}+\hat{\gamma}_{22}y_{2it-1}+\hat{\varphi}_{21}\Big(0-\overline{olf}_i^{par}\Big)+\hat{\varphi}_{22}\big(1-\overline{ue}_i^{par}\big)+\hat{\varphi}_{23}\Big(0-\overline{lp}_i^{par}\Big)+\boldsymbol{X}'_{2it}\hat{\boldsymbol{B}}_2\Big)\\ &\sqrt{1-\hat{\lambda}_2},-\hat{\rho}_u\Big)\\ &-\boldsymbol{\Phi}_2\Big(-\Big(\hat{\gamma}_{11}y_{1it-1}+\hat{\gamma}_{12}y_{2it-1}+\hat{\varphi}_{11}\Big(0-\overline{olf}_i^{par}\Big)+\hat{\varphi}_{12}\big(0-\overline{ue}_i^{par}\big)+\hat{\varphi}_{13}\Big(0-\overline{lp}_i^{par}\Big)+\boldsymbol{X}'_{1it}\hat{\boldsymbol{B}}_1\Big)\\ &\sqrt{1-\hat{\lambda}_1},\ \Big(\hat{\gamma}_{21}y_{1it-1}+\hat{\gamma}_{22}y_{2it-1}+\hat{\varphi}_{21}\Big(0-\overline{olf}_i^{par}\Big)+\hat{\varphi}_{22}\big(0-\overline{ue}_i^{par}\big)+\hat{\varphi}_{23}\Big(0-\overline{lp}_i^{par}\Big)+\boldsymbol{X}'_{2it}\hat{\boldsymbol{B}}_2\Big)\\ &\sqrt{1-\hat{\lambda}_2},-\hat{\rho}_u\Big)\end{aligned}$$

2) the woman's employment probability at a particular point in time

$$\begin{aligned}\hat{PE}_{it}^{EMP} =& \boldsymbol{\Phi}_2\Big(-\Big(\hat{\gamma}_{11}y_{1it-1}+\hat{\gamma}_{12}y_{2it-1}+\hat{\varphi}_{11}\Big(0-\overline{olf}_i^{par}\Big)+\hat{\varphi}_{12}\big(1-\overline{ue}_i^{par}\big)+\hat{\varphi}_{13}\Big(0-\overline{lp}_i^{par}\Big)+\boldsymbol{X}'_{1it}\hat{\boldsymbol{B}}_1\Big)\\ &\sqrt{1-\hat{\lambda}_1},\ -\Big(\hat{\gamma}_{21}y_{1it-1}+\hat{\gamma}_{22}y_{2it-1}+\hat{\varphi}_{21}\Big(0-\overline{olf}_i^{par}\Big)+\hat{\varphi}_{22}\big(1-\overline{ue}_i^{par}\big)+\hat{\varphi}_{23}\Big(0-\overline{lp}_i^{par}\Big)+\boldsymbol{X}'_{2it}\hat{\boldsymbol{B}}_2\Big)\\ &\sqrt{1-\hat{\lambda}_2},-\hat{\rho}_u\Big)\end{aligned}$$

$$-\boldsymbol{\Phi}_2\Big(-\Big(\hat{\gamma}_{11}y_{1it-1}+\hat{\gamma}_{12}y_{2it-1}+\hat{\varphi}_{11}\Big(0-\overline{olf}_i^{par}\Big)+\hat{\varphi}_{12}\big(0-\overline{ue}_i^{par}\big)+\hat{\varphi}_{13}\Big(0-\overline{lp}_i^{par}\Big)+\boldsymbol{X}'_{1it}\hat{\boldsymbol{B}}_1\Big)$$
$$\sqrt{1-\hat{\lambda}_1},\ -\Big(\hat{\gamma}_{21}y_{1it-1}+\hat{\gamma}_{22}y_{2it-1}+\hat{\varphi}_{21}\Big(0-\overline{olf}_i^{par}\Big)+\hat{\varphi}_{22}\big(0-\overline{ue}_i^{par}\big)+\hat{\varphi}_{23}\Big(0-\overline{lp}_i^{par}\Big)+\boldsymbol{X}'_{2it}\hat{\boldsymbol{B}}_2\Big)$$
$$\sqrt{1-\hat{\lambda}_2},-\hat{\rho}_u\Big)$$

3) the woman's probability of being out of the labor force at a particular point in time

$$\tilde{PE}_{it}^{OLF}=\boldsymbol{\Phi}\Big(\Big(\hat{\gamma}_{11}y_{1it-1}+\hat{\gamma}_{12}y_{2it-1}+\hat{\varphi}_{11}\Big(0-\overline{olf}_i^{par}\Big)+\hat{\varphi}_{12}\big(1-\overline{ue}_i^{par}\big)+\hat{\varphi}_{13}\Big(0-\overline{lp}_i^{par}\Big)+\boldsymbol{X}'_{1it}\hat{\boldsymbol{B}}_1\Big)\sqrt{1-\hat{\lambda}_1}\ \Big)$$
$$-\boldsymbol{\Phi}\Big(\Big(\hat{\gamma}_{11}y_{1it-1}+\hat{\gamma}_{12}y_{2it-1}+\hat{\varphi}_{11}\Big(0-\overline{olf}_i^{par}\Big)+\hat{\varphi}_{12}\big(0-\overline{ue}_i^{par}\big)+\hat{\varphi}_{13}\Big(0-\overline{lp}_i^{par}\Big)+\boldsymbol{X}'_{1it}\hat{\boldsymbol{B}}_1\Big)\sqrt{1-\hat{\lambda}_1}\ \Big)$$

Where:

$$\begin{aligned}\boldsymbol{X}'_{jit}\hat{\boldsymbol{B}}_j=&\big(\boldsymbol{x}_{jit}-\bar{\boldsymbol{x}}_{ji}\big)'\hat{\boldsymbol{\beta}}_j+\hat{\phi}_{j1}\overline{olf}_i^{par}\\&+\hat{\phi}_{j2}\overline{ue}_i^{par}+\hat{\phi}_{j3}\overline{lp}_i^{par}+\bar{\boldsymbol{x}}'_{ji}\hat{\boldsymbol{\delta}}_j+\boldsymbol{z}'_{ji}\hat{\boldsymbol{\eta}}_j+\hat{\psi}_{j1}y_{1i1}\\&+\hat{\psi}_{j2}y_{2i1}+\hat{\psi}_{j3}olf_{i1}^{par}+\hat{\psi}_{j4}ue_{i1}^{par}+\hat{\psi}_{j4}lp_{i1}^{par}+\boldsymbol{x}'_{ji1}\hat{\boldsymbol{\psi}}_j+\hat{\tau}_{jt}\end{aligned}$$

Acknowledgements We thank Alexander Plum for his valuable input.

Funding Open Access funding enabled and organized by Projekt DEAL. This research was funded by the German Research Foundation (DFG) [grant number KN 984/1-1]. The DFG was not involved in the conduct of research or the preparation of the manuscript.

Conflict of Interest The authors declare that they have no conflict of interest.

References

Alessie R, Hochguertel S, Van Soest A (2004) Ownership of stocks and mutual funds: a panel data analysis. Rev Econ Stat 86(3):783–796

Ashenfelter O (1980) Unemployment as disequilibrium in a model of aggregate labor supply. Econometrica 48(3):547–564

Ayhan SH (2018) Married women's added worker effect during the 2008 economic crisis—the case of Turkey. Rev Econ Househ 16(3):767–790

Baltagi B (2008) Econometric analysis of panel data, 4th edn. Wiley

Becker G (1991) A treatise on the family (enlarged edition). Harvard University Press

Bell A, Jones K (2015) Explaining fixed effects: random effects modeling of time-series cross-sectional and panel data. Polit Sci Res Methods 3(01):133–153

Benati L (2001) Some empirical evidence on the 'discouraged worker' effect. Econ Lett 70(3):387–395

Bredtmann J, Otten S, Rulff C (2018) Husband's unemployment and Wife's labor supply: the added worker effect across Europe. Ind Labor Relat Rev 71(5):1201–1231
Browning M, Chiappori PA, Weiss Y (2014) Economics of the family. Cambridge University Press
Cardona-Sosa L, Flórez LA, Morales LF (2018) How does the household labour supply respond to the unemployment of the household head? Labour 32(4):174–212
Charles KK, Stephens M Jr (2004) Job displacement, disability, and divorce. J Labor Econ 22(2):489–522
Couch KA, Placzek DW (2010) Earnings losses of displaced workers revisited. Am Econ Rev 100(1):572–589
Cullen JB, Gruber J (2000) Does unemployment insurance crowd out spousal labor supply? J Labor Econ 18(3):546–572
Fallick BC (1996) A review of the recent empirical literature on displaced workers. Ind Labor Relat Rev 50(1):5–16
Federal Employment Agency (2021) Arbeitslosigkeit im Zeitverlauf: Entwicklung der Arbeitslosenquote (Jahreszahlen) Deutschland und Bundesländer 2020, Nürnberg
Goebel J, Grabka MM, Liebig S, Kroh M, Richter D, Schröder C, Schupp J (2019) The german socio-economic panel (soep). Jahrbücher Natlökonomie Statistik 239(2):345–360
Hardoy I, Schøne P (2014) Displacement and household adaptation: insured by the spouse or the state? J Popul Econ 27(3):683–703
Heckman JJ (1981a) Heterogeneity and state dependence. In: Rosen S (ed) Studies in labor markets. University of Chicago Press
Heckman JJ (1981b) The incidental parameters problem and the problem of initial conditions in estimating a discrete time-discrete data stochastic process. In: Manski CF, McFadden D (eds) Structural analysis of discrete data with econometric applications. MIT Press
Hyslop DR (1999) State dependence, serial correlation and heterogeneity in intertemporal labor force participation of married women. Econometrica 67(6):1255–1294
Keldenich C, Luecke C (2020) Unlucky at work, unlucky in love: job loss and marital stability. Rev Econ Household Adv Online Publ. https://doi.org/10.1007/s11150-020-09506-x
Knabe A, Plum A (2013) Low-wage jobs—springboard to high-paid ones? Labour 27(3):310–330
Kohara M (2010) The response of Japanese wives' labor supply to husbands' job loss. J Popul Econ 23(4):1133–1149
Lundberg S (1985) The added worker effect. J Labor Econ 3(1, part 1):11–37
Maloney T (1991) Unobserved variables and the elusive added worker effect. Economica 58(230):173–187
Mincer J (1962) Labor force participation of married women: a study of labor supply. In: Aspects of labor economics. Princeton University Press, pp 63–105
Mundlak Y (1978) On the pooling of time series and cross section data. Econometrica 46(1):69–85
Plum A (2016) Bireprob: an estimator for bivariate random-effects probit models. Stata J 16(1):96–111
Rabe-Hesketh S, Skrondal A (2013) Avoiding biased versions of Wooldridge's simple solution to the initial conditions problem. Econ Lett 120(2):346–349
Roodman D (2011) Fitting fully observed recursive mixed-process models with cmp. Stata J 11(2):159–206
Skrondal A, Rabe-Hesketh S (2014) Handling initial conditions and endogenous covariates in dynamic/transition models for binary data with unobserved heterogeneity. J R Stat Soc: Ser C: Appl Stat 63(2):211–237
Stephens M Jr (2002) Worker displacement and the added worker effect. J Labor Econ 20(3):504–537
Stewart MB (2007) The interrelated dynamics of unemployment and low-wage employment. J Appl Econ 22(3):511–531
Triebe D (2015) *The added worker effect differentiated by gender and partnership status–evidence from involuntary job loss.* SOEPpapers on multidisciplinary panel data research, no. 740, Deutsches Institut für Wirtschaftsforschung (DIW), Berlin
Wooldridge JM (2005) Simple solutions to the initial conditions problem in dynamic, nonlinear panel data models with unobserved heterogeneity. J Appl Econ 20(1):39–54
Woytinsky WS (1942) Three aspects of labor dynamics. Committee on social security, Social Science Research Council, Washington