Labour supply under demand side constraints in the USA and the FRG

- A comparative analysis using PSID and GSOEP data

by

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ABSTRACT

This paper provides an empirical assessment of hypotheses that identify causes of demand side constraints of individual labour supply. In a comparative study for the USA and the FRG we focus on analysing the effect of productivity gaps (industry wage growth beyond productivity growth), industry investment intensity and regional labour market conditions on individual employment probabilities. Furthermore, we investigate whether demand side constraints of labour supply can be caused by a spill over from commodity markets. Efficiency wage theory and the theory of inter-industry wage differentials are utilised to derive identifying restrictions that are applicable to the labour supply models for both countries. The econometric contribution of the paper is the derivation and application of a two step estimation method for the class of simultaneous random effects double hurdle models, of which the labour supply model employed in this paper is a special case. To provide the empirical basis for the comparative study, the Panel Study of Income Dynamics and the German Socio-Economic Panel are linked to the OECD's International Sectoral Database.

Keywords: International comparison, labour markets in USA and FRG, demand side constraints of labour supply, panel data, simultaneous double hurdle model with random effects.
JEL classification: C33, C34, J64, O57

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1. Introduction[1]

Considering the level of official and hidden unemployment figures in developed market economies, the implicit assumption of neoclassical labour supply models that all unemployment is at least ex post voluntary, in the sense that the individual's reservation wage is above the market wage, can hardly be maintained. Efficiency wage, implicit contracts and insider-outsider theorists, like Azariadis (1981), Shapiro, Stiglitz (1984) and Lindbeck, Snower (1988) describe processes which cause wages to loose their market clearing function and create binding restrictions of the desired level of labour supply. For the modelling of labour supply behaviour, this implies that the observed work hours of an individual can be zero despite the reservation wage condition is met. Labour supply models that allow for demand side constraints have been formulated and estimated by Blundell, Ham, Meghir (1987), Cogan (1981), Gönül (1989), Ham (1982), Hujer and Schnabel (1992), Moffitt (1982) and Schnabel (1993). In these approaches, a number of indicators describing the regional and industry labour demand situation is included as explanatory variables in a model equation that measures the intensity of the constraints of the individual labour market participation decision. However, the implicit economic hypotheses, the policy relevance and the motivation behind the variable selection is often not clear. For our comparative US-FRG study, we therefore try to identify demand side indicators that are associated with clearly defined economic hypothesis and arguments: We test the hypothesis, frequently stated during negotiations between trade unions and the employers' side, that a wage growth beyond the productivity growth will have a negative effect on individual employment probabilities. Secondly, we investigate whether an increasing investment intensity has job creating or labour substituting effects in both economies. Thirdly, we analyse whether demand side constraints of labour supply can be induced by a spill-over from commodity markets. Furthermore, we study the effect of regional labour market conditions on employment probabilities.

In an international comparison using structural labour supply models it is important to ensure inter-country comparability. This is not a trivial issue, because one has to keep in mind the result obtained by Mroz (1987) that a variation of stochastic assumptions and overidentifying restrictions has a quite significant impact on the parameter estimates of

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structural labour supply models. When comparing empirical labour supply models across countries, it is indeed a striking result that the estimated parameters differ considerably (c.f. Laisney, Pohlmeier, Staat (1992) for an overview). For comparative analyses it is therefore crucial to control the effect of different econometric assumptions, and especially to carefully consider the identification of the structural form parameters in the country models. It must be guaranteed that differences of the parameter estimates are actually due to different institutional settings in both economies, and not simply the result of different econometric specifications. We therefore propose a economic justification for parameter identification in labour supply models that is applicable for both the USA and the FRG. The procedure is based on efficiency wage theoretical considerations and on hypotheses derived from the theory of inter-industrial wage differentials. The necessary information on industry level, however, is usually not provided with the available household data. For the construction of the industry level variables needed for model identification and the testing of the hypothesis mentioned above, we link FRG and US household data from the German Socio-Economic Panel (GSOEP) and the Panel Study of Income Dynamics (PSID) to the OECD's International Sectoral Database, which includes the relevant indicators on an identical industry aggregation level for both the USA and the FRG.

Besides the economic focus, the paper also contains an econometric innovation: The standard double hurdle specification, originally proposed by Cragg (1971), is extended to a simultaneous latent three equation system including individual specific effects in each equation. This defines a class of simultaneous random effects double hurdle models of which the labour supply model that we employ in our comparative study is a special case. The econometric contribution of the paper is a convenient two step estimation procedure for this class of models that is applicable also for modelling other economic processes than labour supply.

The remainder of the paper is organised as follows: In section 2.1 we outline the economic background and derive the econometric labour supply model to be employed for the US-FRG comparison. The hypotheses that motivate the model specification are outlined in detail in section 2.2. This section also contains our proposal for an identification of structural labour supply models based on the efficiency wage theory and hypotheses for inter-industrial wage differentials. A convenient estimation procedure for the class of simultaneous random effects double hurdle models for panel data is proposed in section 2.3. Section 3 contains the comparative empirical analysis for the FRG and the USA and section 4 concludes.

2. Model specification and estimation issues

2.1 Theoretical background and econometric model

The econometric model that we employ for our comparative study belongs to the class of double hurdle models originally proposed by Cragg (1971). Blundell, Ham, Meghir (1987), Blundell, Meghir (1987) and Blundell (1990) make use of the double hurdle specification to analyse labour supply under demand side constraints. For the purpose of our study, we extend the standard two equation double hurdle model by allowing for unobserved heterogeneity. Before turning to the hypotheses that guide model specification and identification, we first want to outline the economic foundations of the econometric model.

In a neoclassical model, i.e. in the absence of any demand side constraints, it is the reservation wage condition that determines whether an individual's observed hours of work are positive: If the individual's market wage exceeds the reservation wage, then the observable work hours are identical to desired hours. If not, the observed hours of work are zero. Because of economic processes that are described by efficiency wage-, implicit contracts- and insider-outsider-theorists, e.g. by Azariadis (1981), Shapiro, Stiglitz (1984) and Lindbeck, Snower (1988), wages can loose their market clearing function. In such a situation, the reservation wage condition is no longer a sufficient condition for observing positive hours of work, because some individuals can be subject to a rationing of their desired hours of work.[2] This implies that the actual work hours of an individual who is facing such a binding constraint of his choices are zero, although the reservation wage condition is met. The Neokeynesian models by Clower (1965) and Svensson (1980), take into account demand side constraints of the labour supply decision, and conceive the labour supply process as a two step procedure. In the first step, an individual perceives prevailing prices and wages and states the desired level of labour supply. Svensson (1980) considers a regime of stochastic zero/one-rationing where binding constraints of the individual's labour market participation decision are ex ante uncertain, and argues that in such a situation, the following behaviour is rational: If a consumer is facing – ex post –a binding constraint of his/her labour market participation decision, then the desired labour supply level is revised in order to

[2] The type or rationing considered here is zero/one-rationing: Either a consumer is subject to a rationing of his desired level of labour supply and no hours of work can be realised, or he/she is not, and the desired level can be realised. An alternative concept would be proportional rationing where all consumers are affected by the rationing in the same way.

conform to the constraint in the actual period[3]. Because of the stochastic nature of the rationing, possible future constraints of the labour supply decision are ex ante uncertain. Even those individuals who are facing a binding constraint in the actual period will maintain the path of future desired level of labour supply, and continue to signal it to the labour market[4].

These considerations essentially provide the economic foundations to employ the double hurdle specification for modelling labour supply processes. Our version of the model consists of an equation for the desired, unrestricted hours of work, an equation for the market wage, and a equation that measures the intensity of the constraints of individual i's labour market participation decision in period t. Following Blundell, Ham, Meghir (1987) we label this equation "employment (index) equation". The intertemporal labour supply under uncertainty proposed by MaCurdy (1985) provides the basis for deriving an equation for the desired hours of work (i.e. the first decision step). Assuming a within period separable utility function of a Box-Cox-type and utility maximisation under budget constraints, MaCurdy (1985) derives an equation for desired work hours of individual i in period t, and an equation for the individual's market wage:

$$H_{it}^{*} = c_{i1} + c_{t1} + x'_{it1}\beta_1 + \gamma_H W_{it}^{*} + u_{it1} \qquad [1]$$

$$W_{it}^{*} = c_{i2} + c_{t2} + x'_{it2}\beta_2 + u_{it2} \qquad [2]$$

where $H_{it}^{*} = \ln\left(\frac{\bar{L}}{L_{it}^{*}}\right)$ and $\bar{L}$ denotes the maximum time available for leisure, L_{it}^{*} the desired leisure hours and W_{it}^{*} the logarithm of the real market wage. Each equation g contains individual and time specific effects, c_{ig} and c_{tg} . Desired hours and market wages are subject to random shocks u_{itg} .[5] The latent employment index E_{it}^{*} is a function of individual and time specific effects, a set of explanatory variables and a random shock.

$$E_{it}^{*} = c_{i3} + c_{t3} + x'_{it3}\beta_3 + u_{it3} \qquad [3]$$

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3 In Neokeynesian theory, the demand that is observable after the adjustment is called "Drèze demand".

4 In Neokeynesian theory a (latent) demand signal that is maintained despite the restrictions of the actual period is called "Clower-demand".

5 In MaCurdy's (1985) model, $-\gamma$ denotes the elasticity of substitution between leisure hours in different periods and also the elasticity of leisure in response to a expected wage change in the current period.

The specification of the employment index equation [3] is explained in detail in the next section. Two conditions must be met in order to observe positive hours of work and wages: Firstly, the market wage must exceed the reservation wage and secondly, the employment index E^*_{it} must exceed a threshold value, which is set to zero for identification reasons:

$$
\begin{aligned}
&H_{it} = H^*_{it} \quad \text{if} \quad W^*_{it} > W^R_{it} \text{ and } E^*_{it} > 0 \\
&H_{it} = 0 \qquad \text{else} \\
&W_{it} = W^*_{it} \quad \text{if} \quad W^*_{it} > W^R_{it} \text{ and } E^*_{it} > 0 \\
&W_{it} = \text{n. a.} \qquad \text{else}
\end{aligned}
\qquad [4]
$$

W^R_{it} denotes the reservation wage. H_{it} are observed (transformed) work hours and W_{it} the observed log wage. The two events $\{W^*_{it} > W^R_{it} \text{ and } E^*_{it} > 0\}$ and $\{H^*_{it} > 0 \text{ and } E^*_{it} > 0\}$ are equivalent.

2.2 Economic hypotheses, model specification and identification

We now turn to the economic hypotheses that we want to assess in the empirical study. In this process we have to address two central issues, namely the specification of the equation for the employment index E^*_{it} , and parameter identification. As in a neoclassical model of labour supply, the desired hours of work equation [1] contains as explanatory variables individual taste modifiers like years of schooling, labour market experience, and indicators that describe the family context (e.g. number of children). Human capital theory provides the background for the specification of the wage equation [2]. Blundell, Ham, Meghir (1987), Blundell, Meghir (1987) and Blundell (1990), who apply the double hurdle specification for modelling labour supply processes, include a large set of regional and industry specific indicators in the employment equation [3]. However, the economic hypotheses, policy relevance and motivation behind the variable selection are often not clearly defined. For our US-FRG comparison we focus on analysing the effect that the labour demand side indicators "industry investment intensity", "industry productivity gap" and the "industry commodity demand" and the regional labour market situation exert on employment probabilities. The indicator "industry investment intensity" is defined as the ratio of industry gross investment and capital stock. Including this indicator as an explanatory variable in the employment equation, we are able investigate the job creating or labour substituting effects of an intense investment activity. The indicator "industry productivity gap" is defined as the difference between the industry productivity growth and the growth of total payroll per employee. Including the industry productivity gap in the employment equation it is possible to test the hypothesis that a wage growth beyond the growth of productivity reduces employment probabilities. The indicator "industry product demand index" is included in the employment equation in order to analyse the possibility of a spill-over of demand side constraints in the industries commodity market to the labour market. If a reduced demand for the industry's products reduces the the employment probabilities of the workers in that industry, then this can be interpreted as a kind of "Keynesian" unemployment.

In empirical double hurdle models of labour supply, variables that describe the family context and individual characteristics enter both the right hand sides of the latent hours- and the employment-equation. Acknowledging that it is not necessarily the industry or regional labour market situation alone, but also the household context that might impose restrictions of the individual labour market participation decision, we include the variables on household/individual level which are employed in the latent hours equation as explanatory variables (including the market wage) in the employment index equation, too. The implicit economic motivation behind such a specification is based on the assumption of fixed costs of labour supply: If fixed costs of labour supply exist then the qualitative choice "labour market participation" is separated from the quantitative decision "desired work hours" (Cogan 1981). The double hurdle specification is then similar to the generalized tobit type of model proposed by Zabel (1993).

$$E_{it}^{*} = c_{i3} + c_{t3} + x_{it3}^{'} \beta_3 + \gamma_E W_{it}^{*} + u_{it3} \qquad [3']$$

In our specification, the market wage enters both the latent hours equation [1] and the employment equation [2]. To ensure model identification, it is necessary to find identifying restrictions, i.e. variables that explain market wages but that do not affect latent hours and the employment index. The contributions of studies that analyse inter-industry wage differentials provide a solution to that problem: In order to account for inter-industry wage differentials, our specification of the wage equation [2] also contains - besides the human capital theory variables experience, and years of schooling - a set of indicators that are assumed to explain inter-industry wage differentials. Since these variables can be excluded from the employment index- and the latent hours-equation, parameter identification is ensured. Because of their importance for model identification, we outline in the following the motivation behind the indicators that are assumed to explain inter-industry wage differentials.

The inclusion of the indicators industry capital-gross product ratio and industry profit per employee in the wage equation is motivated by efficiency wage theoretical explanations of the inter-industry wage structure (Krueger and Summers 1988). Two contradictory hypotheses have been be stated why a high capital to output-ratio should imply a positive or negative industry wage differential: On the one hand, shirking of employees hazards capital investment of firms. If efficiency wages are paid to prevent shirking, then positive wage differentials for industries with a high capital intensity of production are the result. On the other hand, capital intensive production processes can facilitate monitoring of employees. Monitoring, however, reduces the possibilities of shirking, which implies negative wage differentials for industries with capital intensive production processes. Another argument derived from efficiency wage theory assumes that employee motivation and efficiency depend on the perception of a fair wage. In order to raise their employee's pro ductivity, profitable industries will therefore pay a positive wage differential. The inclusion of the indicator industry profit per employee in the wage equation permits an empirical test of this hypothesis. Two contradictory arguments, outlined in Wagner's (1991) survey of explanations of inter-industry wage differentials, are associated with the inclusion of the variable industry unemployment rate in the wage equation. The first argument states that risk-compensating wage differentials are paid in industries where employees are facing a higher chance of becoming unemployed. The second argument associates inter-industry wage differentials with structural change: If during a process of structural change, expanding industries pay wage premiums in order to attract workers, and shrinking industries try to realise cost reduction by cutting wages and worker layoffs, then transitory inter-industry wage differentials result. Hence, we expect a negative wage differential for industries with high unemployment rates. We also allow for a direct impact of regional labour market conditions on wages by including the regional unemployment rate as an explanatory variable in the wage equation. Based on efficiency wage theoretical considerations, Blanchflower, Oswald (1990) argue that a high level of regional unemployment is expected to have a negative effect on wages.

2.3 Estimation of simultaneous random effects double hurdle models

In this section, we propose a convenient estimation framework for the labour supply model outlined in section 2.1. Actually, the method proposed in the following is applicable to a whole class of interdependent double hurdle models which share the common structure of a three equation structure with latent dependent variables of the form,

$$y^*_{it1} = c_{i1} + c_{t1} + x'_{it1}\beta_1 \qquad + \gamma_{12} y^*_{it2} + \gamma_{13} y^*_{it3} + u_{it1}$$

$$y^*_{it2} = c_{i2} + c_{t2} + x'_{it2}\beta_2 + \gamma_{21} y^*_{it1} \qquad + \gamma_{23} y^*_{it3} + u_{it2}$$

$$y^*_{it3} = c_{i3} + c_{t3} + x'_{it3}\beta_3 + \gamma_{31} y^*_{it1} + \gamma_{32} y^*_{it2} \qquad + u_{it3}\ , \qquad [5]$$

and a threshold model that transfers the latent into observable variables according to the following rule:

$$\begin{aligned} &y_{it1} = y^*_{it1} \text{ if } y^*_{it1} > 0 \text{ and } y^*_{it3} > 0 \\ &y_{it1} = 0 \quad \text{else} \\ &y_{it2} = y^*_{it2} \text{ if } y^*_{it1} > 0 \text{ and } y^*_{it3} > 0 \\ &y_{it2} = 0 \quad \text{else} \end{aligned} \qquad [6]$$

The labour supply model in equations [1]-[4] represents a special case of this general model where $y^*_{it1} = H^*_{it}, y^*_{it2} = W^*_{it}$, $y^*_{it3} = E^*_{it}$, $y_{it1} = H_{it}$, $y_{it2} = W_{it}$, $\gamma_{12} = \gamma_H$, $\gamma_{32} = \gamma_E$, $\gamma_{13} = \gamma_{21} = \gamma_{23} = \gamma_{31} = 0$.

In order to avoid the incidental parameter problem implied by a fixed effects specification for c_{ig} – the number of individuals N being large and the number of panel waves T being small – we advocate a random effects approach[6]. Following Chamberlain (1984), we allow for a correlation of the explanatory variables in [5] with the individual random effect in each equation in the following way:

$$c_{ig} = \sum_{k=1}^{T} x^{c}_{ikg}{}' \cdot \tau_{kg} + a_{ig}\,. \qquad [7]$$

τ_{kg} are parameter vectors and a_{ig} are random variables. x^c_{ig} is a subset of variables in the vector x_{ig} that are assumed to be correlated with the random effect in the g'th equation. We assume that $E(a_{ig}) = 0$, $E(a_{ig} x_{ikg}) = 0$, and zero correlation of the composite error term $e_{itg} = (u_{itg} + a_{ig})$ between individuals,

6 In most applications, an incidental parameter problem for the time effects c_{tg} does not exist. The time specific effects c_{tg} are therefore treated as parameters to be estimated.

$$E\left(e_{itg}\, e_{i't'g'}\right) = 0 \text{ for } i' \neq i. \qquad [8]$$

We stack the errors in a vector $e_i = \left(e_{i11}, e_{i12}, e_{i13}, \ldots, e_{iT1}, e_{iT2}, e_{iT3} \right)'$, and assume that $E(e_i) = 0$. No restrictions on the covariance matrix $E\left(e_i e_i'\right) = \Sigma_e$ are imposed, except that it is identical for all individuals.

The estimation of the structural form parameters $\theta = \left(c_{11}, .., c_{T1}, c_{21}, .., c_{2T}, c_{31}, .., c_{3T}, \beta_1', \beta_2', \beta_3', \gamma_{11}, .., \gamma_{23}, \tau_{11}', .., \tau_{T3}' \right)'$ is carried out in two steps. For the first estimation step, we relax the restriction of time-invariant structural form parameters, and write the reduced form of the simultaneous equation system [5] by substituting the endogenous explanatory variables, and by taking into account the correlated random effects structure [7] as

$$\begin{aligned} y_{it1}^* &= d_{t1} + z_{it1}^{u}{}'\pi_{t1}^{u} + \sum\nolimits_{k=1}^{T} z_{ik1}^{c}{}'\pi_{kt1}^{c} + \varepsilon_{it1} \\ y_{it2}^* &= d_{t2} + z_{it2}^{u}{}'\pi_{t2}^{u} + \sum\nolimits_{k=1}^{T} z_{ik2}^{c}{}'\pi_{kt2}^{c} + \varepsilon_{it2} \\ y_{it3}^* &= d_{t3} + z_{it3}^{u}{}'\pi_{t3}^{u} + \sum\nolimits_{k=1}^{T} z_{ik3}^{c}{}'\pi_{kt3}^{c} + \varepsilon_{it3}. \end{aligned} \qquad [9]$$

ε_{itg} denotes the reduced form error term in the equation g. z_{itg}^{u} denotes the explanatory variables that are uncorrelated, and z_{itg}^{c} a vector of variables that are assumed to be correlated with the random effect in the reduced form of the *g*'th equation. We assume for the contemporaneous reduced form error vector $\varepsilon_{it} = \left(\varepsilon_{it1}, \varepsilon_{it2}, \varepsilon_{it3}\right)'$ that it is trivariate normal, $\varepsilon_{it} \sim N\left(0, \Sigma_{\varepsilon_t}\right)$, where

$$\Sigma_{\varepsilon_t} = \begin{pmatrix} \sigma_{\varepsilon_{t1}}^2 & . & . \\ \sigma_{\varepsilon_{t2}\varepsilon_{t1}} & \sigma_{\varepsilon_{t2}}^2 & . \\ \sigma_{\varepsilon_{t3}\varepsilon_{t1}} & \sigma_{\varepsilon_{t3}\varepsilon_{t2}} & 1 \end{pmatrix}. \qquad [10]$$

Collect the reduced form parameter related to period t in a vector $\xi_t = \left(d_{1t}, d_{2t}, d_{3t}, \pi_{11}^{u}{}', .., \pi_{T3}^{u}{}', \pi_{111}^{c}{}', .., \pi_{TT3}^{c}{}', \mathrm{vec}\left(\Sigma_{\varepsilon_t}\right)' \right)'$. According to the censoring rules in [6] the period t marginal likelihood is

$$\begin{aligned} L_t\left(\xi_t\right) = \prod_{i=1}^{N} &\left[1 - \Phi_{BSN}\left(\frac{\mu_{it1}}{\sigma_{\varepsilon_{t1}}}, \mu_{it3}; \frac{\sigma_{\varepsilon_{t1}\varepsilon_{t3}}}{\sigma_{\varepsilon_{t1}}} \right) \right]^{(1-\delta_{it})} \times \\ &\left[\int_{-\mu_{it3}}^{\infty} \varphi_{TN}\left(y_{it1}^* - \mu_{it1}, y_{it2}^* - \mu_{it2}, \varepsilon_{it3}; 0, \Sigma_{\varepsilon_t} \right) d\varepsilon_{it3} \right]^{\delta_{it}} \end{aligned} \qquad [11]$$

where

$$\mu_{itg} = d_{tg} + z_{itg}^{u}{}'\pi_{tg}^{u} + \sum_{k=1}^{T} z_{ikg}^{c}{}'\pi_{kgt}^{c}\,; \qquad g = 1,2,3$$

$$\delta_{it} = \begin{cases} 1 & \text{if } \left(y_{it1}^{*} > 0 \text{ and } y_{it3}^{*} > 0\right) \\ 0 & \text{else} \end{cases} \qquad [12]$$

$\varphi_{TN}(a_1, a_2, a_3; m, \Sigma)$ denotes the trivariate normal density function of a random vector with mean m and the covariance matrix Σ, and $\Phi_{BSN}(a_1, a_2; \rho)$ the c.d.f of the bivariate standard normal distribution with correlation ρ. Maximising the log of [11] with respect to the reduced form parameter vector ξ_t. Stacking the estimated vectors $\hat{\xi}_t$ we obtain the vector of reduced form parameter estimates $\hat{\xi} = \left(\hat{\xi}_1{}', \hat{\xi}_2{}', ..., \hat{\xi}_T{}'\right)'$. The same vector would be obtained as the outcome of the maximisation of the objective function

[13]

with respect to ξ where

and denotes the likelihood contribution of individual i in period t. Conceiving eq. [13] as a quasi log-likelihood function, we can utilise White's (1982) results to estimate the asymptotic covariance matrix $\hat{\Omega}$ of the first step reduced form parameter estimates by computing

$$\hat{\Omega} = N \cdot \left(\sum_{i=1}^{N} \frac{\partial^2 \ln L_i(\hat{\xi})}{\partial \xi \partial \xi'} \right)^{-1} \cdot \sum_{i=1}^{N} \left(\frac{\partial \ln L_i(\hat{\xi})}{\partial \xi} \cdot \frac{\partial \ln L_i(\hat{\xi})}{\partial \xi'} \right)^{-1} \cdot \left(\sum_{i=1}^{N} \frac{\partial^2 \ln L_i(\hat{\xi})}{\partial \xi \partial \xi'} \right)^{-1} . \qquad [14]$$

Minimising the objective function

$$D(\theta) = \left[\hat{\xi} - f(\theta)\right]' \hat{\Omega}^{-1} \left[\hat{\xi} - f(\theta)\right] \qquad [15]$$

with respect to θ yields the Minimum Distance Estimator (MDE) $\hat{\theta}_{MD}$ of the structural form parameters. The vector valued function $f(\theta)$ contains the functions that establish the relations between the vector of structural form parameters and the first step reduced form parameter vector . Formulating $f(\theta)$ appropriately, one can impose the restrictions of time-invariant structural form parameters, the identifying (exclusion) restrictions, and the parameter restrictions implied by the correlated random effects assumption [7].[7] Choosing the inverse of the first step covariance matrix as a weighting matrix ensures relative efficient parameter estimates. Asymptotic properties of the Minimum Distance estimator are discussed by Chamberlain (1984).

The two step method proposed here transfers Chamberlain's (1984) estimation procedure for the random effects probit to the class of random effects interdependent double hurdle models. We also propose a set of specification tests that are suitable for the class of models considered here, but for the sake of brevity, the details are defered to the appendix[8].

3. Empirical Analysis

3.1. Data

The Panel Study of Income Dynamics (PSID) and the German Socio Economic Panel (GSOEP) are utilized as sources for individual and household data. Detailed descriptions of the panel designs are provided by Hanefeld (1987) for the GSOEP, and Hill (1992) for the PSID. We link industry and regional demand side indicators from various sources with the panel data. Industry level variables are retrieved from the OECD's International Sectoral Database (ISD). The ISD contains indicators with an identical depth of aggregation (31 industries) for both the USA and the FRG. The latest version of the ISD that we could access contains information until the year 1987. Since the earliest GSOEP wave is available for the year 1984, we use data from 1984-1987 in order to provide an overlapping database for both countries. Industry unemployment rates – which are not available in the ISD - are used in a two digit classification (34 different industries) for Germany and a one digit classification (11 industries) for the US. They are retrieved from publications of the Bundesanstalt für Arbeit (1989) and the

7 The construction of $f(\theta)$ can be cumbersome in a situation of a highly interdependent model and a large number of explanatory variables assumed to be correlated with the random effects. Computer programms for a the two step estimation of simultaneous double hurdle models with random effects are available from the authors upon request. The code is written in the programming language GAUSS.

8 In Appendix A-1 a set of generalised score tests is proposed which is based on Lechner's (1993,1995) approach for specification testing of the random effects probit model. In appendix A-2 we adapt the goodness of fit tests developed by Heckman (1984), and Andrews (1988a , 1988b). The standard test of the restrictions imposed in the Minimum Distance estimation step is reviewed in appendix A-3.

US Department of Labour (1989). The PSID is already linked with labour demand indicators on regional level for each household's county of residence. If the county unemployment rate is missing in the PSID, we substitute it by the state unemployment rate, published in the Handbook of Labor Statistics (HLS) (US Department of Labor 1989). For Germany, we use regional unemployment rates supplied by the Federal Institute for Research in Urban and Regional Policy (BfLR). We use weekly hours in our empirical model since the GSOEP data precludes to compute a reliable indicator for yearly work hours. In order to compute the transformed hours variable, maximum leisure hours per week are set to 168. We select females who were continuously married to the same husband between 1984 and 1987, and older than 22 in 1984 and younger than 58 years in 1987, in order to avoid explicit modelling of educational, marriage and retirement decisions. Self employed and members of the GSOEP subsample B, a separate panel study for the five most important groups of foreign workers in Germany, are excluded. A detailed description of the sample selection process that produces the balanced panels of 1302 (USA) and 1044 (FRG) individuals is available on request. Table A1 and A2 in the appendix contain a detailed description and descriptive statistics for the variables used in the empirical analysis.

3.2 Empirical results

In order to assess the validity of the statistical assumptions and overidentifying restrictions, a several of specification test ideas is adapted and applied. In order to focus on the economic contents we refer the reader to the appendix for details. We test for non-normality, heteroskedasticity and non-linearity following Lechner's (1993, 1995) idea to construct the generalized score statistics for testing panel data models estimated using Chamberlain's (1984) two step procedure. Details of the generalized score test procedures that we adapt for the three equation model are provided in appendix A-1. Tables A3-A9 report the detailed test results. We also adapt a goodness of fit test of the type proposed by Heckman (1984), Andrews (1988a, 1988b). Appendix A-2 provides details of the test idea and table A12 reports the test results. Table A10 in the appendix contains the test results of the overidentifying restrictions in the second (Minimum Distance) estimation step. McKelvey-Zavoina Pseudo R^2 are reported in table A-11. Generally, the test results are quite favourable for both the US and the FRG model specification. The reader is referred to the tables of the appendix for a detailed assessment of the specifications.

We now turn to the economic interpretations of the estimation results that are reported in table 1 and 2. Although the empirical results would permit a broader scope for analyses, for example a comparison of the effects of family indicators on labour supply in both countries, we focus in the following on analysing the effects of the labour demand side indicators on wages and employment probabilities. Table A1 in the appendix provides the details of the construction of each indicator used in the analysis.

insert table 1 here

insert table 2 here

The estimation results reported in table 1 and 2 show that the industry unemployment rate is an important explanatory variable in both the FRG and the US wage equation. The negative sign of the coefficient supports the hypothesis, stated in section 2.2, that during a process of structural change, shrinking industries try to realise cost reduction with wage cuts and layoffs. The positive, significant coefficient of the variable "industry profit per employee" in the wage equation of the US model backs the efficiency wage/fair wage explanation for inter industry wage differentials. This hypothesis, however, is not supported for the FRG. The positive, significant impact of the variable "industry capital-gross product ratio" in the FRG model's wage equation, however, supports the hypothesis that positive wage differentials are paid in capital intensive industries. This result, which supports efficiency wage theoretical explanations of inter-industry wage differentials, cannot be established for the USA.

The effects that the industry labour demand indicators that are included in the employment equations of the USA and the FRG model exert on employment probabilities are to a large extend comparable, but also reveal some differences between the two countries. The negative coefficient of the variable "industry investment intensity" in the employment equation indicates labour substituting effects of an intensive capital growth. These effects are present also for the US, but they are, with the exception of 1986, only weakly significant. We simulate the change of the employment probability of a "marginal" individual"[9] in response to an exogenous increase of the

9 A „marginal individual" is assumed to have initially in order provide comparability between the two country models. The model implies that employment probabilties are given by . The simulations conducted in this section change and hence the employment probabilites. Figures 1-4 display the increase and decrease of the employment probabilities of the "marginal individual".

industry investment intensity in figure 1. Starting at sample means, the industry investment intensity is increased by up to 30 percent. Figure 1 depicts the resulting reduction of the employment probability as predicted by the US and FRG models.

insert figure 1 here

The estimation yields significant positive coefficients for the "industry product demand index" in the employment equations of both the USA and the FRG model. As outlined above this indicates a possible spill-over of demand side constraints in the industry commodity market to the labour market. For both countries, a decrease of the industry demand index implies reduced individual employment probabilities. We have argued above that this result can be interpreted as an indicator for "Keynesian" unemployment in both countries. In the FRG model's employment equation, the restriction of a time invariant coefficient for the variable "industry product demand index" could not be imposed. However, the sequence of the time varying slope parameters in the employment equation indicates that "Keynesian" unemployment has decreased during the estimation period in the FRG. This result is compatible with the results of macro-econometric disequilibrium models estimated for the FRG (Hansen 1990). Figure 2 depicts the results of a model simulation where we computed the change of the employment probability of the "marginal individual" in response to an exogenous decrease of the industry product demand index. Starting at sample means the industry product demand index is decreased by up to 20 %.

insert figure 2 here

The hypothesis that a wage growth beyond the growth of productivity reduces employment probabilities can be examined by analysing the coefficient of the variable "industry productivity gap" in the employment equations. The significant positive coefficient for 1987 – the assumption of time-invariant parameters is rejected in both models - supports this hypothesis. However, a distinct structural break concerning the direction of the effect of the productivity gap indicator in the employment equation is indicated in both the model for the USA and the FRG, because the first three (USA) or two years (FRG) the coefficient is significantly negative. We interpret these results as follows: During the years of economic recovery in both countries, expanding and profitable industries allowed a wage growth beyond productivity growth in order to attract workers from the hidden manpower reserve or other, decreasing industries. This implied a higher employment probability for workers in industries with small or even negative productivity gaps. Figure 3 depicts a simulation where we, starting from sample means of the indicator, study the employment probability changes of the "marginal individual" in response to a decrease of the industry productivity gap by up to three percentage points.

insert figure 3 here

Analysing the influence of regional labour market conditions on labour supply and wages, we obtain rather different results for the US and the FRG. A significant negative effect of the regional unemployment rate on wages is detectable in the US model only. However, we obtain a significantly negative, direct effect of the regional unemployment rate in the employment equation of the FRG-model, a result that is not found in the US-model. This result permits the interpretation that a lack of regional wage flexibility, in combination with a lack of regional worker mobility, might have produced demand side restrictions of the labour market participation decision in the FRG. Because of a sufficient regional wage flexibility and worker mobility, these restrictions have not been effective in the US.

4. Concluding remarks

The focus of this paper is to provide a qualitative and quantitative assessment of hypotheses that identify causes for demand side constraints of individual labour supply decisions for the FRG and the US. The study emphasises an aspect of labour supply modelling that is especially important in international comparisons, namely the identification of a structural labour supply model. We propose to base model identification on exclusion restrictions derived from efficiency wage theory and the theory of inter-industry wage differentials. The advantage of this procedure is that, given the necessary data is available, the identification of the US and the FRG labour supply model can rely on the same theoretical basis, which improves comparability of the estimation results. In order to provide the required data, we link household panel information for the US and the FRG - using the German Socio-Economic Panel and the Panel Study of Income Dynamics - with the OECD's International Sectoral Database. For the comparative empirical analysis, we apply an econometric labour supply model that is a member of a class of simultaneous random effects double hurdle models. The econometric contribution of the paper is the formulation and application of a convenient two step estimation procedure for this model class.

The main results of the comparative empirical analysis for the FRG and the USA are as follows. We found rather labour substituting than job creating effects of an intense industry investment in both countries. These labour substituting effects had been significantly weaker in the US. The test of the familiar hypothesis that a wage growth beyond productivity growth ("productivity gap") exerts a negative effect on individual employment probabilities yielded an ambiguous result: We detected a clear structural break concerning the direction of the effect of productivity gaps on the employment probability in both countries. During the period of an economic recovery in both countries, expanding and profitable industries seemed to have allowed a wage growth beyond productivity growth in order to attract workers from the hidden manpower reserve and decreasing industries, causing an higher employment probability for workers in industries with a relatively small or even negative industry productivity gap. Beyond these period, however, we find support for the productivity gap-hypothesis in both countries. The presence of "Keynesian" unemployment, i.e. labour supply constraints caused by a spill-over of demand side restrictions in commodity markets, is indicated in both the USA and the FRG. Analysing the effect of the regional labour market situation on labour supply and wages, we find significant differences between the USA and the FRG. The empirical analysis indicates that a lack of regional wage flexibility, in combination with a low worker mobility, might have produced binding constraints of labour supply in the FRG. A significant regional wage flexibility that is combined with higher worker mobility might have prevented this constraints in the USA.

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Appendix

Appendix A-1: Specification Testing I: Generalized Score tests

Because the estimation is carried out in two consecutive steps, we conduct specification tests for each estimation step. Since we obtain the first step estimates by independent maximum likelihood estimation, specification testing for each cross section estimation using score-, Wald- and likelihood-ratio statistics would be possible. However, Lechner (1992, 1993) pointed out that this would involve two major problems: Firstly, the decision, whether the null-hypothesis should be maintained or rejected may be not clear. We would obtain a set of T test statistics and each of them may support or reject the null-hypothesis. Hence, an overall significance level of the tests can not be given. Secondly, since the first step parameter estimates $\hat{\xi}_t$ are correlated, the test statistics, which are functions of the estimated parameters, are correlated, too. A separate test of the cross section estimates would not take into account this intertemporal correlation, leading to a wrong size of the tests.

However, since the first estimation step can be conceived as a Quasi-Maximum-Likelihood estimation, we can use the generalised score test statistic derived by White (1982). Lechner (1993,1995) used this test statistic to conduct specification tests for a panel Probit model estimated with Chamberlain's (1984) two step estimation procedure. The generalised score statistic can be used if the null hypothesis can be expressed in a set of restrictions on the parameter vector , In our case consists of the reduced form parameters, , and a set of parameters restricted to be zero in the first estimation step. s(·) is a vector valued function from with r as the number of elements in and q the number of rows of , i.e. the number of non-redundant restrictions. denotes the parameter vector that solves the problem

(A-1)

Having obtained , one can compute the generalised score statistic

(A-2)

which is asymptotically distributed as . In order to test for heteroskedasticity, assume that the variance of the *g*'th reduced form equation of period is

(A-3)

(Lechner 1992). is a set of indicators and the corresponding parameter vector. Under the null hypothesis of homoskedasticity, is zero. Hence we write the null hypothesis as Since the unrestricted maximisation of the likelihood would be rather costly, we compute the generalized score statistic with . In order to detect misspecification in our model, we employ RESET type tests and include polynomials of higher order of the mean function of the *g*´ th equation:

(A-4)

in the estimation. RESET tests should be sensitive to various forms of misspecification that are associated with non-linearities of the mean. The RESET test is carried out separately for each equation g. Under the null, the vector is zero, i.e. . Since performing the unrestricted maximisation would be too costly, we compute the generalised score statistic with . In our empirical analysis, we allow for powers of the mean function up to order four when performing the RESET tests (RESET2, RESET3, RESET4, RESET23, RESET234)

Newey (1985) pointed out that a RESET-test of the second and third coefficient of the mean function (RESET23) can be conceived as a test of normality against the Pearson-family of distributions. The null-hypothesis of normality of the errors in the *g*'th equation can therefore be written as , and tested by computing the generalised score statistic using . Test results are reported in tables A3-A9.

insert table A3-A9 here

Appendix A-2: Specification testing II: Heckman-Andrews tests

Our diagnostic framework also includes an application of the goodness of fit tests suggested by Heckman and Andrews (Heckman 1984, Andrews 1988a,1988b). The basic test idea is to separate the combinations of the dependent variable and the explanatory variables in distinct cells. The empirically observed distribution of the sample in the cells is then compared to the distribution implied by the parametric econometric model. The null hypothesis is formulated that the distribution of the endogeneous variable given the exogenous variables is determined by the parametric conditional density function implied by the econometric model with as a parameter vector:

In order to derive the test statistic, the sample space is divided into J distinct cells. The resulting array is denoted Γ. By defining a indicator vector which elements equal one, if individual i´ s observation falls in thej´ th cell and zero else we can write the empirical percentages for each cell in a vector:

. (A-5)

The equivalent to (3.14) implied by the parametric model can be written as the vector of sample average of the conditional expectations

. (A-6)

The vector contains for each of the J cells the conditional probability that individual i´ s observation falls in thej´ th cell. Andrews (1988a) shows that for an asymptotic normally distributed estimator

(A-7)

is under the null asymptotically normal with variance covariance matrix . Using as a consistent estimate of ,

(A-8)

is under the null asymptotically with degrees of freedom equal to the rank of . Andrews (1988a) proposes alternative consistent estimators for . One is given by

(A-9)

is the information matrix of the parametric model, and is the outer product of the individual gradients of the likelihood, each evaluated at .

In our empirical application we divide the observations of each panel wave into two cells, participants and non participants, and conduct Heckman-Andrews tests using the first step parameter estimates for each panel wave. The test results are reported in table A12

insert table A12 here

Appendix A-3: Secification Test for the Minimum Distance Estimation Step

So far, we only considered tests for the first step. In the second (MD) estimation step we are able to test the model specification of a more restrictive model with parameter vector against a less restrictive one with a parameter vector , where = g( ). The number of elements of is s_1, and the number of elements of is s_2, with s_2 <

s_1. Under the null-hypothesis that the additional restrictions are correct, the difference is asymptotically distributed with degrees of freedom equal to (s_1 - s_2) (Chamberlain 1982). Table A-12 reports the results for the MD estimation step for US and the FRG model.

insert table A12 here

Appendix A-5: Variable Construction and Descriptives

insert table A1 here

insert table A2 here

insert table A11 here

Tables and Figures

Table 1: Double-Hurdle Model with Correlated Random Effects (USA)

		Structural Form Parameter Estimates					
Explanatory Variables		Latent Hours Equation		Market Wage Equation		Employment Equation	
ln Wage		0.06245	(0.01408)			2.13606	(0.46740)
year effect	1984	0.26087	(0.02210)	0.32429	(0.13143)	–3.94003	(0.59138)
	1985	0.25679	(0.02193)	0.36032	(0.13150)	–3.43959	(0.56888)
	1986	0.25150	(0.02167)	0.38160	(0.13115)	–3.77199	(0.57610)
	1987	0.25171	(0.02158)	0.38099	(0.13185)	–3.75671	(0.57372)
industry investment intensity	1984					–3.91964	(2.52063)
	1985					–8.30117	(2.46859)
	1986					–2.54171	(2.16537)
	1987					–1.57093	(1.89587)
industry productivity gap	1984					9.03111	(3.13029)
	1985					–7.65377	(1.72455)
	1986					–1.68490	(0.87969)
	1987					–2.49392	(0.86055)
industry product demand index						2.21299	(0.45193)
regional unemployment rate				–1.22662	(0.32116)	0.60497	(1.29565)
industry unemployment rate				–3.95096	(0.72918)		
industry capital-gross product ratio				–0.00850	(0.00820)		
industry profit per employee				0.64472	(0.10829)		
number of children 0-6 years		–0.01907	(0.00300)			–0.50338	(0.03653)
number of children 7-10 years		–0.01021	(0.00287)			–0.15476	(0.04288)
number of children 11-15 years		–0.00778	(0.00251)			0.09133	(0.04523)
husband out of labour force		0.00218	(0.00795)			–0.61578	(0.15071)
husband work hours		0.00864	(0.01468)			–0.50628	(0.22683)
husband unemployed		0.00591	(0.00749)			–0.35430	(0.12583)
age		–0.00966	(0.00252)			–0.17034	(0.05362)
years of schooling		–0.04589	(0.02226)	1.26815	(0.08227)	–0.77016	(0.62308)
experience				0.22575	(0.04003)		
squared experience				–0.04322	(0.01011)		
other income		–0.04651	(0.01465)			–0.88729	(0.23807)

Notes:

Standard deviations in parantheses

The variable other income is allowed to be correlated with the individual random effects

Table 2: Double-Hurdle Model with Correlated Random Effects (FRG)

Explanatory Variables		Latent Hours Equation		Market Wage Equation		Employment Equation	
		Structural Form Parameter Estimates					
ln wage							
year effect	1984	0.18866	(0.05447)	1.98825	(0.11007)	–1.03897	(0.61406)
	1985	0.18810	(0.05247)	1.92609	(0.10890)	–1.68796	(0.62786)
	1986	0.19621	(0.05112)	1.89065	(0.10793)	–1.30344	(0.64234)
	1987	0.18985	(0.05139)	1.90751	(0.10664)	–3.11790	(0.66946)
industry investment intensity						–12.7748	(1.96161)
productivity gap	1984					2.61855	(0.90193)
	1985					0.71634	(0.90439)
	1986					–4.16392	(1.24788)
	1987					–9.40244	(2.59530)
industry gross product	1984					0.77206	(0.27019)
	1985					1.42105	(0.31758)
	1986					1.11915	(0.40635)
	1987					2.90557	(0.47528)
regional unemployment rate				0.62212	(0.34843)	–5.00156	(0.89824)
industry unemployment rate				–3.55240	(0.41535)		
industry capital-gross product ratio				0.01573	(0.00390)		
industry profit per employee				–0.09515	(0.08770)		
number of children 0-6 years		–0.07342	(0.00686)			–0.71312	(0.05983)
number of children 7-10 years		–0.04309	(0.00634)			–0.41198	(0.05646)
number of children 11-15 years		–0.04376	(0.00525)			–0.26748	(0.05083)
husband out of labour force		0.02045	(0.01571)			0.16239	(0.17095)
husband work hours		0.03292	(0.02550)			0.57606	(0.26165)
husband unemployed		–0.02505	(0.01874)			–0.02608	(0.17725)
age		–0.03082	(0.00396)			–0.23489	(0.04383)
years of schooling		0.00585	(0.01995)	0.55278	(0.05384)	0.18564	(0.22042)
experience				0.22558	(0.04288)		
squared experience				–0.04241	(0.00924)		
other income		–0.07629	(0.02468)			–1.32470	(0.24616)

Notes:

Standard deviations in parantheses

The variable other income is allowed to be correlated with the individual random effects

Table A1. Variable Description

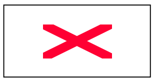
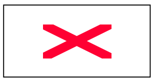
Variable Name Used in Text	Detailed Description for US Data (Data Source in Brackets)	Detailed Description for FRG Data (Data Source in Brackets)
hours	Average weekly hours on main job. (PSID)	Average weekly hours on main job. (GSOEP)
transformed hours	ln  (PSID)	ln  (GSOEP)
wage	Average hourly gross wage. Deflated by consumer price index of current year. (PSID)	Average hourly gross wage. Deflated by consumer price index of current year. (GSOEP)
years of schooling	Years of schooling , academic training and vocational training/apprenticeship programs divided by 10. (PSID)	Years of schooling, academic training and vocational training divided by 10. (GSOEP)
age	Age in years divided by 10. (PSID)	Age in years divided by 10. (GSOEP)
experience	Potential labor force experience divided by 10: (age-years of schooling–0.6).	Potential labor force experience divided by 10: (age-years of schooling–0.6).
squared experience	experience squared.	experience squared.
other income	Other income per month: Family income minus taxes and individual’s earned income in 10000 $. Deflated by consumer price index of corresponding year. (PSID)	Other income per month: Household net income minus individual’s salary on main job in 10000 DM. Deflated by consumer price index of corresponding year. (GSOEP)
number of children 0-6 years	Number of children in family unit up to age 6. (PSID)	Children in family unit up to age 6. (GSOEP)
number of children 7-10 years	Number of children in family unit age 7 to 10. (PSID)	Children in family unit age 7 to 10. (GSOEP)
number of children 11-15 years	Children in family unit age 11 to 15. (PSID)	Children in family unit age 11 to 15. (GSOEP)
husband work hours	Spouse’s average weekly hours on main job divided by 100. (PSID)	Spouse’s average weekly hours on main job divided by 100. (GSOEP)
husband out of labour force	Dummy: 1 = Spouse out of labor force. (PSID)	Dummy: 1 = Spouse out of labor force. (GSOEP)
husband unemployed	Dummy: 1 = Spouse looking for a job. (PSID)	Dummy: 1 = Spouse looking for a job. (GSOEP)
regional unemployment rate	Unemployment rate in the household’s county of residence. (ISR/HLS)	Unemployment rate in the household’s region of residence. (BfLR)
industry unemployment rate	Unemployment rate in individual’s industry. (HLS)	Unemployment rate in individual’s industry. (FBL)

Table A1. Variable Description (Continued)

Variable Name Used in Text	Detailed Description for US Data (Data Source in Brackets)	Detailed Description for FRG Data (Data Source in Brackets)
industry investment intensity	Intensity of gross investment in individual's industry. Computed as gross investment to capital stock in year. (OECD/ISD)	Intensity of gross investment in individual's industry. Computed as gross investment to capital stock. (OECD/ISD)
industry productivity gap	Productivity gap in individual's industry: Difference of productivity growth and growth of total payroll per employee in individual's industry. (OECD/ISD)	Productivity gap in individual's industry: Difference of productivity growth and growth of total payroll per employee in individual's industry. (OECD/ISD)
industry gross product	Index of gross product of individual's industry (base 1980) divided by 100. (OECD/ISD)	Index of gross product of individual's industry (basis 1980) divided by 100. (OECD/ISD)
capital/gross product ratio	Capital–output ratio in individual's industry: Capital stock to gross domestic product per industry. (OECD/ISD)	Capital–output ratio in individual's industry: Capital stock to gross domestic product per industry. (OECD/ISD)
industry profit per employee	Operating surplus in $ per employee in individual's industry divided by 100000. (OECD/ISD)	Operating surplus in DM per employee in individual's industry divided by 100000. (OECD/ISD)

Table A2. Descriptives of Variables

Variable		USA Mean	USA Std. Dev.	FRG Mean	FRG Std.Dev.
work hours	1984	36.889	9.109	30.884	12.355
	1985	36.724	9.086	30.754	11.160
	1986	37.332	8.415	31.246	11.187
	1987	37.506	8.915	30.622	10.491
wage	1984	8.013	4.170	13.950	5.728
	1985	8.399	4.300	14.051	5.092
	1986	8.742	5.269	14.461	5.309
	1987	8.892	4.743	15.304	5.095
years of schooling		1.261	0.160	1.038	0.228
age	1984	3.462	0.863	3.878	0.892
	1985	3.562	0.863	3.978	0.892
	1986	3.662	0.863	4.078	0.892
	1987	3.762	0.863	4.178	0.892
other income	1984	0.215	0.132	0.270	0.110
	1985	0.220	0.141	0.275	0.114
	1986	0.226	0.145	0.294	0.125
	1987	0.234	0.152	0.308	0.134
number of children 0-6 years	1984	0.592	0.801	0.376	0.666
	1985	0.605	0.814	0.357	0.646
	1986	0.597	0.829	0.356	0.667
	1987	0.571	0.817	0.330	0.647
number of children 7-10 year	1984	0.306	0.564	0.193	0.432
	1985	0.316	0.569	0.207	0.446
	1986	0.320	0.573	0.213	0.472
	1987	0.332	0.577	0.219	0.468
number of children 11-15 years	1984	0.300	0.576	0.338	0.577
	1985	0.317	0.580	0.308	0.554
	1986	0.327	0.607	0.288	0.542
	1987	0.356	0.652	0.268	0.517
husband work hours	1984	0.423	0.150	0.408	0.126
	1985	0.421	0.153	0.398	0.145
	1986	0.422	0.156	0.396	0.145
	1987	0.418	0.160	0.394	0.145
husband out of labour force	1984	0.043	0.203	0.038	0.192
	1985	0.049	0.216	0.045	0.207
	1986	0.046	0.210	0.053	0.224
	1987	0.059	0.236	0.057	0.233
husband unemployed	1984	0.036	0.187	0.015	0.123
	1985	0.047	0.211	0.034	0.183
	1986	0.055	0.227	0.034	0.180
	1987	0.039	0.194	0.034	0.183

Table A2. Descriptives of Variables (Continued)

		USA		**FRG**	
Variable		Mean	Std. Dev.	Mean	Std.Dev.
regional unemployment rate	1984	0.071	0.032	0.104	0.030
	1985	0.066	0.024	0.106	0.034
	1986	0.065	0.026	0.104	0.036
	1987	0.054	0.021	0.103	0.035
industry unemployment rate	1984	0.069	0.015	0.081	0.028
	1985	0.065	0.016	0.079	0.028
	1986	0.063	0.015	0.075	0.028
	1987	0.056	0.014	0.075	0.027
industry investment intensity	1984	0.075	0.023	0.044	0.016
	1985	0.074	0.020	0.044	0.016
	1986	0.074	0.020	0.045	0.016
	1987	0.072	0.019	0.046	0.016
industry productivity gap	1984	0.012	0.045	0.006	0.010
	1985	0.046	0.038	-0.001	0.022
	1986	0.009	0.019	0.002	0.030
	1987	-0.005	0.011	-0.006	0.032
industry capital-gross product ratio	1984	2.240	1.479	4.100	2.522
	1985	2.069	1.336	4.090	2.518
	1986	2.008	1.278	4.057	2.503
	1987	1.988	1.240	4.077	2.520
industry gross product	1984	1.121	0.066	1.030	0.068
	1985	1.172	0.075	1.052	0.079
	1986	1.207	0.087	1.071	0.105
	1987	1.256	0.095	1.087	0.139
industry profit per employee	1984	0.085	0.083	0.260	0.141
	1985	0.094	0.086	0.266	0.135
	1986	0.099	0.086	0.277	0.127
	1987	0.102	0.088	0.277	0.127

Table A3. Non-Normality Tests

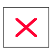
	USA		FRG	
Equation	χ^2	*d.f.*	χ^2	*d.f.*
	3.32	8	31.24	8
	8.04	8	3.51	8
	17.67	8	4.16	8

Table A4. Heteroskedasticity Tests Latent Hours Equation

	USA		FRG	
Variable	χ^2	*d.f.*	χ^2	*d.f.*
number of children 0-6 years	8.40	4	17.58	4
number of children 7-10 years	2.18	4	13.44	4
number of children 11-15 years	1.20	4	8.40	4
age	5.97	4	7.84	4
years of schooling	6.48	4	1.03	4
other income	30.05	16	31.52	16
husband out of labour force	2.00	4	7.11	4
husband work hours	8.37	4	6.52	4
husband unemployed	5.34	4	2.11	4
squared experience	5.60	4	6.00	4
regional unemployment rate	8.18	4	3.66	4
industry unemployment rate	8.53	4	16.93	4
industry capital-gross product ratio	14.72	4	13.47	4
industry profit per employee	27.01	4	4.90	4

Table A5. Heteroskedasticity Tests Wage Equation

	USA		FRG	
Variable	χ^2	*d.f.*	χ^2	*d.f.*
years of schooling	1.83	4	2.28	4
experience	10.65	4	3.74	4
squared experience	8.36	4	3.78	4
regional unemployment rate	18.38	4	2.00	4
industry unemployment rate	7.08	4	8.51	4
industry capital-gross product ratio	4.25	4	17.05	4
industry profit per employee	0.72	4	2.81	4

Table A6. Heteroskedasticity- Tests Employment Equation

	USA		FRG	
Variable	χ^2	*d.f.*	χ^2	*d.f.*
number of children 0-6 years	0.22	4	2.85	4
number of children 7-10 years	2.89	4	0.26	4
number of children 11-15 years	0.21	4	0.74	4
age	1.09	4	8.78	4
years of schooling	4.65	4	5.59	4
other income	26.99	16	18.85	16
husband out of labour force	1.19	4	1.23	4
husband work hours	7.10	4	8.76	4
husband unemployed	6.69	4	2.65	4
squared experience	2.81	4	8.20	4
industry investment intensity	3.30	4	4.46	4
industry productivity gap	8.74	4	5.75	4
industry gross product	6.30	4	8.37	4
regional unemployment rate	12.07	4	9.77	4
industry unemployment rate	53.20	4	5.87	4
industry capital-gross product ratio	7.87	4	4.23	4
industry profit per employee	2.92	4	1.77	4

Table A7. RESET-Tests Latent Hours Equation

	USA		FRG	
Variable	χ^2	*d.f.*	χ^2	*d.f.*
RESET 2	3.05	4	14.19	4
RESET 3	3.05	4	24.77	4
RESET 4	3.01	4	27.86	4
RESET 23	3.32	8	31.24	8
RESET 234	4.65	12	44.56	12

Notes:
RESET xyz stands for the *x*´ th *y*´ th and *z*´ th power of the mean function included in the specification test.

TableA8. RESET-Tests Wage Equation

	USA		FRG	
Variable	χ^2	*d.f.*	χ^2	*d.f.*
RESET 2	1.19	4	2.84	4
RESET 3	0.91	4	2.79	4
RESET 4	0.85	4	2.71	4
RESET 23	8.04	8	3.51	8
RESET 234	10.89	12	5.22	12

Notes:
RESET xyz stands for the *x*´ th *y*´ thand *z*´ thpower of the mean function included in the specification test.

Table A9. Misspecification-Tests Employment Equation

	USA		FRG	
Variable	χ^2	*d.f.*	χ^2	*d.f.*
RESET 2	17.27	4	1.32	4
RESET 3	4.60	4	2.98	4
RESET 4	6.22	4	3.08	4
RESET 23	17.67	8	4.16	8
RESET 234	27.59	12	5.27	12

Notes:
RESET xyz stands for the *x*´ th *y*´ thand *z*´ thpower of the mean function included in the specification test.

Table A10. Specification Tests MDE-Step

	USA		FRG	
Model Specification	χ^2	*d.f.*	χ^2	*d.f.*
M1: No time-invariability restrictions, reduced form, no imposing of CRE structure	0.00	0	0	0
M2: [M1 with overidentifying restrictions] – M1	39.52	28	25.28	28
M3: [M2 with CRE structure] – M2	33.01	22	26.08	22
M4: [M3 with all slope parameters time invariant]–M3)	138.69	87	205.52	87
M5: M4 – [M4 with time-varying parameters for sectoral demand side indicators in employment equation]	30.11	9	57.89	9
M6: [M5 with {FRG: time-invariant slope of industry investment intensity} {USA: time invariant slope of industry gross product}] – M5	7.80	3	1.12	3
M7: M6 – [M6 with time-varying parameters for regional unemployment rate]	4.87	3	7.46	3

Table A10. Specification Tests MDE-Step (Continued)

Model Specification	USA χ^2	USA *d.f.*	FRG χ^2	FRG *d.f.*
M8: M6 – [M6 with time-varying parameters industry unemployment rate, industry profit per employee, industry capital-gross product ratio and regional unemployment rate in wage equation	27.46	18	38.97	18
M9: M6 – [M6 with time-varying parameters for children variables in employment equation]	4.90	9	19.61	9
M10: M6 – [M6 with time-varying parameters for husband´ s variables in employment equation]	14.05	9	13.10	9
M11: M6 – [M6 with time-varying parameters for husband´ s variables in latent hours equation]	13.90	9	13.82	9
M12: M6 – [M6 with time-varying parameters for children variables in latent hours equation]	13.93	9	28.54	9
M13: M6 – [M6 with time-varying parameters for age and years of schooling in latent hours equation]	9.70	6	14.43	6
M14: M6 – [M6 with time-varying parameters for age and years of schooling in employment equation]	9.72	6	8.41	6
M15: M6 – [M6 with time-varying parameters for experience and years of schooling in wage equation]	9.75	6	11.32	6

Table A11. Mc Kelvey–Zavoina´ s R^2 (in %)

Equation	USA	FRG
	33.45	32.17
	15.17	32.90
	23.49	23.68

Table A12. Heckman-Andrews Specification Tests

Panel Year	USA χ^2	USA *d.f.*	FRG χ^2	FRG *d.f.*
1984	0.435	1	0.163	1
1985	0.677	1	0.079	1
1986	0.605	1	0.012	1
1987	0.237	1	0.155	1

Notes:
Cell definition: Two cells with participants and non participants

Figure 1: Effect of an increase of the industry investment intensity on employment probabilities

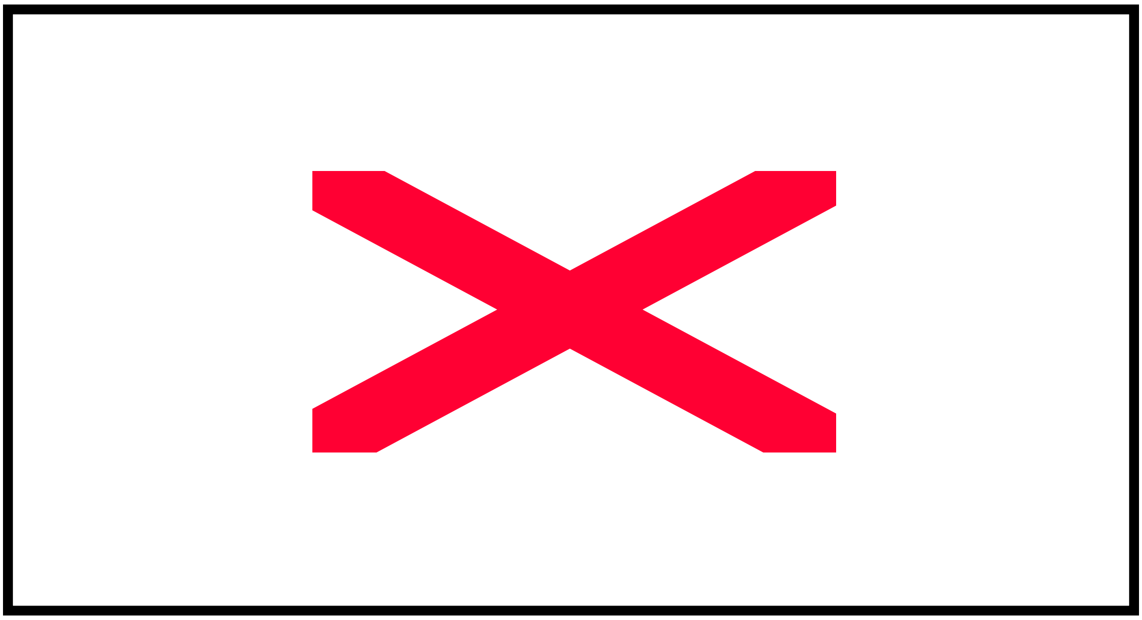


Figure 2: Effect of a decrease of the industry product demand index on employment probabilities

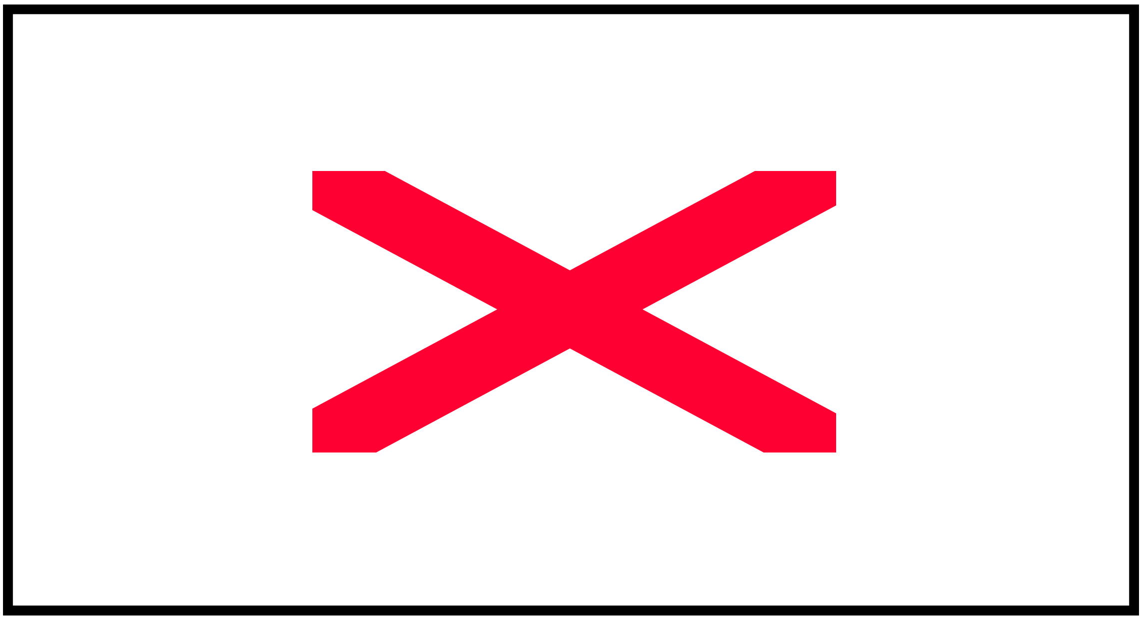


Figure 3: Effect of a decrease of the productivity gap on employment probabilities