CAPITAL STRUCTURE AND LABOUR DEMAND: INVESTIGATIONS USING GERMAN MICRO DATA

Michael Funke, Wolf Maurer and Holger Strulik

I. INTRODUCTION

Recent empirical evidence by Wadhwani (1986, 1987), Nickell and Wadhawan (1988, 1991) and Nickell and Nicolitsas (1999) suggest that financial factors are important and significant determinants of employment in the UK. These results contrast with the ‘independence’ or ‘irrelevance’ assumption which is normally presupposed to be valid in applied labour economics. The theoretical basis for the proponents of the ‘independence’ hypothesis is the Modigliani-Miller (1958) hypothesis. The M–M theorem states that given certain conditions (i.e., perfect capital markets, no uncertainty, no different tax treatment of alternative sources of finance, no agency costs, no moral hazard), the market value of a firm is not influenced by a firm's financing mix. Since the market value of a firm is independent of its financial structure, capital structure is of no importance for production, employment and investment decisions. Since it is clear that the M–M theorem of irrelevance is restricted to perfect financial markets, the paper is concerned with the effects of capital structure upon labour demand, when firms face bankruptcy. The paper is organized as follows: Theoretical considerations are presented in Section II. Section III describes the method of estimation, and the data and the empirical results are surveyed in Section IV. The final section provides a brief summary.

II. THE MODEL

In order to incorporate financial considerations into a model of intertemporal labour demand we proceed in two steps. The first step reviews the

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1Following these considerations, consequences of financial structure and financial constraints upon investment decisions of firms have been extensively discussed in the empirical literature. See, for example, Bond and Meghir (1994), Chirinko (1987), Hayashi (1985), Fazzari et al. (1988), and Whited (1992). On the other hand, sceptics stress that financial indicators are endogenous variables that may serve as a proxy for other effects. One recent study [Kopcke and Howrey (1994)] argues that if one properly controls for fundamental variables, balance sheet effects are not important for factor demand decisions.

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solution of the firm’s optimal finance decision problem. The second step integrates the results obtained into the solution of the firm’s optimal factor demand problem.

We consider the value of equity maximization problem of a competitive firm. All variables are expressed in real terms to make the analysis easier. The time preference rate of the firm’s shareholder (or manager) equals the real interest rate of a riskless bond, $r$, which is assumed to be constant over time. Let $K_t$ and $D_t$ denote the firm’s capital stock and amount borrowed at time $t$. For simplicity the firm holds no other assets besides its own capital stock so that $D_t/K_t$ defines the debt asset ratio. In each period $t$ a probability $q_t$ of bankruptcy in period $t+1$ exists, which depends positively on the current debt asset ratio, $q_t = q(D_t/K_t)$. In case of bankruptcy ownership of the firm is transferred to the creditors who will also suffer a sunk cost $C_t$ that depends positively and linearly on the total amount borrowed ($C_{t+1} = cD_t$). Let $\Pi_t$ denote before tax revenue in period $t$ and $\tau > 0$ an exogenously given corporate tax rate. Lenders will then demand a firm specific interest rate which depends positively on the firm’s debt asset ratio, $i_t = i(D_t/K_t)$ and fulfills the arbitrage condition

$$(1 + r)D_t = (1 - q_t)(1 + i_t)D_t + q_tE_t[(1 - \tau)\Pi_{t+1}] - q_tC_{t+1},$$

where $E_t$ denotes the expectation operator and the left hand side gives the return on a riskless bond. Focussing on a two period analysis the firm’s value in period $t$ is $V_t = (1 - \tau)\Pi_t + D_t + \beta\{(1 - q_t)E_t[(1 - \tau)\Pi_{t+1}] - (1 - q_t)[(1 + (1 - \tau)i_t)D_t]\}$, where tax deductibility of interest payments is assumed and $\beta = 1/(1 + r)$ denotes the shareholders’ discount factor. Insertion of (1) leads to $V_t = (1 - \tau)\Pi_t + \beta E_t[(1 - \tau)\Pi_{t+1}] - \beta q_tC_{t+1} + \beta(1 - q_t)\tau i_t D_t$. Note that this expression shrinks to the standard present value of equity equation if bankruptcy is impossible and interest payments are not tax deductible. Whereas tax deductibility per se increases the present value and hence implies an incentive to raise debt, the probability of insolvency reduces this incentive. To find the intertemporal optimal solution we now let $t \to \infty$ and obtain the present value function

$$V_t = E_t \sum_{i=0}^{\infty} \beta^{t+i}[(1 - \tau)\Pi_{t+i}] - (1 + (1 - \tau)i_{t-1})D_{t-1}$$

$$- E_t \sum_{i=0}^{\infty} \beta^{t+i+1}[q_{t+i}C_{t+i+1}(D_{t+i}) - (1 - q_{t+i})\tau i_{t+i}D_{t+i}],$$

where the second term reflects interest payments on outstanding debt.

To complete the model we specify the revenue function $\Pi_t$. In each period the firm produces an output $Y_t$ using labour, $L_t$ and capital, $K_t$ as

$${}^2$$This part of the analysis is basically a simplified version of the financial side of Bond and Meghir’s (1994) model.

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variable factors of production. The technology \( Y_t = F(K_t, L_t) \) is characterized by positive and diminishing returns on factor inputs so that an interior solution of the maximization problem exists. One unit of labour earns the real wage \( w_t \). Turnover imposes a convex adjustment cost \( G(L_t - L_{t-1}) > 0 \) to the firm. Focussing on the labour demand decision we neglect adjustment costs for investment to keep the analysis simple. Investment depreciates with a constant rate \( \delta > 0 \). For convenience we assume that investment and adjustment costs are measured in terms of output prices \( p_t \). Thus we obtain the revenue function

\[
\Pi_t = p_t \{ F(L_t, K_t) - G(L_t - L_{t-1}) - (K_t - (1 - \delta)K_{t-1}) - w_t L_t \}.
\] (3)

Inserting (3) into (2) and maximizing the firms present value with respect to factor inputs and debt provides the first order conditions

\[
-\beta E_t \left[ \frac{\partial G(L_{t+1} - L_t)}{\partial (L_{t+1} - L_t)} \right] + \frac{\partial G(L_{t+1} - L_t)}{\partial (L_t - L_{t-1})} = \frac{\partial F(L_t, K_t)}{\partial L_t} - w_t,
\] (4)

\[
(1 - \tau) \left[ \frac{\partial F(L_t, K_t)}{\partial K_t} - 1 + \beta(1 - \delta) \right] + \beta \left( \frac{D}{K} \right)_t^2 \phi \left( \frac{D}{K} \right)_t = 0,
\] (5)

\[
q \left( \frac{D}{K} \right)_t c - \left( 1 - q \left( \frac{D}{K} \right)_t \right) \tau \left( \frac{D}{K} \right)_t = -\left( \frac{D}{K} \right)_t \phi \left( \frac{D}{K} \right)_t,
\] (6)

where

\[
\phi' = q' \left( \frac{D}{K} \right)_t \left[ c + \tau \left( \frac{D}{K} \right)_t \right] - \tau \left( 1 - q \left( \frac{D}{K} \right)_t \right) \tau_i \left( \frac{D}{K} \right)_t,
\] (7)

where \( \beta = (1 + r) \) denotes the real discount factor and the assumption of constant output prices has been imposed.\(^3\) After insertion of (6) condition (5) simplifies to

\[
(1 - \tau) \left[ \frac{\partial F(L_t, K_t)}{\partial K_t} - 1 + \beta(1 - \delta) \right] = \beta \left( \frac{D}{K} \right)_t [qc - (1 - q) \tau_i] \] (8)

If bankruptcy is impossible and interest payments are not tax deductible the right hand side of (8) equals zero and we obtain the standard optimality condition for factor demand. If the right hand side of (8) differs from zero spillovers from the financial side to labour demand occur due to the non-

\(^3\) Alternatively, we can obtain the same set of equations by introduction of a time dependent discount factor \( \phi_t = (\Pi_t(1 + r(t)))^{-1} \) and assuming \( p_{t+1}/(p_t(1 + r(t))) \) to be constant over time, c.f. Nickell (1986, pp. 500–501.)
separability of the production technology. Let us define a firm to be leveraged or financially distressed if the right hand side of (8) assumes a positive value. In this case the bankruptcy probability effect of holding debt, \( q_c \) dominates the tax deductibility effect \( (1 - q)\gamma \). From a cross sectional viewpoint capital productivity of the leveraged firm is higher as in an otherwise identical unleveraged firm. The leveraged firm has realized less investment projects, holds a lower stock of assets and employs less workers.

From the adjustment dynamics viewpoint consider, for example, a firm with several promising investment projects ahead. Compared to the steady-state outcome this firm holds a comparatively small stock of assets and employs comparatively few workers. Since capital productivity is high the firm selects a comparatively high debt asset ratio. Along the adjustment path employment increases and – since more and more project with high rates of return are accomplished – capital productivity decreases with the implication that the cost of holding debt increases comparatively. The firm therefore optimally decides to lower its debt asset ratio along the adjustment path. Hence, the model suggests a negative relationship between employment and leverage. To make this result more obvious, assume adjustment costs of the standard (cf. Nickell (1986)) quadratic type

\[
g(L_t - L_{t-1}) = b/2[L_t - L_{t-1}]^2, \tag{9}
\]

and a Cobb-Douglas-type production function

\[
F(K_t, L_t) = AK_t^{\gamma}L_t^{\gamma}, \quad A > 0, \quad 0 < \gamma < 1, \quad \gamma < \epsilon \leq 1, \tag{10}
\]

where \( \gamma \) is the constant production elasticity of labour and \( \epsilon \) reflects the degree of homogeneity in production. Insertion of (9) and (10) in (4) and linearizing around the equilibrium outcome \( \bar{L} \) provides

\[
\theta(L_t - \bar{L}) - b(L_t - L_{t-1}) + b\beta E_t(L_{t+1} - L_t) = w_t,
\]

where

\[
\theta = (\gamma - 1)\gamma AK_t^{\gamma}L_t^{\gamma-2} < 0. \tag{11}
\]

For the solution of (11) we introduce the forward shift operator \( \mathcal{F} \). Factorization then provides

\[
(\mathcal{F} - \lambda_1)(\mathcal{F} - \lambda_2)\mathcal{F}^{-1}E_t[L_t] = 1/(b\beta)[w_t + \theta \bar{L}], \tag{12}
\]

where \( \lambda_1 + \lambda_2 = [(1 + \beta)b - \theta]/(b\beta) \) and \( \lambda_1 \lambda_2 = 1/\beta \) which yields the solution \( \lambda_{1,2} = (b + b\beta - \theta \pm \sqrt{(\theta - b\beta - b)^2 - 4b^2\beta^2})/(2b\beta) \). Let \( \lambda_1 \) denote the smaller root. It is then straightforward to show that \( 0 < \lambda_1 < 1 \) and \( \lambda_2 > 1 \). Division of (12) by \( \mathcal{F} - \lambda_2 \) gives \( L_t - \lambda_1 L_{t-1} = -1/(b\beta \lambda_2)E_t(w_t + \theta \bar{L})/(1 - \lambda_2^{-1}\mathcal{F}) \). Since \( 1/\lambda_2 < 1, \) \((1 - 1/\lambda_2, \mathcal{F})\) can be represented by an infinite series \( \sum_{i=0}^{\infty}\lambda_2^{-i}\mathcal{F}^i \). Expansion and resubstitution of \( \theta \) from (11) provides the solution

\[
\theta = (\gamma - 1)\gamma AK_t^{\gamma}L_t^{\gamma-2} < 0.
\]
Labour demand depends positively on its own lagged value, negatively on the current and expected future wage rate and simultaneous with \(K_t\) and \(D_t\) on the model’s technology and financial parameters in a way that the optimality conditions (13), (5) and (6) are fulfilled. Given the nonlinear nature of the problem, an explicit solution can only be obtained numerically. However, from the empirical viewpoint we can assume that the firm has already solved its maximization problem by deriving an optimal path \(\{L_t, K_t, D_t\}\) and investigate correlations between variables and parameters on this path. Substituting (5) and \(\gamma AK^{\gamma-\gamma} L^{\gamma-1} = \epsilon Y/L - (\partial F/\partial K)K/L\) from Euler’s theorem into (13) provides the implicit function

\[
0 = L_t - \lambda_1 L_{t-1} - \frac{1 - \gamma}{\beta b\lambda_2} \{\epsilon Y_t + K_t[\beta/(1 - \tau)](D/K)_t[q c - (1 - q)\tau i] - 1 + \beta (1 - \delta)\} + \frac{w_t}{\beta b\lambda_2} \sum_{i=1}^{\infty} \lambda_2^{-i} E_i[(1 - \gamma)\gamma AK^{\gamma-\gamma}_{t+i} L^{\gamma-1} - w_{t+i}],
\]

which must hold along the optimal path. In other words, equation (14) should hold across adjacent periods.

Correlations between variables of interest can be analyzed by use of the implicit function theorem. In particular, we find that labour demand correlates positively with current output (or sales), \(\partial L_t/\partial Y_t = (1 - \gamma)\epsilon/(\beta b\lambda_2 L) > 0\), and negatively with the wage rate, \(\partial L_t/\partial w_t = -1/(\beta b\lambda_2) < 0\). The correlation between labour demand and the current debt asset ratio is given by:

\[
\frac{\partial L_t}{\partial (D/K)_t} = -\frac{(1 - \gamma)K_t}{(1 - \tau) b\lambda_2 L} \left\{ c q + \left(\frac{D}{K}_t\right) q' (c + \tau i) \right\} - \left(1 - q\right)(\tau i + \left(\frac{D}{K}_t\right) i').
\]

If the Modigliani–Miller theorem holds, the term in braces equals zero and the model suggests no relationship between capital structure and labour demand. If, however, the firm is financially constrained in the sense that the negative bankruptcy effect (the first term in brackets) exceeds the tax effect (second term in brackets), labour demand is negatively correlated with the...
debt asset ratio along the adjustment path. In other words, according to the theoretical model firm employment decisions are influenced not only by the traditional fundamental opportunity set of the firm, but also by the firms financial condition, especially its capital structure. Moreover, the result suggests that the correlation may possibly be of a non-linear type along the optimal path.

This nonlinearity can also be justified within principal agent model considerations. With low bankruptcy probabilities debt contracts have normally good incentive properties within asymmetric information models. Because the interest payments are fixed, creditors need not monitor total returns; all that is necessary is monitoring actions affecting the bankruptcy risk. In other words, the principal agent problems associated of ensuring that managers act in the interests of equity holders are greater than the corresponding problems of ensuring that managers take actions in the interests of debt holders. Therefore, the existence of asymmetric information gives rise to the conclusion that with low levels of debt a firm can raise funds more cheaply through debt than through equity, even neglecting tax advantages. With high debt asset ratios, however, these microeconomic information advantages of debt are reversed: the more effective monitoring aspect is balanced by the costs that are expected when the firm cannot repay. By the same logic, high debt asset ratios can be used to explain why firms may be credit-rationed.4

III. ECONOMETRIC METHODOLOGY

The dynamic panel data model to be estimated is of the form

\[ Y_{it} = \beta_0 + \beta_1 Y_{it-1} + \beta_2(B)X_{it} + \epsilon_{it} \]  

where \( i = 1, 2 \ldots, N \) refers to the number of cross-sectional units (e.g. firms) and \( t = 1, \ldots, T \) refers to the time period. \( X \) is the set of exogenous regressors including time dummies, and \( B \) indicates a polynomial in the lag operator. A variety of estimators have been proposed for estimation of dynamic panel data equations like that.5 Following a widespread assumption the error term is assumed to be \( \epsilon_{it} = \mu_i + \nu_{it} \) with \( \mu_{it} \sim \text{IID}(0, \sigma_{\mu}^2) \) and \( \nu_{it} \sim \text{IID}(0, \sigma_{\nu}^2) \) independent of each other. Due to the presence of the lagged dependent variable the OLS estimator is biased and inconsistent. We therefore use the generalized method of moments approach (GMM) developed by Arellano and Bond (1991). The equation is first-differenced to eliminate the individual effects \( \mu_i \).6 This introduces a moving average with

4The view that the true role of debt is to align the interests of a firm’s manager with that of its owners have also been emphasised by Jensen and Meckling (1976), Hart (1995) and Myers and Majluf (1984).
5Compare Baltagi (1995), Ch. 8 for an overview.
6Estimation in first differences has the desirable property that the impact of systematically different debt ratios across industries upon the results is eliminated. The determinants of debt ratios across industries are discussed in Bowen et al. (1982).
unit root in the disturbance $\Delta v_{it}$ ($\Delta$ is the first difference operator). Clearly, lagged values (using lags $t - 2$ or earlier) of $Y_{it}$ or $\Delta Y_{it}$ could be used as valid instruments. Arellano and Bond (1991) showed that the use of all available instruments (e.g. for period $T$ instruments dating from 1 to $(T - 2)$) leads to a still more efficient estimator. This set of instruments combined with the MA structure of the error term leads to the preliminary one-step inefficient but consistent estimator. Using the estimated residuals of the one-step estimator for constructing an appropriate weighting the efficient two-step GMM estimator can be calculated.\footnote{For a detailed treatment of optimal or efficient GMM estimation refer to Hansen (1982), White (1982) or Davidson and MacKinnon (1993), Ch. 17.3.} The consistency of the GMM estimator depends crucially on the fact that $E[\Delta v_{it}\Delta v_{i,t-2}] = 0$. If that condition holds, no second order serial correlation should be detected in the residuals of the first-differenced equation. On the other hand due to the MA-structure of the error term, negative first order serial correlation is to be expected. Arellano and Bond (1991) provide the respective test statistics. Another econometric issue is the validity of the chosen set of instruments. A Sargan-type test of overidentifying restrictions is therefore reported as well. The descriptive statistics of our sample indicate that heteroscedasticity might be an issue. We therefore report heteroscedasticity-consistent $t$-statistics.

IV. DATA DESCRIPTION AND EMPIRICAL RESULTS

The Data

Our data is drawn from the published consolidated accounts of quoted German corporations. Using firm level panel data we are able to take into account some of the important labour demand dynamics that aggregate studies miss out. The firms were chosen from a list of the biggest firms in Germany (measured as sales performance). We restrict our attention to the manufacturing sector. Starting at the top and excluding firms which were already included in the consolidated accounts of some other firm we ended up with a panel of 96 firms covering the years 1987 to 1994.\footnote{Mercedes, for example, is included in the consolidated accounts of Daimler Benz AG. Nevertheless, both firms are quoted on the stock exchange. A complete list of the companies included is available upon request.} Due to mergers we were forced to exclude particular years of some firms to sustain comparability over the years. Table 1 illustrates the unbalanced panel structure. Table 2 provides the means and standard deviations of each of the variables included in our analysis. A detailed description of the variables is given in Appendix A. To test the theoretical implications of our model we constructed two different debt asset ratios. DAR$_1$ is the ratio of liabilities to balance sheet total, the second variable DAR$_2$ is a narrower debt asset ratio measure which encompasses bonds and bank loans in relation to balance sheet total.
Figure B1 to B5 in Appendix B indicate the dispersion of the variables in the dataset. Figure B6 displays the correlation between DAR$_1$ and DAR$_2$.

**Estimation Results**

To simplify the interpretation of equation (14) and to bridge the theoretical and empirical sections, equation (14) is rewritten as

$$
\Delta \ln(L_{it}) = \beta_1 \Delta \ln(L_{i,t-1}) + \beta_2 \Delta \ln(S_{it}) + \beta_3 \Delta \ln(W_{it}) + \beta_4 \Delta(DAR_j)_{it} \\
+ \beta_5 \Delta(DAR_j)^2_{it} + \text{Time Dummies} + \epsilon_{it}, j = 1, 2.
$$

(17)

To capture alterations in the general macroeconomic environment time dummies were included in the estimated equation. The debt asset ratio enters the equation linearly and with a quadratic term to check for the presence of nonlinearities. To validate the robustness of our results we estimated several variations of the above mentioned equation including/excluding the higher order term of DAR$_i$.

Table 3 summarizes the results.

The first column shows the most parsimonious specification excluding all financial variables. Columns b) and c) give the results using DAR$_1$ as

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9Estimation was done using GAUSS and the DPD program developed by Arellano and Bond. See Arellano and Bond (1988) for details.
### TABLE 3

**Estimation Results**

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<th></th>
<th>a)</th>
<th>b)</th>
<th>c)</th>
<th>d)</th>
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<td>$\Delta \ln L_{t-1}$</td>
<td>0.3275**</td>
<td>0.3298**</td>
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<td>0.6017**</td>
<td>0.6059**</td>
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<td>$\Delta \text{DAR}^{1)}_{j,t}$</td>
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<td>$-$0.2020*</td>
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<td>Wald-test$^2)$</td>
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<td>6943.74 (4)**</td>
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<td>6636.52 (4)**</td>
<td>6701.76 (5)**</td>
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<td>Joint Significance Wald-test</td>
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<td>362.46 (6)**</td>
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<td>Sargan$^4)$</td>
<td>71.49 (60)</td>
<td>64.17 (59)</td>
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<td>p-value</td>
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<td>AC(1)$^5)$</td>
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<td>$-$3.819</td>
<td>$-$3.718</td>
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<td>AC(2)$^5)$</td>
<td>1.403</td>
<td>1.610</td>
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Notes: Dependent variable $\Delta \ln L_t$; one-step (two-step) $t$-values robust to heteroscedasticity are given in parenthesis (square brackets) below coefficients, **/**/*** indicates (asymptotic) significance at the 10/5/1% level, 1) DAR 1 in columns b,c; DAR 2 in columns d,e; 2) Wald-test of joint significance of the regressors excluding time dummies based upon the two-step $t$-values, number in parenthesis shows degrees of freedom; 3) Wald-test of joint significance of both DAR terms included in the regression; 4) Sargan test of overidentifying restrictions, p-value is the probability of the test statistic under the null of valid instruments; 5) AC(i) test of serial correlation of order i, asymptotically standard normal. Instruments used where lagged $\ln L$, $\ln S$ and $\ln W$ in the way described in Section III. Time dummies are included in all the equations.
financial variable, the last two columns present the results obtained with the alternative measure DAR2. A first look at the table shows that the results are highly stable and the diagnostics as explained in section III are satisfactory. The Wald-tests of joint significance of any regression or subsets of the coefficients and the two-step $t$-statistics of the parameter estimates are highly significant. The Sargan-test shows that the hypothesis of valid instruments could not be rejected. The tests of autocorrelation in the residuals reveal the expected picture. Negative first order autocorrelation is present as was to be expected by taking first differences, while second order autocorrelation cannot be detected.

The positive and highly significant estimate of the coefficient of $\ln(L_{t-1})$ suggests that the partial adjustment process implied by the presence of adjustment costs can indeed be regarded as an adequate representation of firms’ labour demand behaviour. The highly significant coefficient of the sales variable implies a short-run elasticity of labour demand to sales of approximately 0.60 which is well in line with other empirical studies of firms labour demand. The first-order autoregressive coefficient implies a long-run elasticity of labour demand to sales of 0.91. The wage variable has the expected negative sign and is highly significant throughout all specifications. More interesting in the context of our theoretical model is the influence of financial variables upon labour demand. Theory suggests to include the financial variable in a nonlinear way in the estimated equation. Therefore, a linear and a quadratic term in DAR1 and DAR2 were added to the equation. Figure 1 depicts the result. Either debt asset ratio exhibits a

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Figure 1. Impact of Financial Variables upon Employment

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10 We have also reported the robust one-step statistics, since one has to keep in mind that the $t$-statistics of the two-step estimator are systematically too high. In a Monte Carlo Study Arellano and Bond (1991) quantify the downward bias of the standard errors to be about 20%. Given that caveat, our estimated $t$-statistics seem still reasonable.
similar picture and the coefficients generally show the expected negative relationship between \(DAR_j, j = 1, 2\), and labour demand. Figure 1 illustrates that financial constraints can indeed play a substantial role in the labour demand decisions of firms.

To reinforce this conclusion, we have finally analyzed whether higher leveraged firms have experienced greater than average effects of DAR upon employment. We divide the sample into two equal size groups above (`group H') and below (`group L') the median on the basis of \(DAR_j (j = 1, 2)\) in the year prior to the start of the sample period. In other words, the most leveraged 50 percent are placed in the highly leveraged `group H', and the remaining 50 percent are assigned to the less leveraged `group L'. Table 4

<table>
<thead>
<tr>
<th>(\Delta \ln L_{t-1})</th>
<th>(a)</th>
<th>(b)</th>
<th>(c)</th>
<th>(d)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.3225***</td>
<td>0.3155***</td>
<td>0.3505***</td>
<td>0.3525***</td>
<td></td>
</tr>
<tr>
<td>(3.3)</td>
<td>(3.6)</td>
<td>(3.9)</td>
<td>(3.7)</td>
<td></td>
</tr>
<tr>
<td>[27.6]</td>
<td>[29.3]</td>
<td>[18.4]</td>
<td>[17.0]</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>(\Delta \ln S_t)</th>
<th>(a)</th>
<th>(b)</th>
<th>(c)</th>
<th>(d)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5468***</td>
<td>0.5654***</td>
<td>0.4459**</td>
<td>0.4503**</td>
<td></td>
</tr>
<tr>
<td>(3.9)</td>
<td>(5.0)</td>
<td>(4.6)</td>
<td>(4.5)</td>
<td></td>
</tr>
<tr>
<td>[33.3]</td>
<td>[36.8]</td>
<td>[30.1]</td>
<td>[30.8]</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>(\Delta \ln W_t)</th>
<th>(a)</th>
<th>(b)</th>
<th>(c)</th>
<th>(d)</th>
</tr>
</thead>
<tbody>
<tr>
<td>-0.8727**</td>
<td>-0.8858**</td>
<td>-0.8849**</td>
<td>-0.8920**</td>
<td></td>
</tr>
<tr>
<td>(-5.6)</td>
<td>(-5.8)</td>
<td>(-5.8)</td>
<td>(-5.8)</td>
<td></td>
</tr>
<tr>
<td>[-134.7]</td>
<td>[-137.3]</td>
<td>[-39.4]</td>
<td>[-38.5]</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>(\Delta DAR_{j,t})</th>
<th>(a)</th>
<th>(b)</th>
<th>(c)</th>
<th>(d)</th>
</tr>
</thead>
<tbody>
<tr>
<td>-0.1317**</td>
<td>-0.7370**</td>
<td>-0.2545**</td>
<td>-0.5192**</td>
<td></td>
</tr>
<tr>
<td>(-0.4)</td>
<td>(-0.5)</td>
<td>(-1.4)</td>
<td>(-1.5)</td>
<td></td>
</tr>
<tr>
<td>[-4.2]</td>
<td>[-3.5]</td>
<td>[-7.8]</td>
<td>[-7.6]</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>(\Delta DAR^2_{j,t})</th>
<th>(a)</th>
<th>(b)</th>
<th>(c)</th>
<th>(d)</th>
</tr>
</thead>
<tbody>
<tr>
<td>-0.8291**</td>
<td>-0.4462**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(-0.9)</td>
<td>(-0.8)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>[-4.4]</td>
<td>[-3.0]</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\[Wald-test\] 21565.79** 19045.14** 5068.15** 5221.04**
\[Joint Significance\]
\[Wald-test\] 2064.76** 1663.06** 1155.87** 716.15**
\[Time Dummies\]
\[Wald-test\] 45.86** 130.44**
\[Sargan\] 36.65 37.35 36.40 35.81
\[p-value\] 0.4348 0.3601 0.4500 0.4300
\[AC(1)\] -2.421 -2.406 -2.731 -2.807
\[AC(2)\] 1.603 1.626 1.394 1.447

Notes: DAR_1 in columns a,b; DAR_2 in columns d,e; one-step (two-step) \(t\)-values robust to heteroscedasticity are given in parenthesis (square brackets) below coefficients. See Table 3.

We use data prior to the start of the sample period to ensure that the sample split is completely exogenous.
and 5 display the estimation results for both subgroups. The striking result is that, when the specifications permit different coefficients on $\Delta\text{DAR}_j$ for the two groups, the higher leveraged firms exhibit statistically significant responses of $\Delta L$ to $\Delta\text{DAR}_j$ while the corresponding ‘group L’ coefficients are generally insignificant. This lends support for our interpretation of the DAR$_j$-coefficients as genuine financial pressure effects.

V. CONCLUSIONS

This paper links recent theoretical work on capital markets to long-standing empirical debates in the employment literature. Recent models of firm behaviour stressing problems of imperfect capital markets provide a foundation for interpreting evidence that the capital structure can predict labour demand decisions, even after one controls for firms’ employment opportunities. The results indicate that there exists a negative impact of the capital

<table>
<thead>
<tr>
<th>TABLE 5</th>
<th>Estimation Results for Group L</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>a)</td>
</tr>
<tr>
<td>$\Delta \ln L_{t-1}$</td>
<td>0.3132**</td>
</tr>
<tr>
<td>(2.9)</td>
<td>(3.1)</td>
</tr>
<tr>
<td>[12.6]</td>
<td>[12.3]</td>
</tr>
<tr>
<td>$\Delta \ln S_t$</td>
<td>0.5270**</td>
</tr>
<tr>
<td>(4.8)</td>
<td>(5.0)</td>
</tr>
<tr>
<td>[31.5]</td>
<td>[29.3]</td>
</tr>
<tr>
<td>$\Delta \ln W_t$</td>
<td>$-0.5725$**</td>
</tr>
<tr>
<td>(3.2)</td>
<td>(3.2)</td>
</tr>
<tr>
<td>[12.5]</td>
<td>[12.6]</td>
</tr>
<tr>
<td>$\Delta\text{DAR}_{jt}$</td>
<td>0.0022</td>
</tr>
<tr>
<td>(0.1)</td>
<td>(0.05)</td>
</tr>
<tr>
<td>[0.4]</td>
<td>[0.8]</td>
</tr>
<tr>
<td>$\Delta\text{DAR}^2_{jt}$</td>
<td>0.2179</td>
</tr>
<tr>
<td>(0.02)</td>
<td></td>
</tr>
<tr>
<td>[0.9]</td>
<td></td>
</tr>
</tbody>
</table>

Wald-test | 6375.99** | 6394.05** | 4297.14** | 3683.07** |
Joint Significance | 335.40** | 336.07** | 833.88** | 613.52** |
Wald-test DAR | 0.81 | | | 4.75* |
Wald-test Sargan | 36.56 | 35.55 | 34.78 | 40.96 |
p-value | 0.2651 | 0.2624 | 0.5732 | 0.2618 |
AC(1) | $-3.455$ | $-3.578$ | $-3.156$ | $-2.724$ |
AC(2) | $-0.034$ | 1.102 | $-1.091$ | 0.026 |

Notes: DAR$_1$ in columns a,b; DAR$_2$ in columns d,e; one-step (two-step) t-values robust to heteroscedasticity are given in parenthesis (square brackets) below coefficients. See Table 3.
structure upon employment. We also demonstrate that as real wages (sales) increase, employment decreases (increases). The results therefore support the conjecture that ‘capital structure’, as defined in this paper, is associated with modified employment behaviour on the part of German firms. We believe that these findings illustrate the potential richness of research programs to formalize tests of capital market imperfections and to measure their importance for factor demand of firms.

_Hamburg University_

*Date of Receipt of Final Manuscript: October 1998.*

**REFERENCES**


APPENDIX A DATA DESCRIPTION

This appendix describes the calculation and sources of the main variables used in this paper. The data is taken from published consolidated accounts of German enterprises. Sales and total personnel expenses are taken from the profit and loss accounts. The debt/asset-ratios are calculated from the balance sheet and the number of employees stems from the notes to the accounts. To eliminate price effects the variables sales and wage are deflationed with the GDP-deflator.

\[ L \] Total number of employees (annual average).
\[ S \] Total turnover excluding VAT, in millions of DM.
\[ W \] The per capita wage is constructed by dividing total personnel expenses (wages, salaries, non-wage labour costs, social security contributions, allocation to provisions for pensions) by the number of employees (see above); TDM per capita.
\[ \text{DAR}_1 \] Liabilities (i.e. external financing without equity, including accounts payable, bank loans and bonds issued by the firm) divided by balance sheet total. Liabilities include short term and long term debt.
\[ \text{DAR}_2 \] The sum of bonds issued by the firm and bank loans divided by balance sheet total.

APPENDIX B SAMPLE DATABASE CHARACTERISTICS

The following Figures were generated by dividing the range of the variable into 50 classes.
Figure B1. Distribution of the Variable Labour ($L$)

Figure B2. Distribution of the Variable Sales ($S$)
Figure B3. Distribution of the Variable Wage ($W$)

Figure B4. Distribution of the Variable Debt Asset Ratio 1 (DAR$_1$)
Figure B5. Distribution of the Variable Debt Asset Ratio 2 (DAR$_2$)

Figure B6. Scatterplot of DAR$_1$ versus DAR$_2$; the number at the top is the coefficient of correlation

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