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This Discussion Paper is the revised version of a paper presented at the 1. Workshop of the HWWA - Institute for Economic Research - Hamburg and the University of the Federal Armed Forces Hamburg together with Andreas Jahn. I am indebted to Martin Falk, Christian Schmidt, Martin Wolburg, the participants of this Workshop and especially to Andreas Jahn.

Contents

I. Introduction

Politicians and trade unions raise the issue of illegal employment in order to provoke support, voters feel negatively touched by the presence of illegal employment, often also associated with illegal immigration. In addition there was a severe discussion in Germany about passing a minimum wage in the German construction sector in order to keep foreign firms from wage-dumping on German construction sites. There exists a general impression that illegal alien employment poses a major threat for the national social security system and that more illegal aliens can not be tolerated. Schoorl et al. (1996) estimate 277.000 unregistered illegal aliens in Germany. Similar arguments are raised concerning the problem of illegal employment in general in the presence of mass unemployment.

This paper deals with the question of whose interests are effected in which way by illegal employment. Hence, the focus is not on absolute numbers but on the reasons of illegal employment. The West-German construction sector serves as our example. Two different settings of labour market designs are analysed. One is the implicit contract model and the other a traditional model of trade union bargaining. Each approach delivers incentives to demand, supply or tolerate illegal employment for the participating agents. Whereas in the implicit contract framework, illegal employment serves as a buffer to smooth legal employment over different states of the economy, the trade union model leads way to employment of illegally employed workers in order to maximise the utility of organised workers. So the question can be reformulated: is illegal employment a permanent phenomenon caused by the institutional setting of a unionised labour market or is it a transitory phenomenon caused by different states of nature in a long-term contractual arrangement?

The two following sections develop a standard implicit contract and trade union model. The next section transforms these theoretical settings into an empirically testable design. The econometric procedure applied is presented and a data description added. Some results of first estimations are delivered.

The empirical section of this paper contains an application of Martinellos (1988) analysis using panel data. Empirical research on implicit contracts is scarce, a different approach by Ashenfelter and Brown (1986) uses a data set not available for the West-German construction sector.

II. The implicit contract model

According to the basic implicit contract model as presented in Rosen (1985)[1] the expected utility of workers depends on the payment to working employees C_1, the payment to laid-off employees C_2, a worker's employment probability ρ and the units m of a non-market good produced by laid-off workers.

There are two periods. In the first one, the contracting period, the state of nature is unknown to both agents, the employers and the workers. In the first period workers and employers fix a contract [C1(θ), C2(θ), $\rho(\theta)$], which maximises workers' utility subject to the firm's utility constraint for each possible state of nature in the following production period (with θ as state of nature). The distribution function of θ, G(θ), and its mean $E(\theta) = \mu$ are known in the contract period to both agents.

C1, C2 and ρ are functions of the state of nature (θ) in the second, the production period. In this period, a state of nature is drawn and payments are made according to the contract agreed upon in the first period.

The firm's utility depending on profits π is given by

(1) $$v = v(\pi(\theta))$$

with utility constraint

(2) $$E(v) = \bar{v}\,.$$

The expected utility of the firm reads as:

(3) $$\begin{aligned} E(v) &= \int v(\pi(\theta))\; dG(\theta) \\ &= \int [v\big(\theta f(\rho(\theta)n\big) - n\rho(\theta)C_1(\theta) - n(1-\rho(\theta))C_2(\theta))]dG(\theta)\,. \end{aligned}$$

This equation contains $v(\theta f(\rho(\theta)n)$ as output and $n\rho(\theta)C_1(\theta) + n(1-\rho(\theta))C_2(\theta)$ as the firm's total costs of contract, containing the costs

1 For detailed surveys on implicit contract theory see for example Rosen (1985) and Hart (1983). For a more recent overview see Fabel (1990).

of employed and laid off workers respectively (with the number of contracted workers n) depending on the state of nature.

The utility of workers consists of U(C1(θ)) if employed and U(C2(θ)+m) if laid off with m as the benefit of leisure, each weighted with its probability and taken the integral gives the expected utility $E(U)$ with

(4) $$E(U) = \int\left[U(C_1(\theta))\rho(\theta) + U(C_2(\theta) + m)(1 - \rho(\theta))\right]dG(\theta)\ .$$

The following maximisation problem is then solved:

$$\max_{C_1, C_2, \rho} \ E(U)$$
$$s.t.\ \ E(v) = \bar{v}$$

The utility constraint from equation (2) takes the role of a participation constraint on the side of the employers. If employers get less then $\bar{v}$ they do not agree to such a contract and shut down. Maximisation of workers expected utility drives the employer's utility down to the participation constraint, thus simplifying the more general term $E(v) \geq \bar{v}$ to equality.

Taking the Lagrangian and differentiating[2] yields the usual first order conditions for the basic implicit contract model:

(5.a) $$U'(C_1) = -\lambda n v'(\pi(\theta))$$

(5.b) $$U'(C_2 + m) = -\lambda n v'(\pi(\theta))$$

(5.c) $$\rho(1-\rho)\left[U(C_1) - U(C_2 + m) - \lambda n v'(\pi)(\theta f'(\rho n)) - C_1 + C_2\right] = 0$$

for C_1, C_2 and ρ respectively.

2 Note that the maximisation problem gives an optimum for each possible value of θ (compare e.g. Rees 1987, p.7).

The first two conditions give the standard result for optimal risk sharing among risk averse agents. In this context the third equation will be used to determine a condition for the emergence of a submarket. The labour supply in this submarket can be explained in different ways. Although not fully observable, the obvious incidence of illegal labour in West-German construction can be explained as the case of a more favourable state of nature in the production period than projected by expected utility based optimisation in the contract period, regarding all possible states of nature.

By construction the fixed contract must be Pareto-optimal ex ante. But it can be Pareto-inferior to an ex ante Pareto-optimal contract plus the emergence of a submarket ex post if a more favourable state of nature appears in the production period. This implies that a submarket is then advantageous to all agents. If labour is supplied illegally in the submarket, there is an incentive to all market participants to supply, demand or tolerate illegal labour. This is especially relevant in the case of an unforeseeable boom.[3]

Possible values of ρ can be divided in two corner solutions and the intervall $0<\rho<1$. Inserting the first and second order conditions into the third and rearranging yields

(6) $$\rho(\theta)(1-\rho(\theta))\left[\theta f'(\rho(\theta)n)-m\right]=0$$

This gives three possible cases:

- for $0<\rho<1$ (depending on θ) the marginal condition $\theta f'(\rho n)=m$ holds and the marginal product of a labour unit equals social opportunity costs

- for very small values of θ the firm shuts down, because the marginal product of a labour unit is smaller than social opportunity costs

- for sufficiently large values of θ (i.e. more favourable states of nature) the firm employs all contracted workers n (i.e. $\rho=1$), but can gain from hiring additional workers because the marginal product of a labour unit exceeds the social opportunity cost. This is the case of an emerging submarket.

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3 Note that our implicit contract is not renegotiable in the production period. This is a crucial, but common assumption, that encourages the emergence of a submarket as described. We are also refering to the case of symmetric information. For the implications of an asymmetric information structure compare Hart (1983).

III. Trade Union Bargaining

In this section we consider the trade union framework. Consider a firm which produces a single good with two inputs, labour, U=L+I and capital, K, according to a neo-classical production function y=f(I+L,K). Labour can be employed legally, L, or illegally I. Within the production process both types are perfect substitutes. However, if some exogenous control discovers illegal employment within the firm, the employer has to pay a fine[4]. The risk of discovery depends positively on the ratio of illegal to legal employees suggesting that controls follow a random pattern.

Now consider the existence of illegal employment in the labour market. The government conducts controls and if the employer is found employing workers illegally he is fined some amount F. Hence the more people are employed legally, the less likely the employer is discovered.

The employer is rational and risk-neutral. He incorporates expected fines into his calculations. Then, his profit function becomes:

$$(7) \qquad \pi = pf\left(I+L,K\right) - w^L L - w^I I - rK - R\left(\frac{I}{L}\right)FI\ .$$

With *p* denoting the price for the output, y=f(I+L,K) equals production, *w* is the wage paid to legal, L, and illegal, I, workers, K is capital used, R the increasing risk of discovery is a function of the ratio of illegal workers (I) to legal workers (L) and F the amount to be paid for each illegal worker found.

Taking partial derivatives, setting them equal to zero and solving for legal wages yields:

$$(8) \qquad w^L = \frac{\partial f}{\partial U} + \frac{I}{L^2}FIR'\left(\frac{I}{L}\right).$$

With *R'* > 0 legally employed labour can gain in wages if workers are employed illegally. They earn the equivalent to their productivity plus a rent taken from illegally employed workers. In the case of trade union bargaining, employers adjust total demand

4 For a more detailed analysis compare Jahn and Straubhaar (1995).

for labour according to the wages set by the union and pay wages according to their profit maximisation scheme.[5] Thus (8) reflects wages paid to labour in the presence of illegal employment and a wage bargaining trade union.

Assume the trade-union has a simple utility function of the form:

$$(9) \qquad U_{TU} = Lw^{L} + (\overline{L} - L)A$$

The trade-union maximises the wage bill of those employed legally taking into account earnings out of industry, A (i.e. alternative earnings in that branches not covered by the analysed union). These earnings are reached by those who are not employed in the regarded industry. Then an increase in illegal employment leads to higher wages for those who remain employed, L, but at the same time reduces total legal employment, because legally and illegally employed workers are perfect substitutes.

This negative employment effect is tended off against the positive effect of higher wages. Thus, the trade-union faces a decision problem concerning the number of illegal workers it can tolerate. It can tolerate more illegal employment with earnings out of industry, A, relatively high because then a decrease in total employment, L, does not lead to a sharp decrease in trade-union utility. It is therefore that the trade-union considers some illegal employment as beneficial. Similar, profits of employers increase with more workers employed illegally (as long as fines to be payed do not overcompensate the lower wage bill). Thus, some illegal employment is tolerated by both sides of the bargaining process.

IV. Estimation

We present two hypotheses developed by Martinello (1988). Due to the panel structure of our data (compared to the time series analysis carried out by Martinello) several modifications have been carried out.

5 Compare Pencavel (1985) and Oswald (1985) for further details on the theory of trade union bargaining.

IV.1 Estimation Model

In order to identify one of the two cases proposed in section II and III, we use the following procedure: specify equations according to section III, i.e. the case of a standard trade union model. The case of implicit contracts can then be described by imposing restrictions on certain parameters of these equations. The properties of the estimations of both cases are then tested with a Likelihood ratio test to compare the restricted and the unrestricted estimation.

To obtain the estimation results a Maximum Likelihood procedure for simultaneous equations as available in LIMDEP 7.0 for example is used.

To specify a model we use a modified version of Martinellos (1988) analysis[6]. Since both employers and the trade union are assumed to be risk averse, their objective functions have to be concave (compare e.g. Laffont 1990, pp.70). First assume a normalised quadratic restricted profit function without bankruptcy constraint for the employers with q, r and m as prices of output, capital and machines respectively, and L as labour input:

$$\begin{aligned}(10)\qquad & v(q,r,m,L) = q[\alpha_0 + \alpha_1 \frac{r}{q} + \alpha_2 \frac{m}{q} + \frac{1}{2}\alpha_{11}\left(\frac{r}{q}\right)^2 + \frac{1}{2}\alpha_{22}\left(\frac{m}{q}\right)^2 + \alpha_{13}\frac{rm}{q^2} \\ & +\alpha_{04}L + \alpha_{14}\left(\frac{r}{q}\right)L + \alpha_{24}\left(\frac{m}{q}\right)L]\end{aligned}$$

Second assume the unions objective function as follows with B as benefits payed to labour and A as alternative earnings:

$$\begin{aligned}(11)\qquad & U(B,L,A) = \gamma_0 + \gamma_1 B + \gamma_2 L + \gamma_3 A + \frac{1}{2}\gamma_{11}B^2 + \frac{1}{2}\gamma_{22}L^2 + \frac{1}{2}\gamma_{33}A^2 \\ & +\gamma_{12}BL + \gamma_{13}BA + \gamma_{23}LA\end{aligned}$$

In both cases (trade union bargaining and implicit contracts) the following Lagrangian is maximised

6 Details of the derivation are added in Appendix I.

(12) $$U\left(B_t, L_t, A_t\right) + \lambda_t\left[v\left(q_t, r_t, m_t, L_t\right) - p_t B_t - \bar{v}_t\right] \to \max!$$

with $\bar{v}_t$ as firms' negotiated profit in period t as participation constraint. This yields two sets of first-order conditions for both cases. The solution for the trade union case depends explicitly on the actual realisations of the involved variables in each period.

(13.a) $$\frac{U'_{Bt}}{p_t} - \lambda_t = 0$$

(13.b) $$U'_{Lt} + \lambda_t v'_{Lt} = 0\,.$$

The Lagrange multiplier depends on the exogenous variables, which are unspecified in the bargaining process, and is kept linear for sake of simplicity:

(14) $$\lambda = \beta_0 + \beta_1 \frac{r}{q} + \beta_2 \frac{m}{q} + \beta_3 p + \beta_4 A\,.$$

According to this procedure we use the following two equations as the standard trade union model case

(15) $$B = -w_0 - w_1 L - w_2 A + w_3 p + w_4 \frac{rp}{q} + w_5 \frac{mp}{q} + w_6 p^2 + w_7 pA$$

(16) $$\begin{aligned} -L = {} & -z_0 + z_1 B + z_2 A + z_3 q + z_4 r + z_5 m + z_6 \frac{r^2}{q} + z_7 \frac{m^2}{q} + z_8 \frac{rm}{q} + \\ & z_9 qp + z_{10} rp + z_{11} mp + z_{12} qA + z_{13} rA + z_{14} mA \end{aligned}$$

In the case of implicit contracts the following restrictions are added:

w_i=0 for all i>3
z_j=0 for all j>5.

These conditions can be derived from the first-order conditions of the implicit contract case, in which workers are insured against fluctuations in q, r, m, p and A. Note, however, that the realisations of these variables are still important for the firm's situation and so remain partly in the derived restricted model. This implies that the Lagrange-multiplier is a constant, i.e. $\beta_i = 0 \forall i > 0$. The implicit contract case gives the conditions[7]

(17.a) $$\frac{U'_{Bt}}{p_t} - \lambda = 0$$

(17.b) $$U'_{Lt} + \lambda v'_{Lt} = 0 .$$

This yields with equations (10) and (11) the following implicit contract case:

(18) $$B = -a_0 - a_1 L - a_2 A + a_3 p$$

(19) $$-L = b_0 + b_1 B + b_2 A + b_3 q + b_4 r + b_5 m$$

Combining these two equations gives the reduced form

(20) $$B = c_0 + c_1 A + c_2 q + c_3 r + c_4 m + c_5 p$$

(21) $$L = d_0 + d_1 A + d_2 q + d_3 r + d_4 m + d_5 p .$$

This model implies several implicit restrictions on the signs of the estimated parameters for some variables in the implicit contract case, derived from the concavity of labour's and employer's objective function. Differentiating equations 17.a,b gives the following restrictions, which have to be fulfilled in the implicit contract case:[8]

$a_3<0$	$b_3 \leq 0$	$c_2 \leq 0$ as $a_1 \leq 0$	$d_2 \geq 0$
	$b_4 \leq 0$	$c_3 \leq 0$ as $a_1 \leq 0$	$d_3>0$
	$b_5 \leq 0$	$c_4 \leq 0$ as $a_1 \leq 0$	$d_4>0$
		$c_5<0$	$d_5 \leq 0$ as $b_1 \leq 0$.

In addition to these cases several partial insurance hypotheses can be tested. These are insurance against fluctuations in input prices, fluctuations of the consumer price index

7 Compare Appendix I for details.
8 Details are pointed out in Appendix III.

and fluctuations of alternative earnings. The following summary shows the parameter restrictions implied by each case:

Table 1: Imposed restrictions

Case I: trade union	no restrictions
Case II: total insurance	$w_i = 0 \forall i > 3 \qquad z_j = 0 \forall j > 5$
Case III: input price insurance (q,r,m)	$w_{4,5}=0$ $z_{6,7,8}=0$
Case IV: CPI fluctuations	$w_6=0$ $z_{9,10,11}=0$
Case V: alternative earnings fluctuations (A)	$w_7=0$ $z_{12,13,14}=0$
Case VI: reduced form	compare equations 20,21

IV.2 Description of the Data

In order to estimate the equations we use data published by the Federal Statistical Office (Statistisches Bundesamt) in the series no.4[9]. A measures earnings out of industry and is a weighted average from expected earnings out of the construction sector and expected unemployment benefits. As a measure of machine prices we construct m as a weighted average of machines used in various construction branches and their respective price indices. p is the consumer price index, q the price index of production output and r the market prices for capital. Most indices have been constructed due as in Brown and Ashenfelter (1986) and Martinello (1988).

L can be measured in various ways. We have chosen two different approaches. It measures the total number of workers employed and as another measure working hours. Similarly, B measures earnings per capita or per hour.

The data exhibit a panel structure with 15 periods (annual data 1979-1993) and 5 cross-section units (Hoch- und Tiefbau, Hochbau, Fertigteilbau, Tiefbau, Straßenbau according to the standard classification). A Chow-Test was carried out in order to justify pooling of the data.

9 In detail there are Fachserie 4, Reihe 5.1: Beschäftigung, Umsatz und Gerätebestand der Betriebe im Baugewerbe; Reihe 5.2: Beschäftigung, Umsatz und Investitionen der Unternehmen im Baugewerbe; Reihe 5.3: Kostenstruktur der Unternehmen im Baugewerbe.

IV.3 Estimation Results

The following tables summarise estimation and test results. Values in parantheses give the probability that parameters are not significant (concerning significance levels the 99%-level is marked by ***, the 95%-level by ** and the 90%-level by *).

Table 2.a shows the estimation results for wage equation (15) in the trade union case. As expected employment has a negative effect as on wages, alternative earnings a positive effect. Both coefficients are highly significant regardless of whether labour is measured in total number of workers employed (E) or alternatively in working hours (H). The CPI and the product of CPI and alternative wages lower wages when labour is measured in number of workers employed; on the other hand - when labour is measured per hours worked - a positive sign can be observed. Except for a highly significant positive constant, all remaining coefficients are zero.

Table 2.a: Trade union case, wage equation ((15), Case I)

Coefficient of variable	E	H
Constant	65.193*** (0.000)	23.265*** (0.000)
E, H	-0.455*** (0.000)	-1.466*** (0.000)
A	1.946*** (0.000)	0.684*** (0.000)
p	-0.718*** (0.000)	0.209*** (0.000)
rp/q	-0.112 (0.229)	0.037 (0.181)
mp/q	-0.002 (0.665)	0.001 (0.642)
p^2	0.001 (0.127)	-0.000 (0.189)
pA	-0.003*** (0.000)	0.001*** (0.000)

The following table 2.b gives the results for employment equation (16). It shows the expected negative effect of benefits paid to labour and a positive effect of alternative earnings on employment. Effects involving the price of capital are highly significant, but signs are ambiguous. The same is true for the coefficient of qA. Again the constant reveals a positive sign, all remaining coefficients being not significantly different from zero.

Table 2.b: Trade union case, employment equation ((16), Case I)

Coefficient of variable	E	H
Constant	65.193*** (0.000)	23.265*** (0.000)
B	-2.202*** (0.000)	-0.682*** (0.000)
A	1.946*** (0.000)	0.684*** (0.000)
q	0.299 (0.274)	-0.033 (0.189)
r	0.464*** (0.001)	-0.042*** (0.000)
m	0.000 (0.986)	-0.001 (0.955)
r^2/q	0.005 (0.932)	-0.001 (0.915)
m^2/q	0.001 (0.683)	-0.000 (0.693)
rm/q	-0.003 (0.793)	0.000 (0.758)
qp	0.001 (0.646)	-0.000 (0.837)
rp	-0.016*** (0.000)	0.002*** (0.000)
mp	-0.000 (0.794)	0.000 (0.763)
qA	-0.004*** (0.000)	0.000*** (0.000)
rA	0.020*** (0.000)	-0.002*** (0.000)
mA	0.000 (0.832)	-0.000 (0.834)

The wage equation for the standard case of implicit contracts with total insurance (18) gives no significant result for alternative earnings (see table 3.a). Labour and CPI always exercise a negative effect.

Table 3.a: Total insurance, wage equation ((18), Case II)

Coefficient of variable	E	H
Constant	82.583*** (0.000)	69.995*** (0.000)
E, H	-0.665*** (0.000)	-0.774*** (0.000)
A	-0.026 (0.511)	0.011 (0.755)
p	-0.069*** (0.000)	-0.039*** (0.000)

Benefits paid to labour and output prices have a negative, capital prices a positive significant effect on employment.

Table 3.b: Total insurance, employment equation ((19), Case II)

Coefficient of variable	E	H
Constant	82.583*** (0.000)	69.995*** (0.000)
B	-1.455*** (0.000)	-1.268*** (0.000)
A	-0.026 (0.511)	0.011 (0.755)
q	-0.097*** (0.000)	-0.043*** (0.000)
r	0.369*** (0.000)	0.181*** (0.000)
m	0.003* (0.057)	0.001 (0.642)

For case III, insurance against input price fluctuations, wages are negatively influenced by labour, CPI and CPI combined with alternative earnings and influenced positively by alternative earnings and the squared CPI with high significance.

Employment is significantly influenced by alternative earnings, capital prices and the combinations of CPI and output prices, by capital costs and alternative earnings. Employment is negatively influenced by benefits paid to labour, output prices and the combinations of capital costs and CPI and output prices and alternative earnings. Again it is completely immaterial by which units labour is measured.

Table 4.a: Input price insurance, Wage equation (Case III)

Coefficient of variable	E	H
Constant	49.266*** (0.000)	39.615*** (0.000)
E, H	-0.657*** (0.000)	-0.691*** (0.000)
A	1.462*** (0.000)	1.224*** (0.000)
p	-0.453*** (0.000)	-0.335*** (0.000)
p^2	0.001*** (0.000)	0.001*** (0.000)
pA	-0.001*** (0.000)	-0.001*** (0.000)

Table 4.b: Input price insurance, Employment equation (Case III)

Coefficient of variable	E	H
Constant	49.266*** (0.000)	39.615*** (0.000)
A	1.462*** (0.000)	1.224*** (0.000)
B	-1.522*** (0.000)	-1.447*** (0.000)
q	-0.047*** (0.000)	-0.033*** (0.000)
r	0.223*** (0.000)	0.154*** (0.000)
m	-0.000 (0.671)	-0.000 (0.645)
qp	0.001*** (0.000)	0.001*** (0.000)
rp	-0.005*** (0.000)	-0.004*** (0.000)
mp	0.000 (0.663)	0.000 (0.674)
qA	-0.001*** (0.000)	-0.001*** (0.000)
rA	0.007*** (0.000)	0.005*** (0.000)
mA	-0.000 (0.657)	-0.000 (0.679)

For insurance against CPI fluctuations (Case IV) wages are positively influenced by alternative earnings and the combinations of capital costs, CPI and output prices (if labour is measured in number of employees) and the combination of machine prices, CPI and output prices (if labour is measured in hours worked). Labour and the CPI (for labour in number of employees) exercise a negative effect.

Table 5.a: CPI insurance, wage equation (Case IV)

Coefficient of variable	E	H
Constant	-7.921 (0.607)	54.267*** (0.000)
E, H	-0.474*** (0.000)	-1.422*** (0.000)
A	1.903*** (0.000)	0.373* (0.073)
p	-1.142** (0.048)	0.538 (0.289)
rp/q	0.955** (0.017)	-0.456 (0.196)
mp/q	-0.055 (0.276)	0.197*** (0.000)
pA	0.004 (0.378)	-0.002 (0.624)

Significant parameters for benefits paid to labour, capital prices (for employment in number of employees), the combination of squared capital prices and output prices (for employment in hours), the combination of capital prices, machine prices and output prices (employment in hours worked) and the combination of capital costs and alternative earnings (employment in hours) show a negative and for alternative earnings, machine prices (employment in hours), the combination of squared capital prices and output prices (employment in employees), the combination of squared machine prices and output prices (employment in employees), the combination of capital prices and alternative earnings (employment in employees) and the combination of machine prices and alternative earnings (employment in hours) a positive impact on employment.

Table 5.b: CPI insurance, employment equation (Case IV)

Coefficient of variable	E	H
Constant	-7.921 (0.607)	54.267*** (0.000)
A	1.903*** (0.000)	0.373* (0.073)
B	-2.105*** (0.000)	-0.713*** (0.000)
q	-0.114 (0.893)	0.014 (0.954)

r	-1.557*** (0.003)	0.075 (0.630)
m	-0.210 (0.203)	0.195*** (0.000)
r^2/q	1.270*** (0.000)	-0.197*** (0.003)
m^2/q	0.040** (0.012)	-0.001 (0.789)
rm/q	0.038 (0.544)	-0.039** (0.024)
qA	-0.006 (0.384)	0.001 (0.640)
rA	0.033*** (0.000)	-0.003*** (0.005)
mA	0.001 (0.237)	0.001*** (0.000)

Insurance against fluctuations in alternative earnings gives a negative impact on wages by labour, alternative earnings, the combination of capital prices, CPI and output prices (employment in employees) and the squared CPI (employment in employees). Positive parameters are estimated for the combination of capital prices, CPI and output prices (employment in hours) and the squared CPI (employment in hours)

Table 6.a: Alternative earnings insurance, wage equation (Case V)

Coefficient of variable	E	H
Constant	130.35*** (0.000)	55.480*** (0.000)
E, H	-0.519*** (0.000)	-1.443*** (0.000)
A	-0.021*** (0.009)	-0.007* (0.053)
p	-0.016 (0.927)	-0.004 (0.951)
rp/q	-0.355*** (0.000)	0.132*** (0.000)
mp/q	-0.001 (0.845)	0.001 (0.710)
p^2	-0.003*** (0.003)	0.001*** (0.001)

Employment depends negatively on alternative earnings,benefits paid to labour, output prices (employment in hours), the combination of output prices and CPI (employment in employees) and the combination of capital prices and CPI (employment in employees).

A positive relation is estimated for output prices (employment in employees), capital prices (employment in employees), the combination of output prices and CPI (employment in hours) and the combination of capital prices and CPI (employment in hours).

Table 6b: Alternative earnings insurance, employment equation (Case V)

Coefficient of variable	E	H
Constant	130.35*** (0.000)	55.480*** (0.000)
A	-0.021*** (0.009)	-1.443*** (0.000)
B	-1.918*** (0.000)	-0.694*** (0.000)
q	1.126*** (0.000)	-0.181*** (0.000)
r	0.360** (0.029)	-0.029 (0.212)
m	0.006 (0.856)	-0.001 (0.820)
r^2/q	0.049 (0.527)	-0.017 (0.131)
m^2/q	-0.001 (0.665)	0.001 (0.664)
rm/q	-0.003 (0.871)	0.001 (0.790)
qp	-0.006*** (0.000)	0.001*** (0.000)
rp	-0.010*** (0.000)	0.001*** (0.000)
mp	-0.000 (0.841)	0.000 (0.774)

The wage equation for the reduced form gives positive parameters for output prices, and machine prices (when employment is measured in hours). Negative parameters are found for capital prices, CPI and machine prices (employment in employees).

Table 7.a: Reduced form, Wage equation ((20), Case VI)

Coefficient of variable	E	H
Constant	87.286*** (0.005)	80.723** (0.014)
A	0.100 (0.488)	0.167 (0.224)

q	0.774*** (0.000)	0.523*** (0.000)
r	-0.885*** (0.001)	-0.708*** (0.014)
m	-0.100*** (0.000)	0.049*** (0.000)
p	-0.350*** (0.005)	-0.331** (0.013)

The signs of the variables of the employment equation are identical to those of the wage equation.

Table 7.b: Reduced form, Employment equation ((21), Case VI)

Coefficient of variable	E	H
Constant	87.286*** (0.005)	80.723** (0.014)
A	0.100 (0.488)	0.167 (0.224)
q	0.774*** (0.000)	0.523*** (0.000)
r	-0.885*** (0.001)	-0.708** (0.014)
m	-0.100*** (0.000)	0.049*** (0.000)
p	-0.350*** (0.005)	-0.331** (0.013)

Table 8 displays the Log-Likelihood values and table 9 reveals the test results. Insurance is found for one single case, namely when insurance is provided against input price fluctuations and when employment is measured in hours.

Table 8: Log Likelihood values

	E	H
Case I	-160.1	5.128
Case II	-366.74	-260.94
Case III	-106.31	2.825
Case IV	-366.65	-259.45
Case V	-239.31	-71.951
Case VI	-530.7	-527.3

Table 9: Test results

	E	H
Case I vs. Case II	no insurance (413.3>22.4)	no insurance (532.1>22.4)
Case I vs. Case III	no insurance (107.6>11.1)	insurance (4.6<11.1)
Case I vs. Case IV	no insurance (413.1>9.5)	no insurance (529.2>9.5)
Case I vs. Case V	no insurance (158.4>9.5)	no insurance (154.2>9.5)
Case I vs. Case VI	no insurance (741.2>19.7)	no insurance (1044.3>19.7)

Finally the comparative static predictions are checked in table 10:

Table 10: Parameter predictions

comparative static prediction	E	H
sign w_1 = sgn z_1	yes	yes
sign a_1 = sgn b_1	yes	yes
$z_1 w_1 \leq 1$	yes	yes
$a_1 b_1 \leq 1$	yes	yes
$a_3<0$	yes	yes
$b_3<0$	yes	yes
$b_4<0$	no	no
$b_5<0$	no	no
$c_2<0$ as $a_1<0$	no	no
$c_3<0$ as $a_1<0$	yes	yes
$c_4<0$ as $a_1<0$	yes	no
$c_5<0$	yes	yes
$d_2 \geq 0$	yes	yes
$d_3>0$	no	no
$d_4>0$	no	yes
$d_5<0$ as $b_1<0$	yes	yes

V. Summary

This paper presents an implicit contract and a trade union bargaining approach. Incentive structures for illegal employment within these theoretical frameworks have been explicitly modelled, so that the interests of the participating agents can be identified. This can give hints for further research on the political economy of illegal employment as well as on potential policy measures concerning this problem in a unionised labour market.

In order to test the two approaches against each other and to identify the influences of certain parameters, an estimation and test procedure for time series has been transformed into a procedure for panel data. The use of panel data has great advantages in this setting if different industrial sectors are regarded. So instead of focusing on a single industry (like Martinello) or sector (as the preliminary version of this paper does) asimultaneous analysis of several industrial sectors should be added. This would enable us to identify sector specific incentives and incentives common to the whole economy. Such results would be useful in order to evaluate alternative policy measures.

The third part of this paper gives the results of some first estimations concerning West-German construction. Although illegal employment is not fully observable, it is obviously present in this sector. The presented results at this state of the paper remain rough and should be interpreted with caution. They show some encouraging estimates. One should be aware of the fact that even fully developed empirical results on this topic do not always give evidence for either one of the tested hypothesis.

Nevertheless this paper presents a theoretical framework and an empirical methodology that might be used for further research in the economics of illegal employment.

Appendix I

For the derivation of the estimation models we have first of all the objective functions for employers and labour respectively

$$\pi(q,r,m,L) = q[\alpha_0 + \alpha_1 \frac{r}{q} + \alpha_2 \frac{m}{q} + \frac{1}{2}\alpha_{11}\left(\frac{r}{q}\right)^2 + \frac{1}{2}\alpha_{22}\left(\frac{m}{q}\right)^2 +$$
$$\alpha_{12}\frac{rm}{q^2} + \alpha_{04}L + \alpha_{14}\left(\frac{r}{q}\right)L + \alpha_{24}\left(\frac{m}{q}\right)L]u$$

$$U(B,L,A) = \gamma_0 + \gamma_1 B + \gamma_2 L + \gamma_3 A + \frac{1}{2}\gamma_{11}B^2 + \frac{1}{2}\gamma_{22}L^2 + \frac{1}{2}\gamma_{33}A^2 + \gamma_{12}BL + \gamma_{13}BA + \gamma_{23}LA$$

Trade Union Bargaining

The trade union case has the following first-order conditions:

$$\frac{U_{Bt}}{p_t} - \lambda_t = 0$$

$$U_{Lt} + \lambda_t \pi_{Lt} = 0$$

The Lagrange multiplier is specified as a linear combination of those variables, that are left unspecified in the bargaining process:

$$\lambda = \beta_0 + \beta_1 \frac{r}{q} + \beta_2 \frac{m}{q} + \beta_3 p + \beta_4 A$$

Since

$$U_{Bt} = \gamma_1 + \gamma_{11}B + \gamma_{12}L + \gamma_{13}A$$

the first order condition gives

$$0 = \frac{\gamma_1}{p_t} + \frac{\gamma_{11}}{p_t}B + \frac{\gamma_{12}}{p_t}L + \frac{\gamma_{13}}{p_t}A - \beta_0 - \beta_1\frac{r}{q} - \beta_2\frac{m}{q} - \beta_3 p - \beta_4 A$$

Solving for B and renaming the parameters gives the first equation of the estimation model

$$B = -w_0 - w_1 L - w_2 A + w_3 p + w_4 \frac{rp}{q} + w_5 \frac{mp}{q} + w_6 p^2 + w_7 pA$$

The second equation of the estimation model can be derived from the second first-order condition. Since

$$U_{Lt} = \gamma_2 + \gamma_{22} L + \gamma_{12} B + \gamma_{23} A$$

$$\pi_L = \alpha_{04} q + \alpha_{14} r + +\alpha_{24} m$$

rearranging yields

$$-\gamma_{22} L = \gamma_2 + \gamma_{12} B + \gamma_{23} A + \alpha_{04}\beta_0 q + (\alpha_{04}\beta_1 + \alpha_{14}\beta_0) r + (\alpha_{04}\beta_3 + \alpha_{34}\beta_0) m$$
$$+\alpha_{14}\beta_1 \frac{r^2}{q} \alpha_{24}\beta_3 \frac{m^2}{q} + \alpha_{04}\beta_4 qp + \alpha_{14}\beta_4 pr + \alpha_{24}\beta_4 mp + \alpha_{04}\beta_5 qA + \alpha_{14}\beta_5 rA$$
$$+\alpha_{24}\beta_5 A$$

$$-L = -z_0 + z_1 B + z_2 A + z_3 q + z_4 r + z_5 m + z_6 \frac{r^2}{q} + z_7 \frac{m^2}{q} + z_8 \frac{rm}{q} + z_9 qp + z_{101} rp$$
$$+z_{11} mp + z_{12} qA + z_{13} rA + z_{14} mA$$

Implicit Contracts

In the implicit contract case workers are insured against fluctuations of the variables in the Lagrange-multiplier. Thus

$$\lambda = \beta_0 + \beta_1 \frac{r}{q} + \beta_2 \frac{m}{q} + \beta_3 p + \beta_4 A$$

reduces to the constant β_0 through $\beta_i = 0 \forall i = 1, \ldots, 4$. Inserting this into the equations for the trade union bargaining case yields the estimation equations for the implicit contract case

$$B = \frac{\beta_0}{\gamma_{11}} p - \frac{\gamma_1}{\gamma_{11}} - \gamma_{12} L - \gamma_{13} A$$

$$-\gamma_{22} L = \gamma_2 + \gamma_{12} B + \gamma_{23} A + \gamma_{04} \beta_0 q + \alpha_{14} \beta_0 r + \alpha_{24\,0} m$$

Giving the two equations

$$B = -a_0 - a_1 L - a_2 A + a_3 p$$

$$-L = b_0 + b_1 B + b_2 A + b_3 q + b_4 r + b_5 m$$

Appendix II:

The assumptions of the implicit contract model imply the following relations:

$$U_{BB} \le 0 \qquad U_{LL} \le 0 \qquad \Pi_{LL} \le 0 .$$

Let

$$D = U_{BB}U_{LL} - U_{BL}^2 + \lambda U_{BB}\Pi_{LL} \ge 0 .$$

The optimality conditions derived above are

$$f(\ ) = \frac{U_B}{p} - \lambda = 0$$

$$g(\ ) = U_L + \lambda \Pi_L = 0 .$$

The following sections differentiate them according to output prices p, input prices I, alternative earnings A, CPI p and analyse the real wage behaviour.

Output prices

$$\frac{\partial f(\ )}{\partial q} = U_{BB}\frac{\partial B}{\partial q} + U_{BL}\frac{\partial L}{\partial q} = 0$$

$$\frac{\partial g(\ )}{\partial q} = U_{LB}\frac{\partial B}{\partial q} + U_{LL}\frac{\partial L}{\partial q} + \lambda \Pi_{LL}\frac{\partial L}{\partial q} + \lambda \Pi_{Lq} = 0$$

Yielding

$$\frac{\partial L}{\partial q}=\frac{-\lambda U_{BB}\Pi_{Lq}}{D}\geq 0$$ as $\Pi_{Lq}\geq 0$ implying that labour is no inferior input.

$$\frac{\partial B}{\partial q}=\frac{\lambda U_{BL}\Pi_{Lq}}{D}<>0$$ as $U_{BL}<>0$.

Input prices (IP)

$$\frac{\partial f(\;)}{\partial IP}=U_{BB}\frac{\partial B}{\partial IP}+U_{BL}\frac{\partial L}{\partial IP}=0$$

$$\frac{\partial g(\;)}{\partial IP}=U_{LB}\frac{\partial B}{\partial IP}+U_{LL}\frac{\partial L}{\partial IP}+\lambda\Pi_{LL}\frac{\partial L}{\partial IP}+\lambda\Pi_{LI}=0$$

Yielding

$$\frac{\partial L}{\partial IP}=-\frac{\lambda\Pi_{LI}}{\frac{U_{BL}^2}{U_{BB}}+U_{BB}+\lambda\Pi_{LL}}<0$$ as $\Pi_{LI}<0$ i.e. inputs are substitutes for labour

$$\frac{\partial B}{\partial IP}=-\frac{\lambda\Pi_{LI}U_{BL}}{U_{BL}^2+U_{BB}^2+\lambda\Pi_{LL}}<>0$$ as $U_{BL}<>0$

Alternative earnings

$$\frac{\partial f(\ )}{\partial A} = U_{BB}\frac{\partial B}{\partial A} + U_{BL}\frac{\partial L}{\partial A} + U_{BA} = 0$$

$$\frac{\partial g(\ )}{\partial A} = U_{LB}\frac{\partial B}{\partial A} + U_{LL}\frac{\partial L}{\partial A} + U_{LA} + \lambda\Pi_{LL}\frac{\partial L}{\partial A} = 0$$

Yielding

$$\frac{\partial L}{\partial A} = -\frac{\left(U_{LA}U_{BB} - U_{BA}U_{LB}\right)}{D}$$

$$\frac{\partial B}{\partial A} = \frac{-U_{BA}\left(U_{LL} + \lambda\Pi_{LL}\right) + U_{LA}U_{BL}}{D}$$

No predictions can be made since the signs of U_{BA} and U_{LA} are not resticted.

CPI

$$\frac{\partial f(\ )}{\partial p} = U_{BB}\frac{\partial B}{\partial p} + U_{BL}\frac{\partial L}{\partial p} - \lambda = 0$$

$$\frac{\partial g(\ )}{\partial p} = U_{BL}\frac{\partial L}{\partial p} + U_{LB}\frac{\partial B}{\partial p} + \lambda\Pi_{LL}\frac{\partial L}{\partial p} = 0$$

Yielding

$$\frac{\partial L}{\partial p} = \frac{-\lambda U_{LB}}{D}$$

$$\frac{\partial B}{\partial p} = \frac{\lambda U_{LL} + \lambda^2 \Pi_{LL}}{D}$$

According to these results predictions on the signs of a number of estimated parameters can be made based on the implicit contract case predictions about concavity of the utility and the production function.

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