Testing Profit Rate Equalization in the U.S. Manufacturing Sector: 1947–1998

Ajit Zacharias*

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* Resident Research Associate, The Jerome Levy Economics Institute.
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Abstract

Long-run differentials in interindustrial profitability are relevant for several areas of theoretical and applied economics because they characterize the overall nature of competition in a capitalist economy. This paper argues that the existing empirical models of competition in the industrial organization literature suffer from serious flaws. An alternative framework, based on recent advances in the econometric modeling of the long run, is developed for estimating the size of long-run profit rate differentials. It is shown that this framework generates separate, industry-specific estimates of two *potential* components of long-run profit rate differentials identified in economic theory. One component, the noncompetitive differential, stem from factors that do not depend directly on the state of competition; these factors are generally characterized as risk and other premia. The other component, the competitive differential, is due to factors that directly depend on the state of competition (factors such as degree of concentration and economies of scale). Estimates provided here show that during the period under study, the group of industries with statistically insignificant competitive differentials accounted for 72 percent of manufacturing profits and 75 percent of manufacturing capital stock, which is interpreted as lending support to the theories of competition advanced by the classical economists and their modern followers.

1 Introduction

The question of long-run differentials in profitability across industries has arisen in different areas of economics. In the traditional industrial organization literature this problem has been studied with the aim of determining the extent of monopoly power enjoyed by firms in different industries (Bain[1956], 1993). Monopoly power is usually considered as the degree to which firms can set prices above their marginal costs and monopoly profits are, by definition, profits above the competitive norm. The extent of monopoly power would vary across industries according to interindustrial differences in structural characteristics such as concentration, product differentiation and scale economies. The two dominant strands of Post Keynesian micro theory, deriving, respectively, from Kalecki and Eichner, have also focused on the extent and role of market power that firms exercise and its impact on profitability (Sawyer, 1995).

Following the revival of classical political economy (Sraffa, 1960), heterodox economists began to reexamine the classical notion of competition and emphasize its salient differences with the mainstream views of competition (Clifton, 1977; Semmler, 1984; Eatwell, 1982; Shaikh, 1980). The latter conceptualize real-world competition as some sort of departure from the idealized world of perfect competition and employ some version of marginalist theory of value to explain prices and profits in the real world. In contrast, heterodox economists argued that perfect competition is not the appropriate benchmark and that the marginalist theory of value is fundamentally flawed. The formalization of classical theory of value proceeded on the assumption of uniform profit rates across industries; but, it is necessary to emphasize that this assumption was traditionally not made just for the sake of analytical ease and was not meant to be an unobservable theoretical axiom (Ricardo[1821], 1951, pp.89-90; Marx[1894], 1981, p.252).[1] On the contrary, the tendential reduction of actual profit rates, adjusted for risk and other premia, to a common average and the gravitation of actual prices around prices corresponding to a general profit rate were considered as objective phenomena which provided the practical foundation for a theory seeking to determine the forces behind the general profit rate and prices of production.

Recent debates in heterodox macroeconomics around the issue of the existence of "excess capacity" in the long-run have also evoked the nature of long-run profit rate differentials (Dutt, 1995; Glick and Campbell, 1995; Duménil and Lévy, 1995). If indeed, the firms in the economy maintain significant amount of excess capacity in the long-run, as argued by some Post Keynesians, investment flows need not respond to profit rate differentials and therefore there will not be any tendency toward the equalization of industrial profit rates. Economists of a more classical persuasion have argued against this view, contending that excess capacity will be eliminated in the long run as a result of competition and profit maximization will ensure normal capacity utilization rates in the long-run.

It is only natural that this common question appears to play a decisive role in diverse research programs, theories and controversies, since the question under consideration concerns the overall nature of competition under capitalism. Almost all theories and models of different aspects of the capitalist economy or the capitalist economy as a whole, involve implicit or explicit assumptions about the competitive process. Likewise, it is also

[1] Consider the following passage: "The theoretical opinion ... that each portion of capital yields profit in a uniform way, expresses a practical state of affairs" (Marx[1894], 1981, p.270).

natural that empirical findings and theoretical assumptions regarding competition have crucial implications for public policy. Empirical findings of the existence or nonexistence of monopoly power inform competition policy, regulation and legislation. The presence of excess capacity in the long run imply that economic growth is primarily constrained by aggregate demand and therefore government spending will generally impart a stimulus to growth. Monopoly profits in crucial sectors of the economy raise questions about the distribution of income: Are monopoly profits shared between the workers and capitalists of these sectors? And if so, how does it shape the wage differentials between workers in these sectors and workers in the rest of the economy? (Galbraith, 1998).

Given the importance of the issue, a huge literature exists on theoretical and empirical analyses of competition. The focus of the present study is on the latter type of analysis, especially as it pertains to the overall nature of competition, rather than to competition in a narrowly defined industry. I propose an empirical methodology to assess long-run profitability differentials and present results from applying that methodology to the United States manufacturing industries over the period 1947-1998. The rest of the paper has the following structure. First, I discuss some problems with the econometric models used in most empirical studies. An alternative framework, based on vector autoregressive models of unit root processes, is presented next, followed by the empirical results obtained from the estimation and inference conducted with that framework. The final section discusses the limitations of the suggested approach and indicates possible future lines of research.

2 Econometric models of profitability differentials

Empirical studies on profitability differentials conducted in the 1950s and 1960s focused on relating some indicator of profitability in a given year or averaged over a very short period of time (3 or 4 years) to a set of industry characteristics.[2] The crux of the attack, inaugurated by Brozen (1971a,b) and Demsetz (1973), on these early studies was that their data and methods were prone to confound short-term disequilibria with structural barriers to competition. Since theoretical predictions about profitability differentials pertain to long-run differentials, it is difficult to provide an economic interpretation of profitability differentials estimated for a certain point in time. As Mueller puts it, "these inherently short-run glimpses at the profit–market structure relationships ... run the risk of capturing transitory correlations between market structure and profitability and inferring long run causality." (Mueller, 1986, p.1).

The implicit assumption made by the static, cross-sectional model that the deviations from the long-run or equilibrium configurations found at a given point in time is purely random and/or can be controlled for by appropriate exogenous variables is questionable (Geroski, 1990). Consider the usual static model of a particular industry's long-run profit rate, r_i^*:

$$r_i^* = c_i + \mathbf{x}_i\mathbf{b} + \mu_i \tag{1}$$

where c_i is a constant, $\mathbf{x}_i$ a vector of explanatory variables such as measures of concentration, product differentiation, economies of scale etc., $\mathbf{b}$ a vector

[2] A comprehensive listing of the early studies can be found in Weiss (1974). For a selective and critical survey of the important studies see Semmler (1984).

of unknown parameters, and μ_i an error term with the usual properties. The long-run prediction of uniform profitability and perfect competition can be formulated as the null hypothesis of $c_i = c \quad \forall i$ and $\mathbf{b} = \mathbf{0}$. However, the results from such a hypothesis test will be misleading. While in theory what appears on the left hand side of the equation is the long-run profit rate, in practice, when data averaged over a few years or for a particular year is taken, the variable that appears in place of the long-run profit rate is the actual profit rate, r_i. As a result, the estimated model is:

$$r_i = c_i + \mathbf{x}_i\mathbf{b} + \varepsilon_i \tag{2}$$

implying that $\varepsilon_i \equiv \mu_i + (r_i - r_i^*)$. In other words, the error term in equation (2) contains, apart from the usual random shocks, a measurement error equal to the deviation of the actual profit rate from the long-run profit rate. As a result of the measurement error, the standard errors will tend to be higher than their values corresponding to equation (1) thus biasing the t–statistics downward. More importantly, if any of the variables in $\mathbf{x}_i$ is correlated with the deviation from equilibrium, $(r_i - r_i^*)$, then the parameter estimates from equation (2) will be biased (Geroski, 1990, p.18). The possibility of such correlation is quite real when we consider the fact that the explanatory variables included in the regression helps to determine not just the equilibrium position but also the gravitational process around the equilibrium position.

These considerations suggest that the static framework is not suitable for measuring long-run profit rate differentials in a world where industries are constantly out of equilibrium and the dynamics of the profit rates are affected by industry specific factors such as those contained in $\mathbf{x}_i$. A dynamic approach is definitely required in order to characterize profitability differentials in an economically meaningful manner. In a series of influential works Dennis Mueller used methods of time series analysis to measure long-run profitability differentials (Mueller, 1977,1986,1990). While Mueller's main interest was interfirm profitability differences, the time series approach pioneered by him came to be applied in the study of interindustrial differences in profitability also (Glick, 1985; Glick and Ehrbar, 1990; Kessides, 1990; Christodoulopolus, 1996). The models employed by these authors are autoregressive (*AR)* models.

The prominent member of this family of models may be called the *AR(1)* model of profit rates since an industry's profit rate is considered as a first-order autoregressive process in this model. The model posits that each industry's annual profit rate r_{it} is potentially composed of three elements: (1) a competitive rate c that is common to all industries; (2) a permanent rent r_i that is specific to each industry, which could be a risk premium; and (3) a short-run profit rate differential or rent s_{it}:

$$r_{it} = c + r_i + s_{it} \tag{3}$$

The assumption that the profit rate differential in one year is independent of the previous year's profit rate differential is considered to be unrealistic. As a more reasonable approach, short-run rents are assumed to be intertemporally related via a stationary $AR(1)$ process:

$$s_{it} = \lambda_i s_{it-1} + u_{it} \tag{4}$$

where u_{it} is $N(0, \sigma_i^2)$ and $|\lambda_i| < 1$ (Mueller, 1986, p.13; Mueller, 1990, p.35). If this is assumed to hold in each year, equation(3) can be rewritten as:

$$r_{it} = (1 - \lambda_i)(c + r_i) + \lambda_i r_{it-1} + u_{it} \tag{5}$$

Given the assumptions regarding λ_i and σ_i^2, the model can be estimated using well-known methods. From the calculated values of its intercept $\widehat{\alpha_i}$ and the autoregressive coefficient $\widehat{\lambda_i}$ an estimate of the "permanent" element in the profit rate $r_{ip} = c + r_i$ can be obtained:

$$\widehat{r_{ip}} = \frac{\widehat{\alpha_i}}{1 - \widehat{\lambda_i}} \tag{6}$$

If the profit rate differentials did not contain any permanent components, $\widehat{r_{ip}}$ will not differ significantly across industries. The estimated parameter $\widehat{\lambda_i}$ will then indicate the speed at which a particular industry's profit rate approaches the general profit rate. On the other hand, if $\widehat{r_{ip}}$ were to be significantly different across industries, it may be concluded that there exist long-run interindustrial profit rate differentials. In this case, each industry has its own long-run center of gravity and the estimated parameter $\widehat{\lambda_i}$ will indicate the speed of convergence to that industry–specific center of gravity.

While the above model is free from the type of problems associated with the static cross-sectional models, it should be noted that it has its own problems. First, it is impossible to identify whether the estimated permanent rent of an industry is above or below the competitive rate of return because c and r_i are not separately estimated. Second, in so far as there are industry-specific, relatively permanent factors such as risk and other premia influencing profit rates, the estimated permanent rents are likely to be different across industries. By testing the restriction that they are equal, what is being tested is the hypothesis that such factors do not count in the long-run. This is clearly different from testing whether profit rates, adjusted for risk and other premia, have a long-run tendency toward equality. Third, the above formulation requires the competitive rate of return to stay at a fixed level over time. While such an assumption would probably be reasonable for relatively short periods of time (say 5-10 years), there is no guarantee that it would hold over longer periods of time (40-50 years). The marxian theory of the falling rate of profit would suggest that such an assumption is inappropriate over longer periods of time (Marx[1894], 1981, pp.317-338). Furthermore, for the sample I intend to study, it has been widely documented that the average profit rate in the U.S. manufacturing has declined substantially over the postwar period, albeit with some recovery in the 1980s and the 1990s (Shaikh, 1987; Duménil and Lévy, 1993; Zacharias, 2001).

An alternative formulation of the same basic model—which may be called the *AR(1)* model of profitability differentials—allows a way out from problems noted above by allowing the competitive rate of return, c, to vary over time and assuming it to be equal to the average profit rate for all industries r_t at all points in time:

$$c_t = r_t \tag{7}$$

Equation(3) then becomes

$$r_{it} = r_t + r_i + s_{it} \tag{8}$$

Maintaining the same assumptions as before regarding s_{it} and letting $\delta_{it} = r_{it} - r_t$ a new version of equation(5) emerges:

$$\delta_{it} = (1 - \lambda_i) r_i + \lambda_i \delta_{it-1} + u_{it} \tag{9}$$

The estimation of the model specified by equation (9) will allow the assessment of interindustrial differences in r_i and the rate of convergence λ_i. While the model of profit rates presented by Mueller (1986,1990) uses the specification in equation (5), the model estimated by Mueller (1990) employs the specification in equation (9). The latter is also the model of Glick (1985), Glick and Ehrbar (1990) and Geroski (1990).

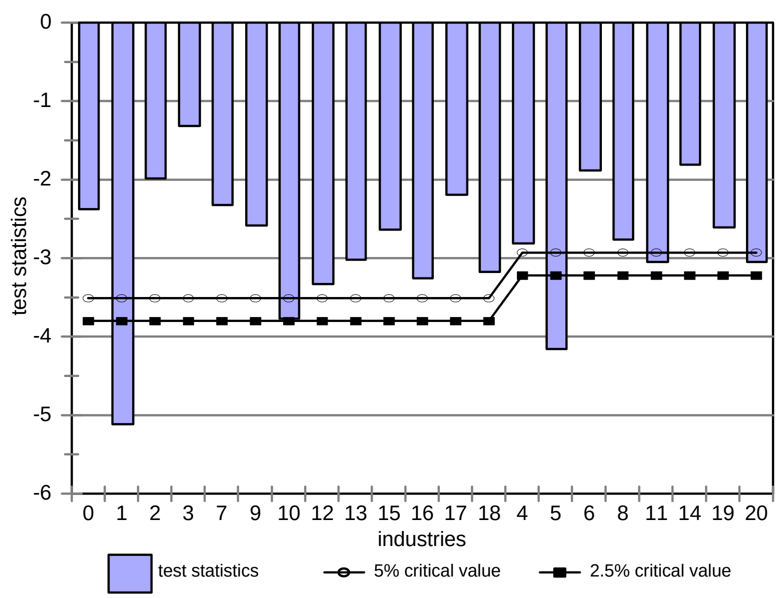
While the alternative specification appears to avoid some of the difficulties associated with the original model, this appearance is misleading. First, if an assumption is explicitly made about the equality between the long-run competitive rate of return and the annual average profit rate, it must be admitted that such an assumption is only as valid as the implicit assumption in the static models that the long-run configurations can be estimated from the data for a single year. As noted above, it was the questioning of this assumption that gave rise to time series models. Of course, such an assumption is only sufficient, not necessary, to arrive at the *AR(1)* model of profit rate differentials. One may begin from equation (8), (as, for example, in Glick and Ehrbar (1990)) and justify the taking of annual profit rate differentials, rather than profit rates, as the variable of interest on the grounds that it factors out business cycles and common trends. As we shall see later, ignoring common trends when they are present can represent a serious loss of information which can be utilized in studying profit rate dynamics.

Second, the *AR(1)* model of profit rate differentials does not improve matters with respect to testing for profit rate equalization. Indeed, the estimate of the permanent rent now does not include the competitive rate of return; but, once again, the hypothesis of equalization can only be formulated as the equality of permanent rents across industries, and therefore, this model suffers from the same deficiency that was noted for the *AR(1)* model of profit rates. An important limitation of both models is that no distinction is made between two *potential* components of observed profit rate differentials. The first component, as is generally recognized, may exist in a particular industry due to time–invariant factors (such as risk, peculiarities of the line of business, etc.) specific to that industry. I call this the noncompetitive profit rate differential (or the noncompetitive differential for short) in order to emphasize the fact that it is not directly related to the state of competition. The actual profit rate differential of any industry may also contain a dynamic component related to the manner in, and the extent to which competition affects that industry as mediated by barriers to entry/exit which themselves will change over time. I call this the competitive profit rate differential (or the competitive differential for short) in order to emphasize the fact that it is directly related to the state of competition. Estimates of permanent rents generated by the time series models discussed above consist of both these components. As a result, even though permanent rents may differ significantly across industries, in the absence of separate estimates of the two potential components of profit rate differentials, it is difficult to assess the implications of the estimated permanent rents for the nature of competition.

The approach taken by Mueller and others (see Mueller, 1986, pp.77,125; Mueller, 1990, p.42; Kessides, 1990, pp.73–4; Odagiri and Yamawaki, 1990, p.135) is to treat the estimated permanent rents as the dependent variable to be explained by a set of industry–specific characteristics associated with barriers to entry/exit, such as advertising/sales ratios, concentration ratios etc. At best, this procedure can provide estimates of how much on the average, for all industries, is the variation in permanent rents due to industry characteristics. It does not produce estimates of the effects of these characteristics on the profitability of a specific industry.

Finally, the statistical model employed in any study has to take into account the prominent features of the data to avoid specification errors. The data used in the present study (described fully later) are the profit rates of 20 U.S. manufacturing industries during the period 1947–1998. As a specification test for the AR(1) model of profit rates, unit root tests were conducted and the results are displayed in Figure 1.

Figure 1: **Unit root test statistics**



Note: (i) The test statistics reported are for the Augmented Dicky-Fuller (ADF) test and the Phillips-Perron (PP) test. (ii)

The critical values are taken from Hamilton (1994, Table B.6, p.763). (iii) The residuals from the ADF test equations for three industries (14, 15 and 19) displayed serial correlation, and therefore the PP test was used for these three industries. (iv) The critical values applicable to the test equations of a few industries are higher because no trend term was included in their test equations. The need for a decision about the trend term arose when there was a conflict between the outcome from test equation with trend and test equation with no trend. To resolve the conflict, the joint null hypothesis of unit root and no trend was tested. The failure to reject the null was taken as indicating that the appropriate test equation was one with no trend. (v) The overall manufacturing is identified by the number 0 in the graph. For the list of industries, see Table 1.

For 15 out of the 20 industries, the null hypothesis of unit root could not be rejected at the 5% level of significance. If the region of acceptance is expanded slightly to 2.5%, it can be seen that the null hypothesis could not be rejected in18 out of the 20 cases. Similarly, the overall manufacturing profit rate also appears to be a unit root process. The results thus indicate that the *AR(1)* model of profit rates may not be suitable for the particular sample studied here. The alternative model—the *AR(1)* model of profit rate differentials—will not exploit the nonstationarity of the data since it simply assumes that a linear combination of an industry's profit rate and the general profit rate with coefficients $(1, -1)$ is stationary. One way to express this assumption is to postulate that an industry's profit rate is cointegrated with the general profit rate with the cointegrating vector $(1, -1)$. While such a proposition can be admitted as a hypothesis to be tested regarding the profit rates, it is strange to adopt it as an assumption in a model that seeks to estimate long-run profit rate differentials. In the next section, I suggest an alternative time series model based on the notion of cointegration that can handle the nonstationarity found in the data (as suggested by the unit root tests) and provide a consistent framework for testing the hypothesis of profit rate equalization. The model for the profit rates for which the null hypothesis of unit root could be rejected will be discussed later in Section 4.4.

3 A cointegrating VAR model of profitability differentials

Formal models of classical competitive dynamics (see, for example, Duménil and Lévy, 1993, pp.82–94; pp.102–108) have at their core a relatively simple idea: outputs of industries will respond to investment flows generated by profitability differentials and prices of their products will respond to supply-demand imbalances. The reaction coefficients governing these adjustment processes have to be assumed to be"small" for the process not to be dynamically unstable. Granted such an assumption, the adjustment processes described above will lead to the establishment of long-run prices corresponding to a uniform profit rate if the underlying technology remains unchanged and satisfies a few assumptions that is found in the usual static versions of the classical theory of value (for example, that the activity levels are sufficient to produce a net output).

If a description, as distinct from an explanation, of the profit rate paths of individual industries in such models is sought, it could be thought of as a process in which the current value of the profit rate of an industry is driven inexorably towards the long-run equilibrium profit rate by the past values of its own profit rate and the combined average profit rate of other industries. As a practical matter, however, there are two respects in which the description should be of a more general character than what is postulated in the models. First, because in reality, especially when data spanning several decades are under consideration as in the present study, the long-run profit rate itself is changing, the description must allow for such a possibility. It is also necessary, as discussed in the previous section, to be able to distinguish between competitive and noncompetitive differentials. These considerations can be formalized in a bivariate *VAR(1)* for the j^{th} industry's profit rate, r_j, and the combined profit rate for the remaining industries, r:[3]

$$\begin{aligned} r_{jt} &= c_1 + a_{11} r_{jt-1} + a_{12} r_{t-1} + e_{1t} \\ r_t &= c_2 + a_{21} r_{jt-1} + a_{22} r_{t-1} + e_{2t} \end{aligned} \tag{10}$$

In these pair of equations c_1 and c_2 are constants, and, e_{1t} and e_{2t} are Gaussian error terms. Subtracting r_{jt-1} from both sides of the first equation and subtracting r_{t-1} from both sides of the second equation yields:

$$\begin{aligned} \triangle r_{jt} &= c_1 - [(1 - a_{11}) r_{jt-1} - a_{12} r_{t-1}] + e_{1jt} \\ \triangle r_t &= c_2 - [-a_{21} r_{jt-1} + (1 - a_{22}) r_{t-1}] + e_{2jt} \end{aligned} \tag{11}$$

Assuming that r_{jt} and r_t are unit root processes, the hypothesis of a

[3] One could add more lags to these equations, but, that would not change the logic of the argument.

stable, long-run relationship between the two profit rates can be expressed as a hypothesis of cointegration between them. The assumption regarding stationarity is justifiable in light of the unit root tests results reported earlier. The general profit rate appearing in each industry's model was also subjected to unit root tests. The results (not reported here) showed that the null hypothesis of unit root could not be rejected at the 5% level of significance. Therefore, the hypothesis of cointegration can be expressed as a restriction on the coefficient matrix in equation (11):[4]

$$\begin{bmatrix} (1-a_{11}) & -a_{12} \\ -a_{21} & (1-a_{22}) \end{bmatrix} = \boldsymbol{\alpha}\boldsymbol{\beta}'$$

where

$$\boldsymbol{\alpha} = \begin{bmatrix} \alpha_1 \\ \alpha_2 \end{bmatrix}, \boldsymbol{\beta} = \begin{bmatrix} \beta_1 \\ \beta_2 \end{bmatrix}$$

The cointegrating vector in the last equation is $\boldsymbol{\beta}$, and the vector of adjustment speeds is $\boldsymbol{\alpha}$. Substituting the new coefficient matrix ($\boldsymbol{\alpha}\boldsymbol{\beta}'$) for the old one in (11) yields the following pair of equations:

$$\begin{aligned} \triangle r_{jt} &= c_1 - \alpha_1 \left[\beta_1 r_{jt-1} + \beta_2 r_{t-1}\right] + e_{1jt} \\ \triangle r_t &= c_2 - \alpha_2 \left[\beta_1 r_{jt-1} + \beta_2 r_{t-1}\right] + e_{2jt} \end{aligned} \quad (12)$$

In long-run equilibrium with no shocks, the following condition must be satisfied:

[4] See, for example, Hamilton (1994, p.579-580).

$$\triangle r_{jt} = \triangle r_t = e_{1jt} = e_{2jt} = 0$$

So that:

$$\begin{aligned} 0 &= c_1 - \alpha_1 \left[\beta_1 r_j + \beta_2 r\right] \\ 0 &= c_2 - \alpha_2 \left[\beta_1 r_j + \beta_2 r\right] \end{aligned} \tag{13}$$

From the first equation in (13) an expression for r_j can be derived:

$$r_j = \frac{c_1}{\alpha_1 \beta_1} - \frac{\beta_2}{\beta_1} r$$

just as from the second equation:

$$r_j = \frac{c_2}{\alpha_2 \beta_2} - \frac{\beta_2}{\beta_1} r$$

The last two equations imply that

$$\frac{c_1}{\alpha_1 \beta_1} = \frac{c_2}{\alpha_2 \beta_2} = c_j$$

where c_j is a constant that can be interpreted as the noncompetitive differential. Let $\beta_j = \beta_2/\beta_1$. The long-run relation between r_j and r can thus be written as:[5]

[5] I am assuming here that the long-run relationship between the two profit rates includes a constant c_j. However, no restrictions are imposed on c_1 and c_2 in the estimation of the system (equation (12)). As is well known, this implies that I am allowing for a linear time trend in the data. See, for example, Hamilton (1994, p.581).

$$r_j = c_j - \beta_j r$$

Subtracting r from both sides yields the long-run profit rate differential, d_j:

$$\begin{aligned} d_j &\equiv r_j - r = c_j - (\beta_j + 1)r \\ &= r_{jp} + r_{jc}r \end{aligned} \tag{14}$$

where $c_j \equiv r_{jp}$ is the noncompetitive differential and $-(\beta_j + 1) \equiv r_{jc}$ is the competitive differential. The hypothesis of profit rate equalization in the long-run can now be postulated as a hypothesis that states that the competitive differential is zero:

$$\beta_j = -1 \tag{15}$$

which, if found true, would imply that the long-run profit rate differential of the j^{th} industry consists solely of the noncompetitive differential.

4 Empirical results

The model sketched above was implemented in three stages: First, cointegration tests were conducted for the j^{th} industry's profit rate and the combined profit rate of the remaining industries. Second, the estimates of the two parameters of interest, r_{jp} and r_{jc} were obtained. Finally, the hypothesis of equalization was tested, including for those industries whose profit rates did not contain any unit roots. I begin with a description of the data and then present the results.

4.1 Data

I focus exclusively on the manufacturing sector. All the data used come from the Bureau of Economic Analysis, United States Department of Commerce and were downloaded from their website. National income related data such as gross domestic product, employee compensation, indirect business taxes, capital consumption allowances and net interest payments are taken from the Industry Economics Division's Gross Product Originating (GPO) by industry data.[6] The data on capital stock as well as depreciation are from the Bureau's Wealth Statistics Division. The profit rate series calculated from the two data sources span the period 1947–98.

The industrial classification used in the capital stock data is the two–digit 1987 Standard Industrial Classification (SIC) system. On the other hand, in the GPO by industry data there are two different classification systems: the two–digit 1972 SIC prior to 1987 and thereafter the two–digit 1987 SIC. The break in the classification system mainly affected, within the manufacturing sector and at the two–digit level of aggregation, industries producing electronic and electrical goods and/or instruments etc.

I have attempted to ensure intertemporal comparability by aggregating the two industries into a single industry, referred to as *Electric and electronic equipment and Instruments* in the list of industries shown in Table 1. This industry is the combination of two 1972 SIC industries prior to 1987: *Electric and electronic equipment* and *Instruments and related products*. From 1987 onwards, the industry is the combination of two 1987 SIC industries: *Electronic and other electric equipment* and *Instruments and related products*. The two combinations are practically equivalent (see, for example,

[6] A discussion of the underlying methodology can be found in Yuskavage (1996).

Yuskavage, 1996, Table 13, n1, p.153).

The above modifications reduced the number of industries in our sample to 20 as compared to 21 industries in the two–digit SIC system. The list of industries is given below in Table 1.

Table 1. List of industries

1	Lumber and wood products
2	Furniture and fixtures
3	Stone, clay and glass products
4	Primary metal industries
5	Fabricated metal products
6	Industrial machinery and equipment
7	Electric and electronic equipment and instruments
8	Motor vehicles and equipment
9	Other transportation equipment
10	Miscellaneous manufacturing industries
11	Food and kindred products
12	Tobacco manufactures
13	Textile mill products
14	Apparel and other textile products
15	Paper and allied products
16	Printing and publishing
17	Chemicals and allied products
18	Petroleum and coal products
19	Rubber and miscellaneous plastic products
20	Leather and leather products

The indicator of profit rate that is used in this study is the net profit rate, r, calculated as follows:

$$r = \frac{\text{GPO} - \text{employee compensation} - \text{indirect taxes} - \text{depreciation}}{\text{Net fixed capital}}$$

All the variables are measured in current prices. Results from using gross profit rate, which would differ from the net profit rate by its exclusion of depreciation in the numerator and the replacement of net fixed capital with gross fixed capital, as the indicator of profit rate are presented in Zacharias (1997). The results from excluding net interest payments from the measure of profits in both indicators are also presented there. Other possible indicators and their ramifications for the hypothesis of equalization are analyzed in a forthcoming paper by the author.

4.2 Testing for cointegration

The Johansen cointegration test was conducted for each industry's profit rate and the combined average profit rate of all the remaining industries. (In order to avoid cumbersome expressions, I will refer to this combined average profit rate of the remaining industries as "the general profit rate," although its very definition points to the fact that it will be different for each industry.) The results, reported previously, from testing for unit roots in industry profit rates indicated that apart from two industries—*Lumber and wood products* and *Fabricated metal products*—the profit rate of all industries did contain unit roots. A separate bivariate error correction model was set up for the general profit rate and each industry's profit rate that contained a unit root. The maximum lag length for the underlying vector autoregressive model was set equal to 4 and model selection was done using the Schwarz

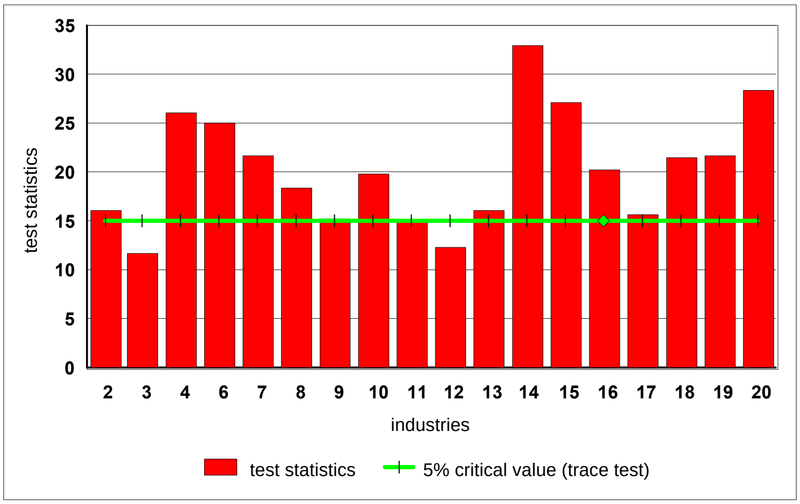
Bayesian Criteria (SBC). For all industries, the SBC recommended a lag length of 1. There were thus eighteen error-correction models of the type shown in (1) to be estimated. Maximum likelihood estimation of the models was performed using the algorithm developed by Johansen (1988,1991).

The null hypothesis of no cointegration was tested using the $\lambda_{\max}$ test and the trace test. The null hypothesis was rejected in cases where the calculated test statistic in at least one test exceeded the critical value at the 5% level of significance. The critical values used are the ones reported in Hamilton (1994, Tables B10 and B11, pp.767-768). The models in which cointegration was found to be a valid restriction were subjected to two types of misspecification tests. The first one tested the residuals of the error correction model of each industry for serial correlation using the Breusch-Godfrey test. The second one tested whether the residuals followed a normal distribution using the Jarque–Bera test statistic. Serial correlation or departures from normality were found to be a problem for five industries. Invariably, these were related to the profit rate in a particular year taking an extraordinary value, presumably as a result of some transient shock. In these cases, a dummy variable for that particular year was added to the error-correction model.

The results shown in Figure 2 indicate that out of the eighteen industries, a statistically significant cointegrating relationship was found for sixteen industries using the trace test.[7] There are two industries, *Stone, clay and glass products* and *Tobacco products*, for which the null hypothesis of no cointegration could not be rejected. The overwhelming majority of the profit rates in our sample do have a cointegrating relationship with the general

[7] Out of these 16 industries, 4 failed to show any cointegration at the 5% level using the $\lambda_{\max}$ test. Their identification numbers are 2, 8, 13, and 17.

Figure 2: **Cointegration test statistics**



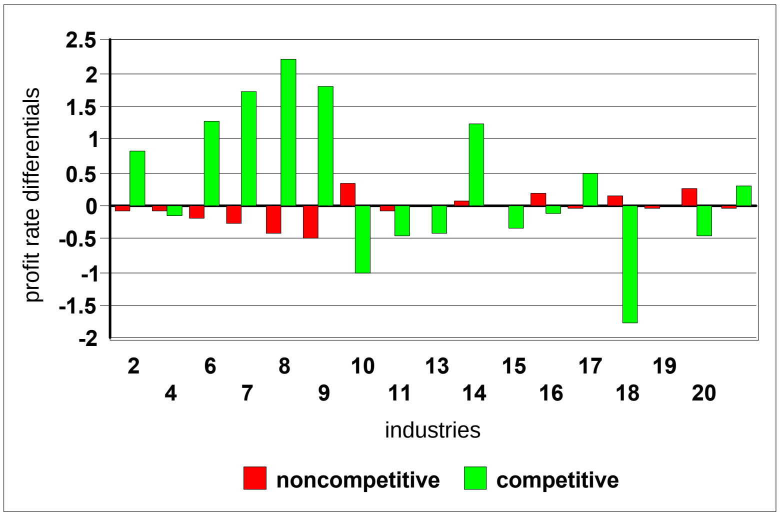
profit rate and therefore, it is reasonable to conclude that the model is capable of capturing the essential aspects of the dynamics of industrial profit rates. Subsequent empirical analysis will be mostly confined to the profit rates which were found to be individually cointegrated with the general profit rate. The profit rate differentials of the two industries that failed the unit root tests will be assessed using an alternative approach discussed in Section 4.4.

4.3 Long-run profit rate differentials and their stability

The maximum likelihood estimates of the noncompetitive and competitive profit rate differentials, represented respectively by the parameters r_{jp} and r_{jc} in equation (14), can be obtained in a straightforward manner once the error-correction model is estimated. They are shown in Figure 3.

The most striking feature of the results is that the noncompetitive profit

Figure 3: **Competitive and noncompetitive differentials**

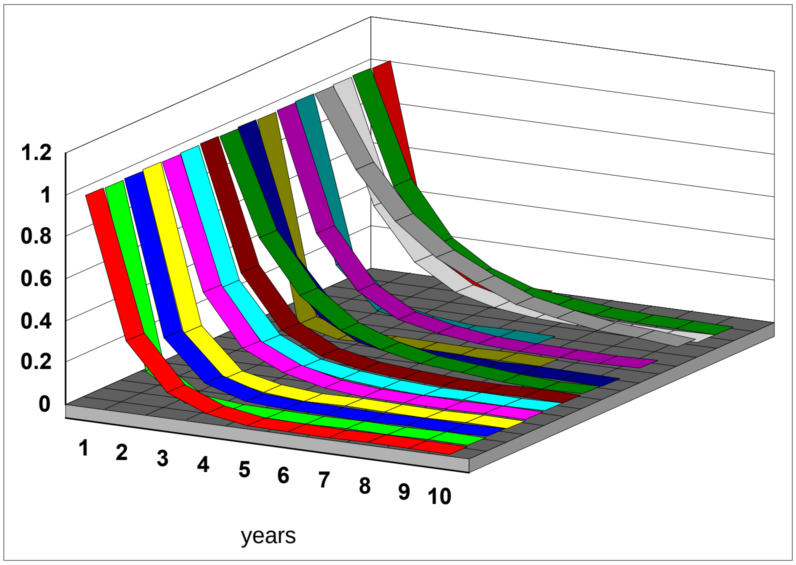


rate differential is quite small relative to the competitive profit rate differential for most industries. This is well reflected in the fact that the average noncompetitive differential for the sample is only about one-tenth of the average competitive differential. Thus the overwhelming portion of interindustrial profit rate differentials may *not* be accounted for by time–invariant industry specific factors such as risk etc., but by the specific manner in which interindustrial competition operates dynamically in different industries. This finding is in stark contrast to the conclusion of Glick (1985) and Glick and Ehrbar (1990)—studies which most closely resemble the current one in terms of the industrial classification used and the definition of profitability. They concluded that the main source of interindustrial differences in average profit rates was risk as measured by the variance of industry profit rates. The contrast in findings may be attributed to the fact that while these authors implicitly lumped together the two components of profit rate differential, the model estimated here distinguishes between the competitive differential and the noncompetitive differential.

The estimates suggest, as one would expect, that there is considerable interindustrial variation in the relationship between the long-run (estimated) and actual path of profit rate differentials. The observed variations are mainly due to the interindustrial differences in competitive differentials which determine how much of the changes in the general profit rate is transmitted to a particular industry and the nature of shocks affecting individual industries. The differences arising from the use of different general profit rates in each industry's equation does not affect the results because the general profit rates do not differ from each other in any significant way.

The long-run profit rate differentials estimated above refers to the profit rate differentials that would obtain in a situation with no shocks to the profit rates and no short run dynamics. Indeed, this hardly occurs in practice. An advantage of the model is that it is able to extract from the data, information regarding the centers of gravity to which industrial profit rates have an inherent tendency to move, without ever actually reaching them due to frequent and often large shocks driving them off the long-run trajectory. Furthermore, some insight into the structural stability of the estimated long-run centers of gravity can be gained by examining how quickly the impact on the cointegrating relation of a one-standard deviation shock to the system can be expected to die out. Of course, since the profit rates modelled here are assumed to be unit root processes, such shocks will have permanent effects on the levels of the profit rates. However, the existence of the cointegrating relation between an industry's profit rate and the general profit rate will ensure that the effects of such shocks will eventually vanish when the linear combination of these two variables, with the weights given by

Figure 4: **Persistence profiles of profit rates**



the cointegrating vector, is considered. The time period taken for this to happen may be thought of, following Pesaran and Shin (1996), as the speed at which a particular industry's profit rate returns to its long-run center of gravity following a system-wide shock. The trajectory on which this return to the long-run center of gravity moves has been called the "persistence profile." The persistence profiles of the profit rates under consideration here are shown in Figure 4.

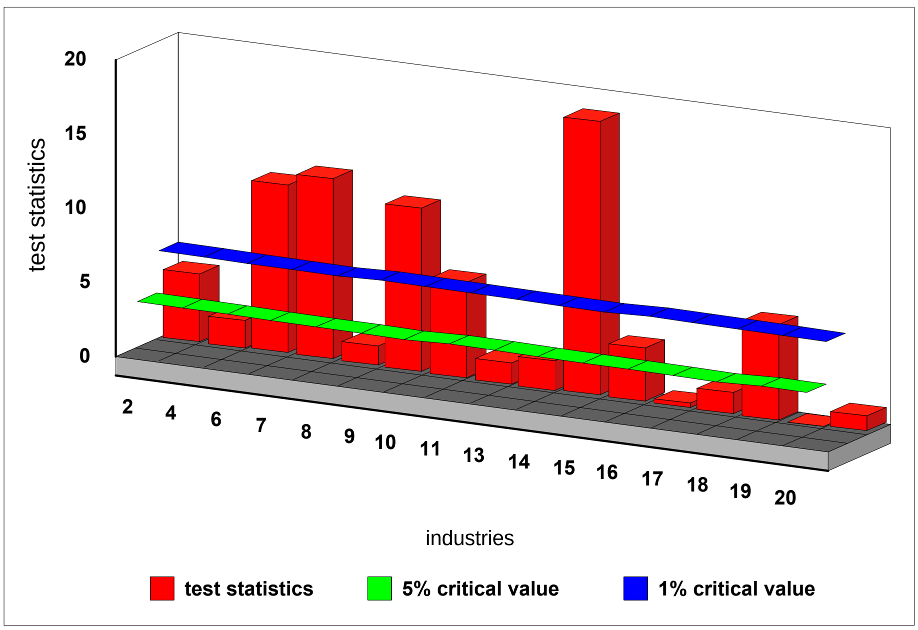
The results depicted suggest that the industrial profit rates return to their long-run rather quickly after a system-wide shock. For most industries, over 80 percent of the effects of the shock vanishes within a 2-3 year period. A couple of industries have a slightly flatter persistence profiles; but, even in their case most of the impact of the shock is gone within a 3-4 year period.

4.4 Testing equalization

I turn now to the main task of the paper: A test of the hypothesis that the profit rate of an industry, when adjusted for risk and other premia, is equalized with the general profit rate in the long run. In terms of the model discussed so far, such a test is equivalent to ascertaining whether the estimated competitive profit rate differential of an industry is statistically significant. If, in the long run, the competitive profit rate differential is equal to zero in every industry we can take this as evidence supporting the hypothesis of profit rate equalization since the long-run profit rate differential of any industry will then reflect only the noncompetitive differential. Formally, for such a hypothesis to be accepted, the elements of the cointegrating vector, β_1 and β_2, have to be equal to each other with opposite signs (see equations (12) and (15)). This is a linear restriction on the cointegrating vector and on the basis of the results arrived at by Johansen (see Johansen, 1990, p.193) the test can be conducted as a likelihood ratio test. The values of the test statistic (which has an asymptotic chi-squared distribution with one degree of freedom) for the industries under study here are shown in Figure 5 along with the critical values at the 5% and 1% levels of significance.

The results indicate that the competitive profit rate differentials of 12 out of 16 industries are not significantly different from zero at the 1% level. The results confirm, for the most part, the expectations one might have formed on the basis of the estimates of competitive profit rate differentials shown in Figure 3. Industries with relatively lower (in absolute terms) estimates of competitive differential are also likely to be industries with a long-run profit rate similar to the general profit rate. Exceptions to this rule does exist—an apparent inconsistency that may due to the fact that the valid re-

Figure 5: **Test statistics for profit rate equalization**

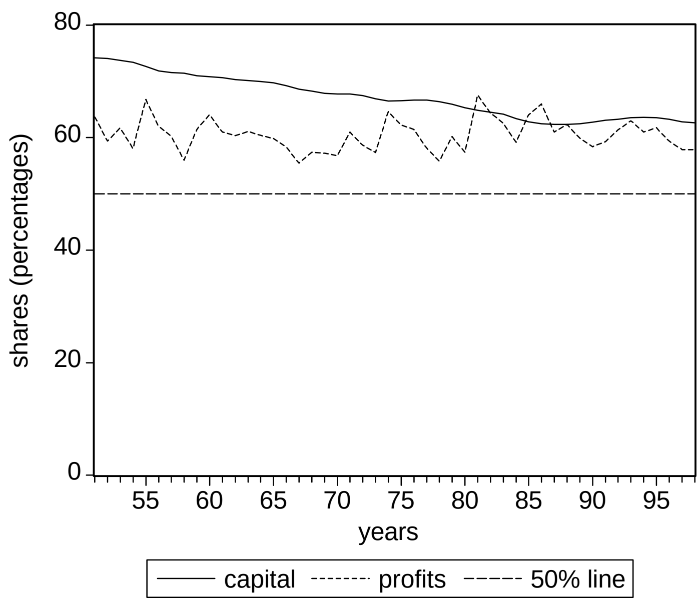


striction about the cointegrating vector was not incorporated in the original estimation of profit rate differentials for these cases.

How important is the group of industries with equalized profit rates within the manufacturing sector? I answer this question by considering the share that the industries with equalized profit rates have had in the capital stock and profits for the entire manufacturing sector during the sample period. The logic is that although these industries is a numerical majority, if the bulk of the capital stock and the realized profits belong to the industries with persistent competitive differentials, then the equalization process can not be taken as a dominant tendency in the manufacturing sector. The numerical majority that had profit rates roughly equal to the general profit rate will then not be an economically significant majority. The shares of this groups of industries in capital stock and profits over the sample period is shown in Figure 6.

The weight of the industries with equalized profit rates is somewhat larger when the "weight" is judged according to their share in capital stock than in profits: the average during the period 1951-1998 for the former share was 67 percent as compared to 61 percent for the latter. In either case, what is interesting here is to observe that the majority of profits and capital stock in the manufacturing sector belonged to industries that have, in the long run, profit rates not statistically different from the general profit rate. As a corollary, it may be also be observed that as a group, the industries that were found to have significant competitive differentials and the industries about which the present model is silent regarding their profit rate differentials, have enjoyed a higher profit rate on the average than those industries found to have no significant competitive differentials. (The shares of the former group in capital stock and profits are, respectively, 33 percent and 39 percent.)

Figure 6: **The weight of industries with equalized profit rates**



I now turn to the industries which were excluded from the formal test of equalization reported above to examine how the above conclusion may be modified when their profit rate differentials are taken into account.

Two industries—*Lumber and wood products* and *Fabricated metal products*—were excluded from the analysis so far because their profit rates were found to be stationary in levels. Two other industries—*Stone, clay and glass products* and *Tobacco products*—were excluded because their profit rates were not cointegrated with the general profit rate. The question now at hand is whether the competitive profit rate differentials of these industries can be considered as significant. I do not attempt to solve the problem posed by the profit rates that were not cointegrated with the general profit rate here, so the only problem tackled is the one posed by profit rates that were found to be stationary.

A possible solution to the problem is to adopt an alternative method to estimate the long-run relationship between an industry's profit rate and the general profit rate. Such an alternative can be found in the autoregressive distributed-lag (ARDL) approach to cointegration developed in Pesaran and Shin (1995). An advantage of the ARDL approach as compared to the Johansen approach is that the long-run relationship between the profit rates can be estimated in a statistically satisfactory fashion, irrespective of whether the industry profit rate and the general profit rate are unit root processes. This is an attractive feature in the current context because the two industry profit rates under consideration were found not to be unit root processes. A crucial difference between the Johansen approach and the ARDL approach is that the latter would explicitly treat one of the two profit rates, the general profit rate, solely as a right-hand side variable, in contrast to the symmetrical treatment of both profit rates in the former.

This can lead to specification errors if the profit rate dynamics of a given industry is to influence the combined profit rate of other industries. Such effects can be expected to be negligible or small in a sample with a large number of industries or firms. However, in the sample used here, the level of aggregation is relatively high and it may not be appropriate to rule out such effects by assumption.

I used the method recommended in Pesaran and Shin (1995) to test whether the general profit rate could be treated as the right-hand side variable, or the "long-run forcing" variable, for the two industries. The test statistics (reported in Table 2) favored such a treatment. Estimates of the noncompetitive and competitive differentials for the two industries were then obtained and the null hypothesis of no competitive differentials was tested. The results are shown in Table 2.

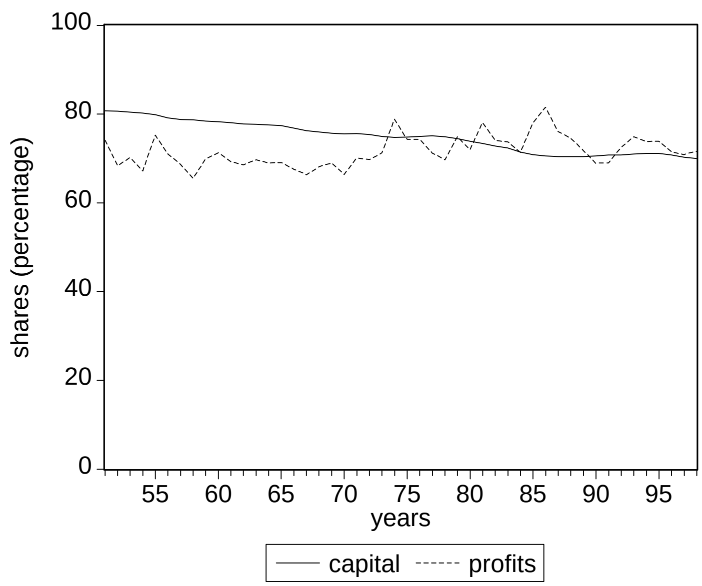
Table 2. Long-run differentials in two industries

Industry	$F(r_i \mid r)$	$F(r \mid r_i)$	$\widehat{r_{jc}}$	$\widehat{r_{jp}}$	$\chi^2(1)$
Lumber and wood	15.159	2.692	0.106	0.146	0.732
Fabricated metal	10.344	2.537	0.043	0.019	0.012

Notes: (i) Both equations had the dimension of (2,1) as recommended by the Schwarz Bayesian Criteria. (ii) The F-statistics refer to the test of the null hypothesis that the last year's profit rate of an industry and the last year's general profit rate are insignificant in the equations for $\triangle r_i(F(r_i \mid r))$ and $\triangle r(F(r \mid r_i))$. The critical values are different from the standard ones for reasons explained in Pesaran and Shin (1995). The 5% critical value band applicable here is 4.934–5.764. (iii) The χ^2

test statistic refer to the test of the null hypothesis that $r_{jc} = 0$. The 5% critical value is 3.84.

The results suggest that competitive differentials are quite small and statistically insignificant for both industries. Combining the results above with the one arrived at earlier regarding equalization, it emerges that the null hypothesis of profit rate equalization could not be rejected for 14 out of the 20 industries in the sample. In terms of the shares in manufacturing capital stock and profits, this group of industries have expanded, respectively to 75 percent and 72 percent. The movement of these shares over the period under study is shown in Figure 7.



The weight of "equalizers"

Note: The "equalizers" refer to the group of industries for which the null hypothesis of profit rate equalization could not be rejected either under the Johansen method or the ARDL method.

It is striking how the discrepancy between the two shares is closing over time. This suggests that the lower profitability of this group—compared to the profitability of the remaining industries taken together—has dissipated as a result of the investment flows that such a discrepancy might have triggered. However, it should be noted that for the period as a whole, this group of industries had a relatively lower average profit rate.

The finding that the industries for which the null hypothesis was rejected consists solely of industries with higher than average long-run profit rates may seem to fit with the characterization of these industries as oligopolistic. The industries *Industrial machinery and equipment*, *Electric and electronic equipment and instruments,* and *Other transportation equipment* have been generally considered by most applied studies in the structure–performance paradigm and by Post Keynesian authors such as Eichner as dominated by corporations with a great deal of market power (Eichner, 1991, p.250). While such a characterization of these industries may or may not be appropriate, there are two reasons why my findings *as a whole* cannot be explained on the basis of oligopoly and market power. First, among the industries for which the null hypothesis of profit rate equalization was accepted there are some prominent oligopolistic industries as exemplified by *Primary metals*, *Food and kindred products*, and *Chemicals and allied products.* Second, in addition to the three industries just mentioned, an industry usually considered as a nonoligopolistic industry—*Apparel and other textile products*—was also found to have a long-run profit rate significantly higher than the general profit rate. The competitive process as modelled here appears to be an active force in industries traditionally classified as competitive as well as in those traditionally classified as oligopolistic industries.

In order to interpret the result that a majority of industries have long-run profit rates not significantly different from the general profit rate, it is useful to recall that the equalization of profit rates is considered in the classical theory as a "general law" of political economy and there is a considerable epistemological gap between the notion of a general law and the statistical conception of long run employed here. The former allows for relatively greater room for ambiguity as well as greater flexibility when it comes to the study of the actual evolution of an industry or a group of industries. The results arrived at regarding equalization on the basis of a statistical model cannot hope to capture the real diversity in industrial evolution. However, the general law is only expected to hold as an observable persistent feature, as a "dominant tendency" of the capitalist accumulation process: "Within the whole of capitalist production, it is always only in a *very intricate and approximate way*, as an average of perpetual fluctuations which can never be firmly fixed, that the general law prevails as the *dominant tendency*" (Marx[1894], 1981, p.261; emphasis added).[8] The null hypothesis of profit rate equalization is therefore not expected to be accepted for every industry but only for a significant number of industries, accounting for the dominant portion of profits and capital invested in the manufacturing sector.

5 Conclusions

A distinct feature of a developed capitalist economy like the United States is the provision of the vast majority of goods and services by privately owned,

[8] For a methodological discussion of the notion of "dominant tendency" and its differences from the standard notion of equilibrium see Shaikh (1981).

profit–seeking firms. Profitability serves as the basic guide for the numerous actions firms take regarding production, technology and growth. Classical theory of value and distribution provides a consistent and coherent explanation of how profits arise under capitalist relations of production and why it is the driving force in the capitalist economy. The process of competition as conceived in the classical theory is inherently anarchic and turbulent, quite removed from the tranquil and impotent notion of perfect competition which, in several guises, came to dominate much of later economic thinking. At the same time, the dynamic process of competition is considered to give rise to observable regularities that emerge ex post, as an average of past movements, from the actual variations in prices and profits. An important instance of such regularities is the equalization of profit rates.[9]

The objective of this paper was to propose an empirical framework in which long-run profit rate differentials can be estimated and the hypothesis of equalization of profit rates can be tested. The statistical models employed here aimed to account for the nonstationarity found in most industry profit rates, and in the overall manufacturing profit rate. The first model, used for 16 out of the 20 industries in the sample, is a vector autoregressive model for nonstationary variables developed by Johansen. The second type of

[9] The fact that the equalization of profit rates was assumed to take place *ex post* in the classical theory runs contrary to an interpretation sometimes found in the literature: equalization of *expected* profit rates. The equalization process is reduced in this interpretation to a process that takes place inside the heads of the investors and not in the actual battle of competition. The notion that expected profit rates are equalized is in fact a proposition from the conventional (neoclassical) investment analysis dressed in "classical" garb. It is well known that in the latter type of analysis, a firm devotes to each investment project an amount of capital so that an extra dollar invested in any project is *expected* to yield the same return.

model, used for 2 industries whose profit rates were found to be stationary, employs the ARDL approach that allows for a mixture of unit root and stationary processes. The common feature of both models is that they allow for a statistically satisfactory estimation of the long-run centers of gravity of profit rates and distinguishes between competitive and noncompetitive profit rate differentials. The hypothesis of profit rate equalization can be tested in both frameworks as the null hypothesis of no competitive differentials. The failure to reject the null implies that the long-run profit rate differential consists only of a noncompetitive differential, which can be interpreted as industry-specific risk and other premia.

The data examined here is the annual profit rates of 20 manufacturing industries in the United States during 1947–98. The indicator of profit rate used is the ratio of profits after depreciation to net fixed capital stock. In order to determine the lag length to be used in the models, the first four observations were set aside and all the results reported here pertain to the period 1951-1998. The central finding of the paper is that 14 out of the 20 industries studied have no significant competitive profit rate differentials in the long-run; in other words, their profit rates are equalized in the long run with the general profit rate, after allowing for risk and other premia. Over the period under study, these industries accounted, on the average, for about 75 percent of net fixed capital stock and 72 percent of profits in the manufacturing sector. These results suggest that profit rate equalization may be considered as a dominant, long-run tendency in the U.S. manufacturing sector.

Nevertheless, it should be pointed out that the implementation of the statistical model could be improved. Inference regarding cointegration and equalization were conducted on the basis of asymptotic theory. To apply small-sample adjustments to the test statistics or to estimate sample-specific critical values based on bootstrap methods would be one line of improvement. The effects of such improvements on the findings of the paper are hard to predict. It is reasonable to expect that some profit rates might no longer appear to be cointgerated with the general profit rate once the small-sample adjustments have been made, just as some profit rates might no longer appear to have significant competitive differentials. The first expectation is grounded on the well-known fact that, in small samples, the Johansen cointegration test is biased towards rejecting the null of no cointegration (Toda, 1994). The second expectation is based on the evidence from recent Monte Carlo experiments suggesting that the likelihood ratio test for structural hypothesis on cointegrating relations is biased towards rejecting the null in small samples (Zhou, 2000).

Yet another way in which the findings here can be extended and refined is to examine the properties of the adjustment process more closely. While I have examined the stability of the long-run centers of gravity by constructing the persistence profiles of profit rates, several questions remain open: How different are the speeds by which individual profit rates eliminate their discrepancies from the long-run centers of gravity? How significant is the impact of this adjustment process on the trajectory of the general profit rate itself? Does incorporating additional information about the properties of adjustment process change the results regarding equalization? Within the framework adopted here, these questions can be answered by a series of tests on the vector $\boldsymbol{\alpha}$ (see equation (12)) and conducting the test of equalization as a nested hypothesis test.

Further work would also address the sensitivity of the findings reported in this paper to alternative indicators of the profit rate. Alternative indicators can be developed by changing what appears in the denominator, the numerator or both for the formula for profit rate. For example, one could define capital to include, apart from structures and equipment, stocks of inventories. Alternative indicators can also be developed by changing the basis of valuation. For example, capital could be reckoned in historical cost rather that current cost. Another line of enquiry would relate the estimated profit rate differentials and the observed properties of adjustment processes to factors which has been the focus of much of the applied studies in industrial organization: degree of concentration, scale economies, product differentiation, foreign competition etc. It seems that, with suitable modifications, the approach suggested here may be capable of shedding light on the overall character of competitive dynamics and the profit rate trajectories of individual industries.

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