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Does market structure affect labour productivity and wages? Evidence from a smooth coefficient semiparametric panel model

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HIGHLIGHTS

- We investigate the impact of market structure on labour productivity and wages.
- We employ a smooth coefficient semi-parametric panel model.
- We use the concentration ratio (CR-4) as a smooth threshold variable.
- There is a negative non-linear relationship of competition and labour productivity.
- Oligopolistic structure decreases the level of wages of non-manual workers.

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ABSTRACT

This paper investigates the impact of market structure on labour productivity and wages using a panel data set of US manufacturing industries over the period 1958–2007. To account for nonlinear effects, we employ a smooth coefficient semiparametric model (SCSM). We find evidence in support of a nonlinear relationship between market concentration and labour productivity and wages. Lastly, our empirical findings shed new light on the competition–labour productivity nexus.

1. Introduction

Within the last twenty years there is a plethora of studies examining the effect of market structure on labour productivity and wages (Nickell, 1996; Hay and Liu, 1997; Disney et al., 2003; Symeonidis, 2008). Despite the rich body of the literature, existing studies impose strong theoretical assumptions. First, they argue that any possible impact is apparent in a linear form. However, this is a rather restrictive assumption that has to be tested rather than assumed since it may lead to biased results. Second and most importantly, they adopt parametric regression models that may lead to misspecification of their functional form unless it is correctly specified by the economic theory (Tran and Tsionas, 2010).

In order to overcome this problem, we rely on panel data semiparametric methodology where little prior restriction is imposed on the model's structure. We use a particular type of semiparametric panel data model, the SCSM with fixed effects (Li et al., 2002; Mamuneas et al., 2006; Stengos and Zacharias, 2006). This specification traces the effects of the concentration ratio of the four largest companies in each 4-digit sector (CR-4) on the coefficient of each regressor (marginal response) over the sample. Put it another way, the CR-4 acts as a (smooth) threshold variable in order to capture the marginal effect of a given variable as an unknown function of an observable covariate (CR-4), introducing heterogeneity.

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Our findings based on data from 459 US manufacturing industries over the period 1958–2007 reveal the existence of two nonlinear relationships between market structure and labour productivity and wages respectively. The rest of the paper is organized as follows. Section 2 introduces the data and describes the SCSM, while Section 3 discusses the empirical results and concludes the paper.

2. Data and empirical modelling

The panels used in this study consist of 459 SIC 4-digit industries and thirteen years: 1958, 1963, 1966, 1967, 1970, 1972, 1977, 1982, 1987, 1992, 1997, 2002 and 2007.[1] This sample period is selected based on data availability. All variables are taken from the National Bureau of Economic Research (NBER).

We estimate a SCSM following the methodology described in Li et al. (2002). Let the model be given by the following equation:

$$y_i = a(z_i) + x_i^T \beta(z_i) + \varepsilon_i = (1, x_i^T)\begin{pmatrix} a(z_i) \\ \beta(z_i) \end{pmatrix} + \varepsilon_i \tag{1}$$

where $\delta(z_i) = (\alpha(z_i), \beta(z_i)^T)^T$ is a smooth but unknown function of z_i, x_i and z_i are vectors of exogenous regressors with dimension $p \times 1$ and $q \times 1$ respectively and ε_i are zero mean i.i.d. innovations. In this case, we could estimate $\delta(z)$ using a local least squares approach[2]:

$$\begin{aligned} \widehat{\delta}(z) &= \left[(nh^q)^{-1} \sum_{j=1}^{n} X_j X_j^T K\left(\frac{z_i - z}{h}\right) \right]^{-1} \\ &\quad \times \left\{ (nh^q)^{-1} \sum_{j=1}^{n} X_j y_j K\left(\frac{z_i - z}{h}\right) \right\} \\ &= [D_n(z)]^{-1} A_n(z) \end{aligned} \tag{2}$$

where $D_n(z) = (nh^q)^{-1} \sum_{j=1}^{n} X_j X_j^T K\left(\frac{z_j - z}{h}\right)$, $A_n(z) = (nh^q)^{-1} \sum_{j=1}^{n} X_j y_i K\left(\frac{z_j - z}{h}\right)$ $K(.)$ is a kernel function and $h = h_n$ is the smoothing parameter for sample size n chosen by cross validation, see Li et al. (2002) and Stengos and Zacharias (2006) for details.

The equation of interest is a simple extension of Eq. (1), where we also add a component to the model that contains information that is not considered to be of the hedonic type and as such not directly affected by z (Mamuneas et al., 2006; Stengos and Zacharias, 2006; Baglan and Yoldas, 2014). In this case, the model that we estimate is given by the following expression:

$$y_i = w_i^T \gamma + x_i^T \beta(z_i) + \varepsilon_i. \tag{3}$$

The dependent variables that enter the y vector are the value added per employee as a proxy for labour productivity (VADD_EMP) and the average real wage of non-manual workers (PRODWOTH) per industry over the time period. Additionally, the w-vector includes the year dummy variables, while the x-vector includes the list of the independent variables of the SCSM including the constant term. These are the capital to labour ratio (K/L), the real total value of shipments (SHIP) as a proxy for market size, the real total capital expenditure (INV) as a proxy for capital, the real total cost of materials (MAT) as a proxy for intermediate inputs and the real cost of electricity and fuels (ENER) that serves as a proxy for energy cost. Finally, we include the CR-4 as a proxy for market structure allowing for certain cyclical behaviour (nonlinearities) in the effect of the covariates on the dependent variables as the z-variable.[3]

Table 1
The linear model.

Variable	Without the year dummies		With the year dummies	
	Model I	Model II	Model I	Model II
lnK/L	1.316^{***} (0.022)	0.729^{***} (0.020)	0.137^{***} (0.013)	-0.195^{***} (0.015)
lnSHIP	0.352^{***} (0.052)	0.193^{***} (0.048)	0.139^{***} (0.022)	0.052^{**} (0.027)
lnINV	0.150^{**} (0.032)	0.237^{***} (0.030)	0.032^{**} (0.014)	0.144^{***} (0.017)
lnMAT	0.058^{**} (0.057)	0.362^{***} (0.053)	−0.028 (0.024)	0.362^{***} (0.029)
lnENER	-0.012^{***} (0.034)	0.325^{***} (0.031)	-0.044^{***} (0.014)	0.194^{***} (0.017)
Cr4*lnK/L	-0.0005^{***} (0.0004)	-0.0007^{*} (0.000)	0.0003 (0.002)	−0.0004 (0.000)
Cr4*lnSHIP	0.0005^{***} (0.000)	0.002^{**} (0.000)	0.0006 (0.000)	0.0007 (0.000)
Cr4*lnINV	-0.0003^{***} (0.000)	−0.0008 (0.000)	0.0002 (0.000)	0.00008 (0.000)
Cr4*lnMAT	-0.0003^{***} (0.000)	−0.001 (0.000)	−0.0004 (0.000)	-0.0015^{***} (0.000)
Cr4*lnENER	0.0006^{***} (0.000)	0.0007 (0.000)	−0.0001 (0.000)	0.0008^{***} (0.000)
Constant	-2.220^{***} (0.060)	-1.884^{***} (0.056)	1.402^{***} (0.046)	0.8004^{***} (0.054)
Diagnostics				
Adjusted R^2	0.482	0.496	0.870	0.808
F-statistic	12.04^{***} [0.00]	24.59^{***} [0.00]	23.60^{***} [0.00]	51.73^{***} [0.00]
Observations	4361	4361	4361	4361
Industries	459	459	459	459

Note: The dependent variable is either the value added per employee (Model I) or the average real wage of non-manual workers (Model II). To preserve space, we have deleted the results of the time dummies and their interactions with the threshold variable CR-4. Robust standard errors are in parentheses. The numbers in square brackets are the p-values. Y_{2002} was excluded from the model because of collinearity.
* Significant at 10%.
** Significant at 5%.
*** Significant at 1%.

3. Results and discussion

Table 1 presents the results from the benchmark linear specification that will be contrasted with the SCSM and is given by the following equation:

$$y_i = a + x_i^T \beta + w_i \gamma + z_i \theta + \varepsilon_i. \tag{4}$$

It is evident that nearly all of the variables are statistically significant in either of the two models (with or without the year dummies). The magnitude and the sign of the estimates are on average in line with the current empirical literature (see for example Symeonidis, 2008). Specifically, there is strong evidence that capital intensity (lnINV) increases labour productivity and wages of non-manual workers. Similarly, market size (lnSHIP) increases both wages and productivity. On the other hand, there is little evidence supporting the notion that the market structure (CR-4) is positively correlated with a higher productivity growth,

1 For the years 2002 and 2007 we use the concordance between SIC and NAICS codes.

2 For presentational simplicity for the observations we only use subscript i and omit t.

3 The CR-4 variable was transformed to log (CR-4 + 0.001) in order to eliminate some zero values.