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Markup Differentials, Cost Flexibility, and Capacity Utilization in West-German Manufacturing

von

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Zusammenfassung

Ein ökonometrisches Modell zur Erklärung des Preis-Grenzkosten-Verhältnisses wird für die Branchen des Verarbeitenden Gewerbes auf Basis einer flexiblen nicht-homothetischen Kostenfunktion mit Kapital als quasi-fixem Faktor geschätzt. Die Produktionsstruktur wird durch Kostenflexibilitäten und ein ökonomisch fundiertes Maß der Kapazitätsauslastung beschrieben. Die Ergebnisse für die einzelnen Branchen zeigen, daß der Preis deutlich über den Grenzkosten liegt, und dieses Verhältnis für den Großteil der Branchen im Beobachtungszeitraum stabil ist. Kurzfristig ist ein Großteil der Branchen hinsichtlich des Kapitalstocks nicht optimal angepaßt, langfristig bestehen in den meisten Branchen steigende Skalenerträge. Die inter-industriellen Unterschiede im Preis-Grenzkosten-Verhältnis können auf unterschiedliche Skalenerträge zurückgeführt werden, die üblichen Indikatoren für Marktkonzentration üben keinen zusätzlichen Effekt aus.

Abstract

An econometric model based on a flexible non-homothetic cost function with capital as quasi-fixed factor is estimated to explain the ratio of price to marginal costs in West-German manufacturing industries. The production structure is described by measures of cost flexibility and an economically meaningful capacity utilization concept. The results show substantial markups in virtually all industries which in most cases remain rather stable over time. In a majority of industries the capital stock is not optimally adjusted within a year. Most industries exhibit long-run increasing returns. Inter-industry differences in markups are mainly explained by differences in economies of scale, the usual indicators of market concentration showing no extra effect.

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Markup Differentials, Cost Flexibility, and Capacity Utilization in West-German Manufacturing

by

Gebhard Flaig and Viktor Steiner*)

I. Introduction

The empirical analysis of the relationship between pricing behaviour and market structure has a distinguished tradition in industrial economics. The size of markups of price over marginal or average costs has been the traditional indicator for market power in most empirical studies usually based on a cross-section of industries (for a survey see Schmalensee 1989). The standard explanation given for inter-industry differences in markups has usually been the existence of entry barriers arising from scale economies (see Scherer 1980 for a survey). Although no concurring opinion on the proper interpretation or even the existence of a positive relationship between industry markups and market concentration seems to have emerged so far, it remains the basis for the predominance of the structure-conduct-performance paradigm in empirical industrial economics (see Schmalensee 1989 for a comprehensive survey). A related issue that has been extensively investigated within this approach is the cyclical variation in markups and prices and its dependence on market structure (see Scherer 1980, Ch. 13, Carlton 1989) although here too, judging from the literature, no unambiguous results seem to be available.

More recently, the relationship between imperfect competition and macroeconomic fluctuations in prices and output has been the topic of much empirical research (see e.g. Gahlen, Buck and Arz 1985, Hall 1986, Nickell 1988, Carlton 1989). Several authors

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(Hall 1986, 1988; Domowitz et al. 1987, 1988) using a Solow productivity equation approach have investigated the relationship between industry markups and concentration in US manufacturing and found substantial market power in virtually all industries. Hall (1986) concluded that high markups over marginal costs can to a large degree be explained by chronic excess capacity, while Domowitz et al. (1988) attributed high markups over marginal costs to high overhead costs. The latter authors have also investigated the cyclical behaviour of markups in U.S. manufacturing and found strong evidence that markups behave procyclically, and the more so the higher market concentration is. Bils (1987) on the other hand found some evidence for procyclical marginal costs and countercyclical markups for U.S. manufacturing, without any effect from concentration.

The main problem with all of the studies cited is that they are only rudimentarily based on the modern theory of production and costs. They usually assume rather restrictive specifications for the production technology including constant returns to scale, Hicks-neutral technical progress and full flexibility of all factors of production. In particular, the assumption of constant returns to scale does not seem a terribly useful one considering the importance that increasing returns to scale occupy in much of recent research on productivity growth (see e.g. Romer 1986) and international trade (for surveys see Caves 1985 and Krugman 1989).

Our approach differs from previous studies primarily in that we allow for a considerably more general production structure. In particular, we account for both a non-homothetic production function incorporating non-constant returns to scale and the quasi-fixity of factors of production. Furthermore, in explaining industry markups we make extensive use of some modern concepts in applied production analysis such as short-run and long-run cost flexibility as well as an economically meaningful measure of capacity utilization. Compared to previous related studies, especially by Appelbaum (1982) for U.S. manufacturing and Borooah and van der Ploeg (1986) for the U.K., our empirical work is based on a much larger sample of manufacturing industries.

The first step in our modelling strategy is to estimate for each industry a three equation system consisting of a pricing equation and two demand equations for variable factors of production on industry time-series data. These equations are derived under the assumptions of short-run profit maximization with respect to the pricing decision and cost minimizing with respect to the input demands, respectively. In a second step, we follow the traditional structure-conduct-performance approach and correlate estimated price-cost margins with both the usual proxy variables for market structure and our derived measures for inter-industry differences in technology and capacity utilization.

The paper is structured as follows. In the next section the theoretical framework used to model pricing behaviour with special reference to the cost flexibility and capacity utilization measures used in the empirical model is explained in some detail. The subsequent section sets out the econometric specification of the restricted cost function and derives the estimating equations of our empirical model. The main results of the present study are summarized and discussed in section IV. In the concluding section the main conclusions of the paper are summarized. The appendix contains a short data description and some additional estimation results.

II. Theoretical Framework

Our empirical model is based on the proposition that pricing decisions in an industry can be described as the outcome of profit maximizing behaviour. We do not develop a fully formulated model of pricing behaviour of imperfectly competitive firms depending on market structure, but rather refer to the general proposition that profit maximizing firms equate short-run marginal costs to marginal revenue. In the recent literature there exist different approaches to identify and estimate the structural parameters of the cost and revenue functions as well as the conduct parameters determining pricing behaviour in oligopolistic markets (for recent surveys see Geroski 1988 and Bresnahan 1989). The traditional structure-conduct-performance approach has been partly replaced by the so-called "new empirical industrial organization" approach (Bresnahan 1989) which differs from the former in that, instead of correlating the traditional accounting profitabilty measures with concentration measures across industries, price-cost margins and their determinants are estimated econometrically using time series data for a single industry. In the present study, we follow this general approach. In particular, we try to estimate marginal costs and industry markups econometrically. This is achieved by specifying a rather general cost function which is capable of describing the technology for each industry in our sample as follows.

Let $Y = Y(X, Z, t)$ denote the industry production function characterizing how output Y depends on a vector of variable inputs X, a vector of quasi-fixed inputs Z, and a time index t representing the state of technology. It will be assumed that variable inputs can be fully adjusted within a year whereas, due to costs of adjustment, quasi-fixed inputs are not always at their long-run optimal level. If the production function satisfies certain regularity conditions, and if firms minimize variable costs $q'X$, where q' denotes a vector of exogeneously given prices of variable inputs, there exists a restricted cost function (Lau 1976) given by

$$(1) \quad G = G(q, Y, Z, t).$$

which is dual to the production function and contains all economically relevant information on the underlying technology. To qualify as a proper variable cost function G must be homogeneous of degree one and non-decreasing as well as concave in q, non-decreasing in Y, and non-increasing and convex in Z. The specification of variable costs as given by (1) assumes that adjustment costs with respect to quasi-fixed factors are external to the industry, which will be the maintained hypothesis of the present study (for the distinction of external and internal adjustment costs see Berndt, Morrison and Watkins 1981, and Morrison 1988a).

One of the main advantages of the dual approach to modelling the technology in an industry is that it allows for an straightforward derivation of input demand functions. For a given level of output and exogeneously given input prices the cost-minimizing demands for variable factors of production can be derived from the restricted cost function by applying Shephard's Lemma:

$$(2) \quad X_i = \frac{\delta G}{\delta q_i} .$$

The derived demand equations for variable factors are homogeneous of degree zero in all input prices and non-increasing in own input prices.

In the present study derived factor demand equations primarily serve as an important tool to identify and estimate the parameters of the cost function. As the properties of the demand functions in eq. (2) place quite a few restrictions on the parameters of the estimating equations, they can be used to check whether estimated marginal costs are economically meaningful. For example, a positive own-price elasticity of a variable factor would indicate nonsensical estimates for marginal costs.

Formulating the determination of pricing decisions within the restricted cost function approach offers two additional advantages over the more traditional approach. First, the effect of a change in output demand on marginal costs can properly estimated. Secondly, the effect that a disequilibrium in the level of quasi-fixed inputs has on costs and prices can be modelled within a coherent framework. The first of these effects can be described by the concept of cost flexibility, the latter by an adequately defined measure of capacity utilization.

Cost flexibility measures the proportionate change in costs attributable to a proportionate change in output and is therefore given by the ratio of marginal costs to average costs. Its reciprocal is termed economies of size in the literature and serves in the dual cost function approach an analogous purpose as the concept of scale economies in the primal production function approach (for a more complete discussion of the relationship between these concepts see Chambers 1988, Chapter 2).

In case of quasi-fixed inputs this concept has to be extended to distinguish between different cost flexibility measures. The short-run elasticity of variable costs with respect to output, ϵ_{GY}, is defined by

$$(3a) \quad \epsilon_{GY} = \frac{\delta G}{\delta Y} \cdot \frac{Y}{G} \ .$$

The short-run elasticity of total costs, C, with respect to output, ϵ_{CY}, is given by

$$(3b) \quad \epsilon_{CY} = \frac{\delta C}{\delta Y}\cdot\frac{Y}{C} = \frac{\delta G}{\delta Y}\cdot\frac{Y}{G}\cdot\frac{G}{C} = \epsilon_{GY}\cdot\frac{G}{C}$$

with total costs

$$(4) \quad C = G(q, Y, Z, t) + r'Z,$$

where the vector r denotes the one-period market prices (user costs) of the quasi-fixed factors. As we have only one quasi-fixed input in our empirical model, for notational convenience, we restrict the following analysis to this case, the generalization to more than one quasi-fixed inputs being straightforward.

The two short-run cost flexibility measures defined above are calculated for a given level of the quasi-fixed factor. The full (long-run) change in costs due to a change in output is given by the total differential of the cost function in eq. (4), i. e.:

$$(5) \quad \frac{dC}{dY} = \frac{\delta G}{\delta Y} + \frac{\delta G}{\delta Z}\frac{dZ}{dY} + r\cdot\frac{dZ}{dY} .$$

Some obvious manipulations yield the following expression for the long-run cost flexibility measure:

$$(6) \quad \frac{dC}{dY}\frac{Y}{C} \equiv \eta = \epsilon_{GY}\cdot\frac{G}{C} + \eta_Z(\epsilon_{GZ} + r\frac{Z}{G})\frac{G}{C} ,$$

where ϵ_{GY} and ϵ_{GZ} denote the partial elasticity of variable cost with respect to output and the quasi-fixed input, respectively, and η_Z is the total (long-run) elasticity of the quasi-fixed input with respect to output.

The long-run optimal value of the quasi-fixed input is derived by minimizing the total cost function (4) with respect to this variable, which yields

$$(7) \quad \frac{\delta C}{\delta Z} = \frac{\delta G}{\delta Z} + r = 0,$$

where $S_Z \equiv -\delta G/\delta Z$ is the shadow-value of the quasi-fixed factor. Eq. (7) therefore affords an economically intuitive interpretation: At the optimum the effect of an additional unit of the quasi-fixed input in reducing variable costs must be equal to its one-period rental price. Solving this optimality condition for Z in terms of Y, q and r, we can derive the optimal value of the quasi-fixed factor and hence calculate η_Z.

From eq. (6) it is obvious that, at this optimal value Z^*, the long-run cost flexibility η is given by $\epsilon_{GY} \cdot G/C^*$, where C^* is total costs at the optimum, i.e. $C^* = G + r \cdot Z^*$. The difference between the short- and long-run cost flexibility measure is given by

$$(8) \quad \epsilon_{GY} - \eta = (\eta - \eta_Z) r\frac{Z}{G} - \eta_Z \cdot \epsilon_{GZ}$$

which collapses to $\eta \cdot r \cdot Z^*/G$ at the long-run optimum.

As suggested by Berndt and Fuss (1986) and Morrison (1985, 1988b), an economically meaningful measure of capacity utilization (Γ) is given by the ratio of the short-run total cost flexibility to the long-run cost flexibility measures, i.e.:

$$(9) \quad \Gamma = \epsilon_{CY} / \eta.$$

This capacity utilization measure indicates the cost consequences of not having adjusted the capital stock optimally in the short-run. Since $(\delta C/\delta Y) \cdot (Y/C) = \epsilon_{GY} \cdot G/C$, we get from eq. (9) and eq. (6)

$$(9') \quad \Gamma = (\eta - \eta_Z(\epsilon_{GZ} + r \cdot \frac{Z}{G}) \cdot \frac{G}{C}) / \eta$$

$$= 1 - (\eta_Z/\eta) \cdot \epsilon_{CZ}$$

where

$$\epsilon_{CZ} = (\epsilon_{GZ} + r \cdot \frac{Z}{G}) \cdot \frac{G}{C}$$

denotes the elasticity of total costs with respect to Z. (Note that for a homothetic cost function this measure collapses to $\Gamma = 1 - \epsilon_{CZ}$).

Therefore, at the output level where the shadow-value of the quasi-fixed factor is equal to its one-period rental price our capacity utilization measure equals one. It is above unity for all output levels where the shadow value of the quasi-fixed factor exceeds its user costs, and is below unity where the former falls short of the latter. Following suggestions by Morrison (1985, 1988b), our capacity utilization measure has been adjusted for scale effects, i. e. it depicts only the cost impact of a suboptimal level of existing fixed capacity, not the cost consequences of output variations resulting from economies of size.

Having outlined the cost side of the model, we now turn to the formulation of the marginal revenue function. As this part of the model is rather standard, we may be brief here. Static profit maximization implies the following optimality condition

(10) $$\frac{\delta G}{\delta Y} = P(1 + \frac{\Phi}{\epsilon})$$

or

(10') $$P = \frac{\delta G}{\delta Y} \cdot \theta,$$

where P is the price of industry output and $\theta = 1/(1 + \Phi/\epsilon)$ is the markup on marginal costs composed of the price elasticity of demand for industry output, ϵ, and a conduct parameter, Φ, characterizing competition in the industry. Under perfect competition $\Phi = 0$, implying $\theta = 1$, whereas under pure monopoly $\Phi = 1$. For the probably more relevant case of oligopolistic behaviour Φ lies between these two extremes $(0 < \Phi < 1)$ implying a markup that is larger than one.

Identification of ϵ and Φ could be obtained by appending an inverse demand function for industry output to the system of estimating equations (see Appelbaum 1982, Roberts 1984, Borooah and van der Ploeg 1986, Conrad 1989). However, for the following reasons we have not attempted to identify these parameters. First, a priori reasoning and some empirical experimentation suggest that, at least for our rather diverse sample of industries, an output demand equation cannot satisfactorily be modelled as simply as it is done in the papers cited. To specify a general output demand equation that is appropriate for our relatively large sample of industries would call for a rather elaborate modelling of the demand equations based on a flexible functional form which is beyond the scope of the present study. Secondly, even if a demand function fits the data well it may nevertheless provide poor estimates of marginal revenue. Finally, in the present study we are primarily concerned with the assessment of market power in a basically descriptive sense which does not necessitate the identification of the price elasticity and conduct parameters, the interpretation of the latter, at least at this level of aggregation, being a rather adventurous task anyway (Geroski 1988, Bresnahan 1989).

In our empirical model we simply make industry markups dependent on time trends and the growth rate of industry output to capture possible cyclical effects in markups. Although estimating the pricing equation (10') does not allow us to identify the parameters ϵ and Φ, we can test against perfect competition in an industry which would imply $\Theta = 1$.

III. Econometric Specification

We try to estimate the model outlined in the previous section for the majority of West-German manufacturing industries (for a brief data description see the next section) based on a given specification of the restricted cost function which has therefore to be formulated in a rather flexible way. We have chosen a variant of the Generalized Leontief functional form proposed by Diewert (1971) and extended by Morrison (1988a), the latter allowing for the incorporation of quasi-fixed factors of production. In our model variable inputs are labour L and materials M with prices w and v. For the labour input variable we use total yearly hours actually worked in an industry. Although a somewhat restrictive assumption as this implies equal elasticities of workers and hours with respect to output, it allows us to treat labour as a variable input within the period under consideration. The only quasi-fixed input in the model is the stock of capital K. We assume that immediate adjustment of the capital stock to its optimal level is not economically feasible due to increasing costs of adjustment which we treat external to the industry (for alternative formal tests of this assumption see Kulatilaka 1985, Schankerman and Nadiri 1986, Conrad and Unger 1987). Hence, the variable or restricted cost function is specified as

$$(11)\quad G = Y[a_{11}v + 2a_{12}(v\cdot w)^{1/2} + a_{22}w + v(b_{11}Y^{1/2} + b_{12}/Y + b_{13}t^{1/2} + b_{14}/t) + w(b_{21}Y^{1/2} + b_{22}/Y + b_{23}t^{1/2} + b_{24}/t)] + (Y\cdot K)^{1/2}\cdot(c_1v + c_2w)$$

The restricted cost function (11) is homogenous of degree one and concave in factor prices if $a_{12} > 0$, and is non-increasing and convex in K if $(c_1v + c_2w) < 0$. This specification is a second-order approximization to an arbitrary cost function and allows for fairly complex interactions between output, factor prices and the trend terms which represent the state of technology. In contrast, the term involving the capital stock is held somewhat simple as preliminary explorations have shown that our sample size does not allow more terms to be included in the cost function (for a more general formulation of the Generalized Leontief cost function see Morrison 1988, and for the underlying theory of flexible functional forms Diewert and Wales 1987).

Applying Shephard's Lemma to eq. (11), we get the following equations for the labour-output and materials-output ratios

(12)

$$\frac{M}{Y} = a_{11} + a_{12}(\frac{W}{V})^{1/2} + b_{11}Y^{1/2} + b_{12}/Y + b_{13}t^{1/2} + b_{14}/t + c_1(\frac{K}{Y})^{1/2}$$

(13)

$$\frac{L}{Y} = a_{22} + a_{12}(\frac{V}{W})^{1/2} + b_{21}Y^{1/2} + b_{22}/Y + b_{23}t^{1/2} + b_{24}/t + c_2(\frac{K}{Y})^{1/2}$$

The long-run optimal value for K is calculated using the optimality condition $r = -\delta G/\delta K$ and is given by

$$(14)\quad K^* = Y(c_1v + c_2w)^2/4r^2$$

The short-run variable cost flexibility, ϵ_{GY}, and the elasticity of variable cost with respect to K, ϵ_{GK}, can easily be derived from the restricted cost function as given by eq. (11). As it is obvious from eq. (14), the long-run elasticity of capital with respect to output is 1. Given values for ϵ_{GY} and ϵ_{GZ}, it is straightforward to calculate the long-run cost elasticity from eq. (6) and the capacity utilization measure from eq. (9').

Finally, the pricing equation is given by

$$(15) \quad P = [v(a_{11} + b_{13}t^{1/2} + b_{14}/t) + w(a_{22} + b_{23}t^{1/2} + b_{24}/t) + 2a_{12}(v\cdot w)^{1/2} + \tfrac{3}{2}Y^{1/2}(b_{11}v + b_{21}w) + \tfrac{1}{2}(c_1v + c_2w)\cdot(\tfrac{K}{Y})^{1/2}] \cdot[\beta_0 + \beta_1 t + \beta_2 t^{1/2} + \beta_3(\ln Y - \ln Y_{-1})],$$

where the first factor in square brackets denotes marginal costs as derived from eq. (11) and the second expression is the markup factor which includes two trend terms and the growth rate of industry output. Whereas the time trends should pick up long-term trends in factors affecting pricing behaviour, the latter variable is assumed to capture cyclical effects on pricing.

The system of estimating equations comprises the input demand equations given by (12) and (13) and the price equation (15). The model is estimated by nonlinear three stage least squares. All symmetry conditions and cross equation restrictions have been imposed on the estimating equations. To econometrically account for the potential endogeneity of the output variable, we instrument it by using the factor prices, the trend terms and lagged values of both the endogeneous variables and output as instruments.

IV. Results

Given the available data (see the appendix), the model was estimated for 25 out of 31 industries comprising the manufacturing sector of the West-German economy. (TSP 4.1. was used for estimation.) As the growth rate of industry output enters the pricing equation as an explanatory variable, we lose one observation. The estimation period is therefore from 1961 to 1985. As the main focus of the present study is on the pricing equation, the input demand equations being used to obtain reliable estimates for marginal costs only, discussion of estimation results from the input equations may be brief here. To save space we do not report parameter estimates for the input equations, but summarize output, own price and cross price elasticities in Table A1 in the appendix.

IV.1 Estimated Input Demand Equations and Marginal Costs

Before we briefly discuss the results with respect to the input demand equations, we note that for two industries (road vehicles and wood working) the convexity condition of the variable cost function with respect to the capital stock is not fulfilled. Our maintained model specification seems not an adequate description of technology in these industries which were therefore excluded from the subsequent analysis.

The elasticities in Table A1 in the appendix show the short-run response of input demand with respect to a change in factor prices and an exogeneous shift in output for a given capital stock, respectively. Thus, they do not account for possible second-round effects arising from adjustment of the capital stock to its long-run optimal level (see Morrison 1988a). Furthermore, we do not allow for the indirect effect a change in factor prices may have on the level of output. This would imply to model the output demand function for each industry explicitely, which is - as already explained - beyond the scope of the present study.

The time variation of the elasticities in Table A1 can be gleaned from their reported mean values and standard deviations over the estimation period. Furthermore, to give some information on the significance of the estimated elasticities, we report their absolute t-values for the year 1980, i.e. the year where prices in the model have been normalized.

With the exception of two industries (iron and steel, and wood working) the estimated elasticities of labour input with respect to output are within reasonable magnitudes. In most cases their time variation, as given by the reported standard deviations, is quite modest. Although these elasticities vary substantially between industries, as a rule they are rather smaller than one. In case of the two industries mentioned the estimated elasticities of labour input with respect to output are negative, although not significantly different from zero, at least for some years, which does not seem very plausible on a priori grounds. They are therefore excluded from the sample in the subsequent analysis.

The estimated own price elasticities are non-positive in all cases as it is required from the definition of a proper cost function. Although statistically different from zero in most cases, they tend to be rather small. These estimates do however confirm reasonably well with the few disaggregated results for West-German manufacturing (Hansen 1983, Nakamura 1984, Rutner 1984, Stark 1988).

The elasticity of intermediate inputs with respect to output is estimated at or above one in most cases. This result seems quite reasonable as it indicates that, with a given capital stock and with rather low employment elasticities, short-run adjustments to varying output levels are mainly brought about by variations in the level of intermediate inputs. This is also consistent with the fact that in our model labour and raw materials are substitues in the production process. Empirically, in the majority of industies, the cross price elasticity is significantly different from zero. These results indicate that studies that assume strict proprotionality between the demand for intermediate inputs and output and/or neglect substitution possibilities, as e.g. in the studies by Hall (1988) and Domowitz et al. (1988), cannot be relied upon to give sensible estimates of marginal costs.

For each industry the usual summary statistics, e.g. the Durbin-Watson statistics and the adjusted coefficients of determination, for the input equations and the price equation are summarized in Table A2 in the appendix. Although in a number of cases the DW statistic seems rather low and falls into the inconclusive region in some cases, only for two industries (iron and steel, wood working) our model was definitely rejected by the data. For further reference note that for the pricing equation the DW test statistics do not indicate that dynamic misspecification may be a serious problem for the industries not excluded from the sample.

To sum up the results with respect to the factor demand equations, it may be concluded that, with the exception of four industries (iron and steel, road vehicles, wood working and wood products) which are excluded from the subsequent analysis, marginal costs in individual industries seem to be quite adequately estimated by our specification.

IV.2 Time Profiles of Markups, Cost-Flexibility and Capacity Utilization

We may therefore turn to the main results of the present study which are summarized in the following Table 1. The table shows for each of the industries remaining in the sample estimates of means and standard deviations of the markup (θ), the variable short-run (ϵ_{GY}) and long-run cost flexibility (η) and the capacity utilization measure (Γ) over the estimation period. In addition, the respective values of these variables and their test statistics for the year 1980 are given. The reported t-statistics test against the natural null hypothesis that each of these measures is equal to one. Before we comment on the variation of these measures over the estimation period, the results are assessed with respect to this year.

For the year 1980, the estimated markups are significantly larger than one in virtually every industry and within a reasonable range. Our estimates suggest that most industries in West-German manufacturing are characterized by a considerable extent of market power. Our estimated markups are between those reported for selected industries in the related studies by Appelbaum (1982) for the U.S. and Borooah and van der Ploeg (1986) for the U.K.. Furthermore, it may be interesting to note that these estimates are comparable to those obtained, though by a rather different method, by Domowitz et al. (1988) for two-digit U.S. manufacturing industries.

TABLE 1. Markups, Cost elasticities and capacity utilization in selected industries

INDUSTRY	Θ 1961-1985 μ	Θ 1961-1985 σ	Θ 1980[1]	ϵ_{GY} 1961-1985 μ	ϵ_{GY} 1961-1985 σ	ϵ_{GY} 1980[1]	η 1961-1985 μ	η 1961-1985 σ	η 1980[1]	Γ 1961-1985 μ	Γ 1961-1985 σ	Γ 1980[1]
14 Chemical products	1.498	0.100	1.358 (6.63)	0.793	0.024	0.809 (6.23)	0.748	0.021	0.732 (7.54)	0.867	0.054	0.915 (1.45)
16 Plastic products	1.290	0.145	1.160 (2.99)	0.941	0.059	0.998 (0.04)	0.888	0.023	0.907 (2.09)	0.934	0.023	0.966 (0.54)
17 Rubber products	1.279	0.034	1.305 (5.64)	0.877	0.019	0.864 (3.89)	0.833	0.036	0.804 (5.71)	0.899	0.015	0.906 (1.83)
18 Stones and clay	1.364	0.194	1.198 (3.43)	0.914	0.083	0.962 (0.85)	0.857	0.038	0.861 (3.44)	0.810	0.038	0.857 (3.04)
19 Ceramic goods	1.471	0.054	1.432 (4.19)	0.815	0.010	0.813 (3.33)	0.638	0.026	0.621 (6.72)	1.034	0.036	1.065 (0.56)
20 Glass	1.247	0.027	1.242 (5.18)	0.946	0.030	0.939 (1.73)	0.941	0.027	0.932 (1.54)	0.827	0.029	0.813 (3.62)
22 Non-ferrous metals	1.122	0.023	1.109 (1.59)	0.997	0.021	0.985 (0.25)	0.822	0.078	0.764 (5.59)	1.041	0.086	1.119 (1.11)
23 Foundries	1.218	0.031	1.246 (4.99)	0.910	0.035	0.878 (3.58)	0.627	0.123	0.509 (8.12)	1.226	0.181	1.414 (2.23)
24 Drawing plants etc.	1.296	0.022	1.286 (7.80)	0.915	0.038	0.898 (3.86)	0.871	0.053	0.833 (2.48)	0.869	0.033	0.910 (1.13)
25 Structural metal products	1.182	0.075	1.214 (3.20)	0.953	0.044	0.934 (1.43)	0.438	0.150	0.317 (4.40)	2.177	0.705	2.686 (1.20)
26 Mechanical engineering	1.167	0.034	1.187 (3.90)	0.958	0.050	0.912 (2.35)	0.849	0.055	0.796 (3.74)	0.985	0.016	0.998 (0.02)
31 Electrical engineering	1.223	0.018	1.227 (1.70)	0.927	0.015	0.914 (0.87)	0.654	0.062	0.593 (3.24)	1.284	0.087	1.366 (0.96)
32 Precision and optical instruments	1.457	0.048	1.432 (5.23)	0.843	0.016	0.843 (3.21)	0.710	0.093	0.628 (5.96)	1.072	0.132	1.207 (1.41)
33 Finished metal goods	1.245	0.024	1.222 (4.26)	0.935	0.010	0.932 (1.71)	0.748	0.061	0.690 (6.11)	1.093	0.063	1.158 (1.59)
34 Musical instruments, toys etc.	1.553	0.098	1.446 (6.13)	0.804	0.017	0.813 (4.47)	0.816	0.017	0.822 (3.70)	0.864	0.014	0.863 (1.88)
37 Paper manufacturing	1.171	0.023	1.175 (3.07)	0.957	0.031	0.949 (1.08)	0.814	0.095	0.720 (5.49)	0.913	0.077	1.001 (0.01)
38 Paper processing	1.257	0.015	1.264 (4.99)	0.938	0.043	0.908 (2.47)	0.993	0.035	0.970 (0.86)	0.821	0.036	0.792 (5.25)
39 Printing and duplicating	1.228	0.014	1.229 (1.59)	0.974	0.032	0.947 (0.48)	0.965	0.074	0.896 (0.62)	0.823	0.028	0.857 (0.59)
41 Textiles	1.156	0.043	1.131 (3.21)	0.988	0.030	0.958 (1.25)	0.864	0.056	0.794 (6.35)	0.926	0.024	0.946 (1.06)
42 Clothing	1.175	0.039	1.205 (3.64)	0.959	0.037	0.917 (1.99)	0.872	0.073	0.793 (5.93)	1.019	0.028	1.051 (0.69)
43 Food and beverages	1.052	0.047	0.914 (1.21)	1.117	0.071	1.065 (0.93)	1.128	0.078	1.065 (1.52)	0.867	0.009	0.866 (3.00)

1) absolute t-values for the hypothesis that the coefficient is one

The short-run cost elasticity is only significantly smaller than one for half of all industries under consideration. In contrast, the long-run cost elasticity is estimated significantly below one in the great majority of industries. The latter result indicates that overall West-German manufacturing industries exhibit economies of size to a considerable extent. Imposing the homogeneity or homothecity assumption on industry cost functions as e.g. in the studies of Booroah and van der Ploeg (1986), Morrison (1988) and Conrad (1988) therefore seems (at least for West-German manufacturing) too restrictive an assumption. This, by the way, is also one of the results of various stastistical tests by Conrad and Unger (1987) based on a translog variable cost function for a somewhat different sample of West-German industries.

Except for one industry, the estimates for our measure of capacity utililzation seem within a reasonable range. For the year 1980 capacity utilization is not significantly different from one for the majority of industries which were therefore in equilibrium in the sense defined in the theoretical section. This conforms reasonably well with the result of the mentioned study by Conrad and Unger (1987) who, however, base their formal test on the whole observation period. For the structural metal products industry the estimated value for the capacity utilization measure seems absurdely high numerically, although it is insignificantly different from one. As the precision of this estimate is rather poor, this industry will be excluded from the subsequent analysis. From those seven industries (rubber products, stones and clay, glass, foundries, musical instruments and toys, processing of paper) which were not in long-run equilibrium in this year six industries were operating at excess capacity.

The behaviour of markups, costs and capacity utilization in West-German manufacturing over the estimation period can be assessed by looking at the estimated standard deviations of these variables reported in Table 1. However, a more impressive picture of the long-term development of these measures is given in the following Figure 1 where, for each industry remaining in our sample, the markup, the long-run cost flexibility and the capacity utilization measure are plotted over the estimation period.

FIGURE 1. Markups, Long-run Cost Flexibility and Capacity Utilization

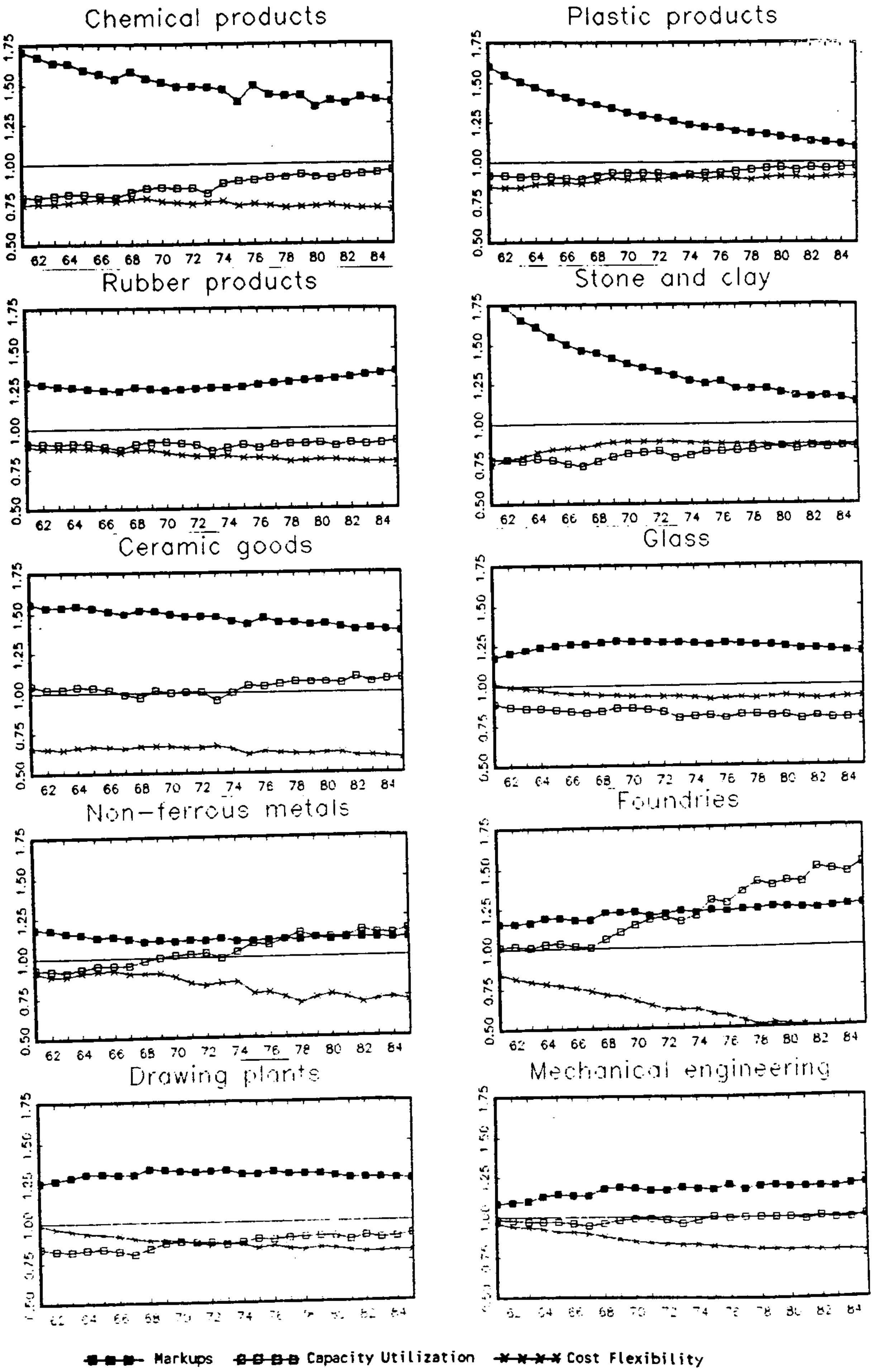
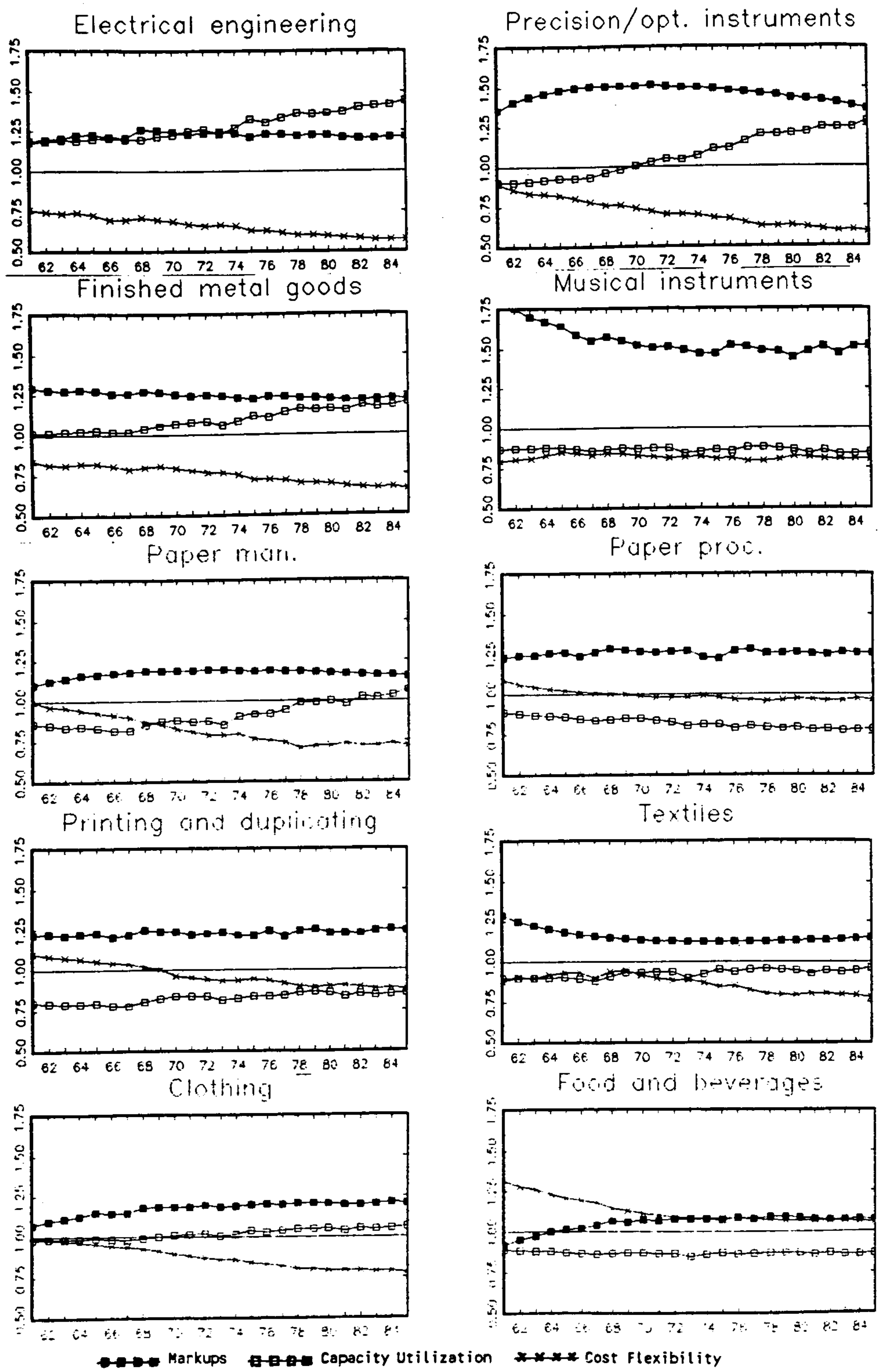


FIGURE 1. Continued



The general picture emerging from Fig. 1 can be summarized as follows. Except for those ind3ustries with very high markups at the beginning of the observation period (chemical products, plastic products, ceramic goods, stones and clay, musical instruments) which show a rather pronounced decline in markups, there seems to be no clear time trend in the levels of estimated industry markups. If anything, markups seem to be increasing on average. Prices well above marginal costs persist virtually in all industries for a relatively long period of time. This result indicates that high positive price-cost margins are not just a disequilibrium phenomena but rather a structural feature of the economy which can be attributed to the fact that for virtually all industries in our sample the elasticity of long-run cost with respect to output is considerably smaller than one. As this implies that marginal costs are lower than average costs, a positive markup is necessary to sustain an industry equilibrium.

With respect to the capacity utilization measure which captures short-run disequilibrium phenomena within our model specification, the conclusion from Fig. 1 would be that capacity utilization shows no or at most a modest positive trend in the great majority of industries. Although not particularly strong, our capacitiy utilization measure does show some cyclical variation in the recession years 1967 and 1973. In quite a few of the industries studied, there has been excess capacity over remarkable prolonged periods of time or even over the whole observation period. In stark contrast, over-utilization of capacity over longer time periods is only observed for a few dynamic industries such as electrical engineering, precision and optical instruments, and finished metal goods. The major exeption that does not fit into the picture foundries industry which shows a very sharp rise capacity utilization measure.

IV.3 Flexibility of Prices, Marginal Costs and Markups

The analysis so far has been mainly restricted to the levels of markups and costs. A recurrent theme in the literature on industrial pricing has been how prices and/or markups respond to changes in the level of demand, and how these fluctuations are

TABLE 2. Elasticities of price, marginal costs and markups with respect to output in selected industries

INDUSTRY	ϵ_{PY} 1961-1985 μ	σ	ϵ_{PY} 1980[1)]	$\epsilon_{G'Y}$ 1961-1985 μ	σ	$\epsilon_{G'Y}$ 1980[1)]	$\epsilon_{\theta Y}$ 1961-1985 μ	σ	$\epsilon_{\theta Y}$ 1980[1)]
14 Chemical products	0.211	0.023	0.207 (2.40)	-0.042	0.037	-0.071 (1.07)	0.253	0.016	0.278 (3.86)
16 Plastic products	0.102	0.018	0.117 (1.94)	0.068	0.015	0.079 (1.31)	0.034	0.004	0.038 (0.99)
17 Rubber products	0.046	0.027	0.019 (0.29)	-0.003	0.026	-0.029 (0.45)	0.049	0.001	0.048 (0.97)
18 Stones and clay	0.049	0.115	-0.084 (1.00)	-0.056	0.128	-0.200 (2.67)	0.104	0.014	0.117 (3.28)
19 Ceramic goods	0.072	0.021	0.041 (0.81)	-0.048	0.024	-0.082 (1.65)	0.120	0.004	0.123 (3.79)
20 Glass	0.113	0.079	0.208 (4.16)	0.065	0.079	0.160 (3.46)	0.048	0.001	0.048 (1.47)
22 Non-ferrous metals	-0.124	0.043	-0.161 (1.36)	-0.027	0.042	-0.063 (0.83)	-0.100	0.002	-0.099 (1.24)
23 Foundries	-0.011	0.022	-0.045 (0.43)	-0.108	0.021	-0.140 (1.62)	0.097	0.003	0.095 (2.28)
24 Drawing plants etc.	0.150	0.081	0.238 (2.56)	0.064	0.081	0.152 (1.92)	0.086	0.001	0.086 (1.42)
25 Structural metal products	-0.237	0.061	-0.256 (3.86)	-0.189	0.060	-0.209 (4.87)	-0.048	0.003	-0.046 (0.83)
26 Mechanical engineering	0.016	0.022	0.001 (0.02)	-0.154	0.018	-0.166 (2.13)	0.171	0.005	0.168 (3.63)
31 Electrical engineering	0.116	0.027	0.087 (0.66)	-0.054	0.026	-0.081 (0.71)	0.169	0.003	0.169 (3.11)
32 Precision and optical instruments	-0.142	0.024	-0.193 (2.35)	-0.100	0.024	-0.151 (2.16)	-0.042	0.001	-0.042 (1.11)
33 Finished metal goods	0.136	0.036	0.100 (1.46)	0.050	0.037	0.009 (0.16)	0.085	0.002	0.087 (2.84)
34 Musical instruments, toys etc.	0.143	0.151	0.159 (1.91)	-0.036	0.160	-0.032 (0.42)	0.179	0.010	0.191 (4.29)
37 Paper manufacturing	-0.011	0.102	0.106 (1.56)	-0.022	0.103	0.095 (1.31)	0.012	0.001	0.012 (0.37)
38 Paper processing	0.211	0.040	0.246 (3.40)	0.032	0.041	0.069 (0.92)	0.178	0.002	0.177 (3.37)
39 Printing and duplicating	0.187	0.021	0.165 (1.30)	-0.008	0.020	-0.305 (0.25)	0.195	0.002	0.195 (2.93)
41 Textiles	0.063	0.303	-0.277 (2.26)	0.056	0.303	-0.283 (2.99)	0.006	0.001	0.007 (0.10)
42 Clothing	0.001	0.054	0.067 (1.40)	-0.104	0.051	-0.169 (4.72)	0.105	0.004	0.103 (3.48)
43 Food and beverages	0.247	0.058	0.313 (2.33)	-0.008	0.065	0.067 (0.67)	0.255	0.012	0.247 (2.65)

1) absolute t-values are in parentheses

influenced by market concentration (see e.g. Scherer 1980, Carlton 1989). Most studies in this area are, however, blurred by their neglect to distinguish between changes in (marginal) costs and in markups leading to fluctuations in prices by implicitly assuming that (marginal) costs are constant (see e.g. Hall 1986, Domowitz et al. 1988). In contrast, the specification adopted in the present study enables us not only to directly estimate the elasticity of price with respect to output, but also allows for a proper identification of its components, i.e. the elasticity of marginal costs and the elasticity of the markup with respect to the level of output. The results of these calculations are summarized in Table 2.

Looking at the estimated price elasticities in Table 2 for the year 1980, the general conclusion that may be drawn from our results is that prices tend to be procyclical on average. This in itsself is probably not a very controversial result as a lot of a priori reasoning may derive an upward sloping industry supply curve, the usual reason given for it being rising marginal costs. There is also some other supportive evidence for procyclical pricing behaviour in West-German manufacturing industries (see Arz 1989). However, as shown by the estimates for the elasticity of marginal costs for our reference year in Table 2, this seems not to be the case for the majority of industries under study. In fact, with the exception of two industries (glass and drawing plants), estimated elasticities at least for the reference year 1980 are either negative or not significantly different from zero.

This leaves the explanation for observed procyclical price fluctuations with procyclical markups. There is in fact strong evidence for quite a number of industries in our sample that markups are raised with increasing demand. This is also the result of a recent study by Domowitz et al. (1987, 1988) who have found, by extending the method developed by Hall (1988), evidence for procylical price-cost margins in U.S. manufacturing industries.

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IV.4 Inter-industry Differences in Markups

The results presented so far naturally evoke a host of questions on pausible explanations for the observed facts. Our main interest in this section is in possible explanations of inter-industry differences in markups and its relationship to market structure. Following established tradition in the industrial economics literature, we use both the Herfindahl-index of concentration (HERF) and the ten-firms concentration ratio (CR10) as indicators of market power. The Herfindahl-index is only available for the years 1977 to 1985. The particular CR measure was chosen because, compared to alternative CR measures, it is the most completely available measure for the observation period. In view of the very high correlation between the various concentration ratios, the choice of a particular measure does not seem very important anyway. Given the availability of these two measures and the fact that they change rather slowly over time, the years 1960, 1970, 1977, 1980 and 1985 were selected for the regressions in the following table.

TABLE 3. Determinants of inter-industry differences in markups

	Simple Pooling		Fixed Effects	
	I	II	I	II
Constant	2.840 (19.19)	2.600 (23.11)	-	-
CR10	-0.035 (1.06)	-	-0.013 (0.10)	-
HERF	-	-0.023 (0.86)	-	0.019 (0.10)
IMQ	-0.084 (2.44)	0.016 (0.58)	-0.218 (2.87)	-0.230 (2.66)
η	-1.687 (15.86)	-1.514 (17.76)	-1.535 (9.87)	-1.505 (9.70)
$(\epsilon_{GY}-\eta)$	-2.043 (12.85)	-1.759 (13.87)	-2.466 (7.79)	-2.410 (6.82)
Γ	0.052 (0.57)	0.067 (0.88)	0.496 (2.67)	0.478 (2.74)
$\bar{R}^2$	0.83	0.87	0.77	0.69
N	95	60	95	60

Heteroscedasticity-consistent standard errors are in parentheses.

In Table 3 we report the results of some simple pooled cross-section time series regressions for the twenty remaining industries in our sample for these selected years. Each regression was run with the estimated markups from the previous section as the dependent variable and, alternatively, the CR10 measure (Model I) and the Herfindahl index (Model II) as an explanatory variable by pooling the years available for the respective alternative. Following a priori reasoning and usual tradition in the industrial economics literature (Schmalensee 1989), we included the share of imports in an industry as a proxy variable for the competitive threat arising from international trade (see also Neumann et al. 1985) and three cost-based measures from our preceding analysis as explanatory variables in all regressions. To control for constant unobserved industry differences we have also estimated the various models by the standard fixed-effects within-group estimator. As heteroscedasticity seems a potential problem in cross section work of this kind, we have in each case calculated heteroscedasticty-consistent standard errors.

The rationale for the latter three variables is as follows. As explained above, long-term cost flexibility should be a very important predictor for differences in inter-industry markups. A significant negative correlation between these two variables can be considered a plausibility test of the estimated model. An alternative explantion for a negative correlation of the elasticity of (long-run) costs and markups with somewhat more intuitive appeal which is popular in the industrial economics literature is in terms of scale economies as barriers to entry. In our model the reciprocal of long-run cost elasticity defines the economies of size in an industry which, although not exactly equal to the elasticity of scale, may be seen as a proxy for barriers to entry. Our second cost-based variable is the difference between the short-run and long-run cost flexibility which, ceteris paribus, is the larger the more responsive variable costs are to an increase in the quasi-fixed factor (see eq. (8)). Finally, we have our capacity utilization measure which should account for disequilibrium effects on pricing behaviour.

Both the long-run cost flexibility and its difference to the short-run cost flexibility turned out highly significant in the regressions explaining the level of markups irrespective of the concentration measure and the estimation method used. It may be noted that the rather high explanatory power of these regressions, as measured by the coefficient of determination (corrected for degrees of freedom), is entirely due to these two variables. Although the capacity utilization measure shows a signifcant positive effect on the level of markups after unobserved industry effects have been controlled for, it is quantitatively less important. The traditional concentration measures have no significant effect on the level of markups irrespective of the particular model specification. This seems hardly surprising as the structure of production costs can be shown to play a key role in determining concentration in a number of theoretical models (see Davis 1988 for a survey, and Aiginger 1990 for a similiar argument in a related context). In contrast, the import share in an industry shows the expected negative coefficient after unobserved industry effects have been controlled for.

V. Conclusions

Our specification of the restricted cost function with capital as quasi-fixed factor of production allowed a satisfactory description of factor demand and pricing behaviour for the great majority of industries studied in this paper. For West-German manufacturing the following results have been established:

The hypothesis of perfect competition can be firmly rejected for all industries in our sample. In virtually all industries prices are considerably higher than marginal costs over the whole estimation period. Although the levels of markups differ quite substantially between industries, with the exception of a few industries which had exceptionally high margins at the beginning of the observation period markups have remained fairly stable over time.

The estimated long-run cost flexibilities are considerably smaller than one in virtually every industry indicating the importance of economies of size in West-German manufacturing. This structural feature of the West-German economy is the single most important explanation for the previous result of high industry markups.

In contrast to the former result, the short-run cost flexiblity is significantly smaller than one only for about half of the industries studied. This quite clearly underpins the crucial role that accrues to the capital stock as a quasi-fixed factor of production. This corresponds reasonably well with our results with respect to the capacity utilization measure which reveals that a number of industries have been in disequilibrium with respect to the capital stock for substantial periods of time.

In the majority of industries under study prices behave procyclically, which is compatible with a priori reasoning and some of the available evidence. The reason for procyclical prices is, however, not to be found in increasing marginal costs which tend to be countercyclical on average, but in procyclical mark-ups. The latter result is compatible with both some theoretical models of pricing behaviour and the recent empirical results for U.S. manufacturing.

Our pooled cross-section time series regressions suggest that traditional measures of market concentration such as the Herfindahl-index and the ten-firms concentration ratio cannot explain inter-industy differences in the level of markups after differences in economies of size have been statistically controlled for. Although differences in import competition seem modestly important to keep markups down, the inter-industry markups are predominantly determined by our derived cost flexibility measures.

Appendix

Data

The data refer to the manufacturing sector of the West-German economy over the period 1960 to 1985. Data for nominal gross output, nominal intermediate inputs and real value added have been taken from the yearly disaggregated national income accounts (Source: Statistisches Bundesamt (StaBu), Fachserie 18). Real gross output series have been obtained as follows: After correcting the producer price index for domestic and foreign sales at the industry level (Source: StaBu, Fachserie 17 and Fachserie M) for the change in the tax system in 1968 (when the sales tax was replaced by the value added tax), we obtained weights for the respective bundle of goods in each of our industries from the disaggregated input-output table for 1982 (StaBu, Fachserie 18, Reihe 2, Table 4.2). Then, price indices for industry gross output were calculated as a weighted sum of the domestic producer price index. An implicit price index for intermediate inputs for each industry was derived by dividing nominal intermediate inputs by the difference between real gross output and real value added. Yearly total hours at the industry level are average yearly hours actually worked per employee (Source: Institut für Arbeitsmarkt- und Berufsforschung Nurenberg, Kohler and Reyher 1988) multiplied by the number of employees in the respective industry. The capital stock and the user costs of capital which are fully compatible with the disaggregated national income accounts have kindly been made available by the IFO Institute Munich (see Gerstenberger et al. 1989). All variables have been normalized at the year 1980. Values for the Herfindahl-index and the CR10 for the years 1960, 1970, 1977, 1980 and 1985 have been obtained from Statistisches Bundesamt (1985) and Statistisches Jahrbuch (various issues), respectively.

Because of data problems six industries had to be excluded from the sample. For these industries there are either no consistent price indices (mineral oil refining, shipbuilding, aircraft and spacecraft, tobacco) or data is not available over the whole estimation period (office machinery and data processing equipment, leather and leather goods).

TABLE A1. Elasticities of the input equations with respect to output and the wage rate.

INDUSTRY	ϵ_{LY} 1961-1985 μ	σ	ϵ_{LY} 1980[2]	ϵ_{LW} 1961-1985 μ	σ	ϵ_{LW} 1980[2]	ϵ_{MY} 1961-1985 μ	σ	ϵ_{MY} 1980[2]	ϵ_{MW} 1961-1985 μ	σ	ϵ_{MW} 1980[2]
14 Chemical products	0.337	0.043	0.312 (2.46)	-0.163	0.041	-0.201 (2.78)	0.954	0.028	0.974 (31.09)	0.057	0.012	0.067 (2.76)
16 Plastic products	0.701	0.189	0.874 (5.53)	-0.225	0.051	-0.272 (3.40)	1.051	0.009	1.052 (23.96)	0.100	0.019	0.119 (3.42)
17 Rubber products	0.502	0.059	0.445 (4.07)	-0.097	0.015	-0.114 (1.88)	1.081	0.004	1.085 (29.86)	0.053	0.009	0.060 (1.86)
18 Stones and clay	1.309	0.147	1.109 (3.14)	-1.645	0.391	-2.043 (4.63)	0.720	0.188	0.900 (6.90)	0.767	0.109	0.863 (4.16)
19 Ceramic goods	0.650	0.069	0.589 (8.30)	-0.280	0.041	-0.327 (7.85)	1.003	0.060	1.051 (13.89)	0.321	-0.035	0.347 (7.90)
20 Glass	0.674	0.097	0.828 (8.94)	-0.139	0.030	-0.165 (2.07)	1.111	0.108	1.004 (20.37)	0.081	0.012	0.094 (2.07)
21 Iron and steel	0.046	0.236	-0.103 (0.50)	-0.015	0.004	-0.021 (0.11)	1.148	0.084	1.061 (20.36)	0.006	0.001	0.007 (0.11)
22 Non-ferrous metals	0.527	0.056	0.506 (2.40)	-0.131	0.039	-0.173 (3.08)	1.098	0.029	1.075 (16.22)	0.027	0.006	0.032 (3.02)
23 Foundries	0.575	0.045	0.559 (5.13)	0.018	0.002	0.021 (0.24)	1.155	0.043	1.107 (21.57)	-0.013	0.002	-0.015 (0.24)
24 Drawing plants etc.	0.481	0.100	0.612 (3.73)	-0.219	0.022	-0.244 (2.16)	1.106	0.083	1.026 (18.78)	0.097	0.013	0.110 (2.14)
25 Structural metal products	0.457	0.198	0.796 (4.68)	-0.216	0.048	-0.273 (1.70)	1.231	0.183	0.997 (21.79)	0.110	0.014	0.123 (1.70)
26 Mechanical engineering	0.685	0.022	0.683 (6.65)	-0.249	0.027	-0.273 (3.49)	1.115	0.077	1.050 (20.61)	0.145	0.019	0.165 (3.55)
28 Road vehicles[1]	0.816	0.054	0.861 (6.11)	-0.600	0.095	-0.724 (6.78)	1.033	0.061	0.980 (14.84)	0.245	0.042	0.287 (7.28)
31 Electrical engineering	0.569	0.088	0.653 (3.30)	-0.212	0.041	-0.250 (3.71)	1.140	0.061	1.081 (13.79)	0.129	0.031	0.160 (3.76)
32 Precision and optical instruments	0.621	0.126	0.753 (8.01)	-0.040	0.006	-0.046 (0.56)	1.005	0.100	0.912 (12.48)	0.030	0.005	0.035 (0.55)
33 Finished metal goods	0.500	0.039	0.456 (3.85)	0.031	0.004	0.036 (0.22)	1.172	0.024	1.192 (25.22)	-0.017	0.003	-0.019 (0.22)
34 Musical instruments, toys etc.	0.632	0.176	0.605 (7.91)	-0.251	0.023	-0.278 (4.84)	0.904	0.111	0.921 (14.93)	0.145	0.012	0.145 (4.55)
35 Wood working[1]	0.213	0.290	-0.066 (0.53)	-0.570	0.108	-0.687 (5.12)	0.919	0.038	0.884 (13.31)	0.162	0.036	0.190 (4.80)
36 Wood products	0.435	0.115	0.600 (3.47)	-0.060	0.013	-0.077 (0.41)	1.190	0.082	1.111 (20.19)	0.031	0.004	0.035 (0.41)
37 Paper manufacturing	0.821	0.334	1.103 (7.11)	-0.076	0.023	-0.092 (2.04)	1.011	0.127	0.900 (24.74)	0.024	0.005	0.029 (2.05)
38 Paper processing	0.612	0.051	0.642 (4.95)	-0.300	0.048	-0.327 (6.30)	1.075	0.075	1.015 (24.52)	0.117	0.017	0.131 (6.24)
39 Printing and duplicating	0.774	0.006	0.771 (3.68)	-0.218	0.043	-0.258 (3.49)	1.139	0.071	1.079 (8.52)	0.175	0.020	0.193 (3.46)
41 Textiles	0.666	0.238	0.386 (3.13)	-0.077	0.015	-0.092 (1.20)	1.127	0.122	1.201 (48.39)	0.033	0.006	0.039 (1.20)
42 Clothing	0.615	0.103	0.488 (4.43)	-0.250	0.040	-0.297 (4.27)	1.108	0.011	1.097 (35.31)	0.108	0.017	0.125 (4.28)
43 Food and beverages	0.722	0.288	1.066 (3.67)	-0.052	0.006	-0.057 (0.37)	1.183	0.127	1.065 (12.41)	0.009	0.001	0.011 (0.37)

1) The convexity condition of the variable cost function with respect to the capital stock is not fulfilled.

2) absolute t-values in parentheses

TABLE A2. Summary statistics for the input equations and the price equation.

INDUSTRY	L/Y		M/Y		P	
	DW	$\bar{R}^2$	DW	$\bar{R}^2$	DW	$\bar{R}^2$
14 Chemical products	1.91	0.759	1.68	0.999	1.91	0.992
16 Plastic products	1.33	0.881	1.47	0.997	1.14	0.998
17 Rubber products	1.73	0.931	1.54	0.994	0.94	0.997
18 Stones and clay	1.16	0.635	1.82	0.994	1.31	0.999
19 Ceramic goods	1.39	0.942	1.91	0.997	2.12	0.999
20 Glass	1.46	0.956	1.50	0.999	0.94	0.998
21 Iron and steel	1.05	0.620	0.75	0.987	1.48	0.993
22 Non-ferrous metals	1.09	0.405	1.16	0.999	1.93	0.994
23 Foundries	1.03	0.878	1.06	0.993	1.47	0.998
24 Drawing plants etc.	1.86	0.983	1.62	0.994	1.13	0.997
25 Structural metal products	1.80	0.934	1.01	0.992	1.13	0.998
26 Mechanical engineering	1.57	0.975	1.83	0.998	1.40	0.999
28 Road vehicles[1)]	0.78	0.861	1.07	0.996	0.77	0.997
31 Electrical engineering	1.34	0.886	2.16	0.997	1.50	0.993
32 Precision and optical instruments	0.97	0.914	1.41	0.999	1.07	0.994
33 Finished metal goods	1.58	0.925	1.06	0.997	1.42	0.999
34 Musical instruments, toys etc.	1.50	0.822	1.70	0.995	1.67	0.999
35 Wood working[1)]	0.98	0.498	1.39	0.997	1.41	0.993
36 Wood products	1.17	0.967	0.58	0.998	1.17	0.998
37 Paper manufacturing	1.79	0.874	1.44	0.996	1.64	0.996
38 Paper processing	1.52	0.970	1.55	0.995	1.71	0.997
39 Printing and duplicating	1.72	0.953	1.35	0.996	1.51	0.997
41 Textiles	1.61	0.941	1.62	0.998	1.40	0.996
42 Clothing	1.49	0.982	1.62	0.999	1.81	0.999
43 Food and beverages	0.91	0.948	1.90	0.999	1.31	0.997

[1)] The convexity condition of the variable cost function with respect to the capital stock is not fulfilled.

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