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Comparative Advantages in Estimating Markups

SCALES
SCientific AnaLysis of Entrepreneurship and SMEs

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Contents

Abstract

We compare two methods for estimating a markup: Roeger (1995) on the one hand, and the structural approach of Appelbaum (1982) and Bresnahan (1982) on the other. Roeger estimates the average Lerner index. Furthermore, he uses the assumption of a constant markup as a substitute for data on the level of capital cost, which he takes to be unobservable. We discover an anomaly for Roeger's method and propose an alternative way to estimate it. The structural approach is theoretically superior: it aims at estimating marginal instead of average cost, while it includes more competition-related parameters. Our empirical results indicate that this approach is very sensitive to changes in specification. We conclude that 'parsimonious' applications of this approach are not very reliable without prior information about supply or demand. Neither one of the sophisticated methods can be shown to be superior to simply equating the markup to the average Lerner index and determining its value by calculating the user cost of capital.

Keywords: average cost, profit-sales ratio, marginal cost, markup, Lerner index, *elasticity-adjusted* Lerner index, conjectural elasticity, *New Empirical Industrial Organisation*.

JEL: D43, L13, L60

Summary

We investigate the comparative advantages of three methods for determining the Lerner index – a relative markup of price over marginal cost. What we call the benchmark method starts from the assumption of constant returns to scale, i.e. marginal equals average cost. Hence, this method results in a markup of price over long run average cost. The average Lerner index can be calculated from data on sales and costs of inputs, since it equals one minus the sum of the income shares of the inputs. Because data on sales and on labour and material cost are readily available, the only variable that is problematic is capital cost, which is needed for calculating the income share of capital.

We distinguish two versions of the benchmark. The first uses the profit-sales ratio as a measure of the average Lerner index. Since this ratio relies implicitly on capital cost as reported by the firms themselves, we designate this version as the "reported benchmark". The second version of the benchmark relies on capital cost (the user cost of capital) constructed by us, i.e. by economists outside of these firms. Hence, we refer to it as the "constructed benchmark". We weakly prefer the constructed benchmark, primarily because of the theoretical arguments Fisher (1989) voices with respect to the reported benchmark, also known as the profit-sales ratio. A main question we ask is whether more sophisticated methods of determining the Lerner index are able to outperform our benchmark. The two more intricate methods that we consider are part of the *New Empirical Industrial Organisation* (NEIO).

The first alternative to the benchmark method is a reduced form method proposed by Roeger (1995). Just as is done by the benchmark method, Roeger (1995) estimates the average Lerner index. Apart from this, the results of our investigation of Roeger's method consist of four main components. First, Roeger does not need data on the income share of capital cost. We show that he uses the assumption of a constant markup as a substitute for these data. Second, we note that, since he estimates the average Lerner index, a simple equation can be used to calculate the income shares of capital that are implied by the estimates. As such, Roeger's method can be seen as a way of determining the income share of capital cost. Third, we find that the estimates of the average Lerner index imply capital income shares that are negative. This is a highly anomalous outcome. Fourth, we propose an alternative way of applying Roeger's method that results in estimates that are more plausible than those that follow from the original version.

The second alternative to the benchmark is the structural approach as exemplified by Bresnahan (1982) and Appelbaum (1982). The structural method consists of the estimation of supply and demand relations, and can be complemented with input demand functions. We argue that this method is theoretically superior to the other two methods: first, it aims at estimating marginal instead of average cost; second, in addition to the Lerner index, it incorporates the elasticity of demand and the *elasticity-adjusted* Lerner index as parameters to be estimated.

Its empirical performance, however, is generally poor, especially with respect to these additional parameters. We conclude that without substantial prior information about the industries to which the models are applied or other elements that enrich the application of this method, the risk of misspecification is quite large and the results should be considered to be unreliable. Notably, this conclusion cannot be drawn with respect to the Lerner index, which turns out to be quite robust to differences in specification.

In evaluating the comparative advantages of the three methods, we note with respect to the (constructed) benchmark that its data requirements are very easy to meet, whereas the effort involved in applying it is low. The reliability of the depreciation data is a main concern here. In relation to our alternative way of applying Roeger's method, it is worth noting that the explained variance is very high. Apart from that, a crucial consideration is how plausible the assumption of a constant markup is as a way to determine the level of capital cost. The structural method, in turn, has as a large advantage that it does not require the assumption of constant returns to scale. Although its performance with respect to the elasticity of demand and the *elasticity-adjusted* Lerner index is poor, the Lerner index that can be calculated from the estimated model might be reliable.

The upshot of our investigation is that neither one of the NEIO-methods can be conclusively shown to be superior to the constructed benchmark that determines the average Lerner index by calculating the user cost of capital.

1 Introduction

In assessing the type of market structure that prevails in a certain industry, the relation between price and marginal cost is a crucial piece of information. If price diverges from marginal cost, one knows for sure that the industry being investigated cannot be characterised as one of perfect competition, and it can be inferred that some kind of market power is present. Although this is just the beginning of any serious examination of market structure – other aspects such as barriers to entry and regulatory environment need to be considered as well – the determination of the markup of price over marginal cost on its own is already quite a complicated matter. Several different approaches are available, but no consensus as to the relative quality of these methods has been achieved. Instead, severe criticisms have come forward with respect to virtually all of the available methods, as is evidenced by papers such as Hyde and Perloff (1995) and Corts (1999).

Whereas investigating the markup is interesting in its own right, it is also important for the debate on cyclicality of the markup. This debate plays an important role in bridging the gap between industrial organisation and macroeconomics (Hall1986, Schmitt-Grohé 1997, Oliveira Martins and Scarpetta 1999). Different measures for the markup have been used for investigating cyclicality, and the results are likely to be sensitive to the choice of the measure for cyclicality. Because of this, assessing the relative quality of measures of the markup may be crucial for making progress in the debate on cyclicality.[1]

At EIM, several methods for estimating markups have been applied in the past. The Lerner index and the *elasticity-adjusted* Lerner index have been the focus of this research. The former gives the percentage deviation of price from marginal cost, and is important for assessing the welfare costs related to market power, whereas the latter represents producer behaviour and, as such, is a measure of market power. The methods used consist of the reduced form method of Roeger (1995), and the structural method as exemplified by Appelbaum (1982) and Bresnahan (1982). Both of these methods belong to the *New Empirical Industrial Organisation* (NEIO).[2] The results can be found in Hindriks (1999a), Hindriks et al. (1999), and Lever et al. (1999). As noted in Hindriks (1999b), it was not clear which method is to be preferred and why. This report aims at answering these questions. We will use a

1 Many papers base their conclusions about cyclicality on the markup of price over average variable cost, also known as the Census of Manufacturers price-cost margin (Domowitz et al. 1986, Ghosal 2000). This measure has been heavily criticised (Schmalensee 1989, Salinger 1990). Other studies base their conclusions on a measure of the markup that takes capital cost into account (Domowitz et al. 1988, Haskel et al. 1995, Oliveira Martins and Scarpetta 1999). This paper considers only measures from this last category.

2 The name *NEIO* was coined by Bresnahan (1989) and has been used by, among others, Salinger (1990), Domowitz (1992), Bhuyan and Lopez (1997), Nevo (1998), Genesove and Mullin (1998), and Corts (1999). Other NEIO-methods, such as the non-parametric method of Ashenfelter and Sullivan (1987) and the reduced form method of Rosse and Panzar (1977) and Panzar and Rosse (1987), are not considered here, since they can only be used to test for market structure and do not result in an estimate of a markup.

variety of criteria, and it is unlikely that one method will come out as best on all counts. Therefore, the main question that guides us throughout this paper is: What are the comparative advantages of the methods for estimating markups that we consider?

Societal Relevance

We want to consider a set of distinct industries with only a limited amount of resources being available, both in terms of time and money. As such, our perspective will resemble that of an anti-trust agency that wants to know in which industries there may be a lack of competition, and, hence, which industries should be investigated more thoroughly. We believe that including these pragmatic considerations increases the societal relevance of our investigation. Apart from that, we intend to use the resulting values of the markup in the SCALES programme at EIM, where they will figure as initial values in a model of competition.

The Benchmark Method and Our Contributions

As a point of reference in our comparative endeavour, we introduce a simple benchmark method for determining the Lerner index to which the two more sophisticated methods can be compared. Our benchmark method starts by assuming constant returns to scale. Accordingly, marginal cost equals average cost. Hence, the output of this method is a markup of price over average cost: the average Lerner index. This average Lerner index can be calculated from data on sales and costs of inputs, since it equals one minus the sum of the income shares of the inputs. Because data on sales and on labour and material cost are readily available, the only variable that is problematic is capital cost, which is needed for calculating the income share of capital.

The benchmark method calculates the average Lerner index either from capital cost as implied by the profits reported by the firms themselves, or from constructed capital cost data – using for instance the user cost of capital approach of Hall and Jorgenson (1967), as we do. The former version of the benchmark is the well-known profit-sales ratio. The two versions of the benchmark are compared to the two more sophisticated methods mentioned above – both theoretically and empirically – in order to determine the comparative advantages of different methods of estimating the Lerner index.

A main concern in the determination of price-cost margins is capital cost. The profit-sales ratio as a measure of the Lerner index has been criticised severely because of problems connected with the valuation of capital (Fisher 1989).[1] Fisher concludes that '[t]he profit-sales ratio is an unreliable estimate of the Lerner index.' (1989, p.395) This prompts a more

[1] Similar criticisms have been put forward with respect to accounting rates of return as a measure of monopoly profits by Fisher and McGowan (1983), which were commented upon in a series of papers in the *American Economic Review* in 1984.

specific question: do the more sophisticated methods outperform a simple method such as the profit-sales ratio?

Data and Methodology

Our dataset consists of time series of prices and quantities of inputs and output, and some additional variables that determine demand. This is more than is required for Roeger's method, and suffices for connecting to common practice with respect to the structural method. This common practice may be characterized as follows: '[S]ince Bresnahan the frequent practice has been to adopt the *parsimonious* industry-form *CSE* [Case Study Econometric] model, as it conveniently leaves "averaged" price and output variables and the standard set of exogenous demand and cost parameters as the only data requirement.' (Krouse 1998, p.695; emphasis added) This parsimonious approach to the structural method fits nicely with the perspective of an anti-trust agency chosen above.

The industries that we consider are clothing (SBI 23), printing (SBI 27), and construction material (SBI 32), which encompass 11 three-digit industries. They have been selected by the degree of non-competitive rents we expect to find based on previous research. We expect these industries to cover a wide range of performances. This choice of industries is discussed in further detail in chapter 3.

In contrast to Hyde and Perloff (1995), and Corts (1999), we do not use simulations. This limits the extent to which we can arrive at definite conclusions, since it will be virtually impossible to reach a final verdict as to the approximation of our estimates to the true value of the markup(s). However, this is a common feature of economic research, and forces us to make full use of the normally available criteria for evaluation.[1]

In order to compare the different methods discussed in this report, we consider a variety of criteria. We look at the respective data requirements, and we consider the usual test statistics. Apart from that, we resort to economic intuition, and compare our results with those found by others. Another important consideration is the sensitivity of the results to changes in functional specification. In other words, the risks of misspecification are evaluated. The output of the methods – in terms of the number of key variables – is compared, and, finally, the assumptions are judged on their stringency and plausibility. In addition to these criteria, we take some more pragmatic considerations into account. As was said above, we take into account the resources needed in terms of effort and cost will play a role as well.

Structure of Report

Chapter 2 introduces the three methods, discusses the relevant assumptions, and – with respect to the structural method – the functional specifications. We present the empirical

[1] Exceptions to this are Genesove and Mullin (1998) and Wolfram (1999). They are able to generate sufficient independent information on the markup as to evaluate their results against high quality evidence of the size of the markup(s).

results in chapter 3. A thorough evaluation of the comparative advantages of the three methods is given in chapter 4. The final chapter – chapter 5 – presents a final evaluation of the methods, linking our conclusions to those drawn by others.

2 Theory

The most important variables of this paper are two markups: the Lerner index and the *elasticity-adjusted* Lerner index. These variables are central to issues of welfare loss and market power. In this chapter, these key variables are defined and three methods for estimating one or both of these markups are presented.

Section 2.1 presents our benchmark method, which is a simple way of calculating the average Lerner index. Section 2.2 discusses Roeger's method, which bears – as we will show – a close resemblance to the benchmark method. In section 2.3 the structural method is introduced. It includes the *elasticity-adjusted* Lerner index as a parameter. The key variables and the values they may assume are discussed in section 2.4. Finally, an overview of the versions and assumptions of these methods, that are applied in chapter 3, is given in section 2.5.

2.1 The Benchmark Method

The Lerner index L is a relative price-cost margin that is given by:

(1) $$L \equiv \frac{P - MC}{P}$$

where *P* denotes the output price and *MC* the marginal cost of the firm.

The most straightforward way of determining the Lerner index – which we will call the benchmark method – starts by assuming constant returns to scales, that is: marginal costs (*MC*) equals average costs (*AC*). Hence, the Lerner index is equal to the average Lerner index:

(2) $$L = L^{AC}$$

where the average Lerner index L^{AC} is defined as: $L^{AC} \equiv \frac{P - AC}{P}$.

Within this benchmark method, we distinguish two versions. In the *first* version, we simply use the profit-sales ratio as a measure of the average Lerner index. That the two are equal follows from the definition of the average Lerner index. Multiplying both the numerator and the denominator by the quantity supplied (Q), equation (3) results:

(3) $$L^{AC} = \frac{PQ - C}{PQ}$$

where C is total cost. Since the profit-sales ratio is based on profits reported by the firms themselves, we refer to this method as the *reported* benchmark. By using reported profits, we implicitly rely on capital cost as calculated by the firms themselves.

In the *second* version, the average Lerner index is calculated from the income shares of the inputs:

(4) $L^{AC} = 1 - \frac{\sum C_j}{PQ} = 1 - \sum_j a_j$,

where C_j denotes the cost of input *j*, $j = \{N, M, K\}$ for labour, material, and capital respectively, and a_j denotes the income share of input *j*. The income shares of labour and material can be calculated from readily available data on sales and the levels of labour and material cost. We construct the level of capital cost that is required for the income share of capital (see appendix C). This second version of the benchmark is referred to as the *constructed* benchmark.

2.2 Roeger's Method

Like the benchmark method, Roeger's method results in a value of the average Lerner index. There are two related differences between Roeger's method and the benchmark method. First, Roeger eliminates the income share of capital from the estimation equation. Second, he assumes a constant markup, and uses this assumption as a substitute for the income share of capital. In order to make this explicit, we present his method in a new – and in our view more transparent – way. The historical derivation is discussed in appendix A.

2.2.1 Roeger's Method in a Nutshell

Point of departure is the following identity:

(5) $\Delta c = \sum_j \frac{a_j}{\sum_j a_j} \Delta c_j$

We use $\Delta c = \ln C_t - \ln C_{t-1}$ as a notational convention for designating the growth rate of C. In this equation, the growth rate of total cost is written as the weighted average of the growth rates of the various cost components, the weights being the income shares of the inputs divided by the sum of these income shares.

The growth rates of the various cost components and the incomes shares of labour and materials are readily available. In contrast to the benchmark method, Roeger takes the income share of capital (a_K) to be unknown, since he assumes the level of capital cost to be unobservable. Apart from that, the growth rate of total costs (Δc) is unknown.

Roeger assumes a constant markup. This implies that the growth rate of total cost can be eliminated from equation (5), since it can now be equated to the observable growth rate of sales:

(6) $\Delta c = \Delta pq$

Thus, the income share of capital – being the only unknown variable left - can be inferred from equations (5) and (6).

Having established the capital income share in this way, the average Lerner index follows from (4). Finally, the real Lerner index follows – just as was the case in the benchmark method – by assuming constant returns to scale (see equation (2)).

2.2.2 Estimation Equations

For reasons that will become clear in later chapters, we will estimate Roeger's method in *two versions*. The *first* version is the original one proposed by Roeger. This version requires the estimation of the following equation:

(7) $\Delta g = L^{AC} \Delta c + \omega$.

The variables designate the following: $\Delta g = \Delta pq - \Delta c_K - \sum_{j \neq K} \alpha_j \left(\Delta c_j - \Delta c_K \right)$, $\Delta c = \Delta pq - \Delta c_K$, and ω is an error term. Equation (7) follows from substituting equations (4) and (6) in equation (5), rearranging terms, and adding an error term. Equation (4) plays two roles in the substitution process. It is used both to replace the denominator of equation (5) with $1 - L^{AC}$ and to eliminate the capital income share of the numerator.

The *second* version follows from this by reformulating equation (7) in terms of the average markup $m^{AC} \equiv \frac{P}{AC}$, with ν as the error term:

(8) $\Delta pq - \Delta c_K = m^{AC} \sum_{j \neq K} \alpha_j \left(\Delta c_j - \Delta c_K \right) + \nu$.

2.2.3 The Crux of Roeger

From this exposition, it should be clear that Roeger's method is a way of determining the income share of capital, and – in virtue of that – a way of determining the average Lerner index. As such, it resembles the benchmark to a great extent. It is *not* a genuinely new method for estimating marginal cost.

The crux of the method is that the income share of capital can be inferred from data on revenue and labour and material cost and the growth rate of capital by assuming some relation between sales and total cost. Roeger assumes a constant markup. An important conclusion that follows is that such an assumption is essential to the method – contrary to what Roeger suggests (1995, p.318).[1]

Our derivation of Roeger's method differs from the one Roeger presents himself. He derives his estimation equation from primal and dual productivity growth measures.[2] A difference between his and our presentation is that the intuition behind our presentation is much easier to understand. No reference to productivity growth is needed. A second difference between the two presentations is that we show that Roeger's method is not as different from the benchmark method – and hence from the profit-sales ratio – as one might take it to be.

The third and most important difference is that – as we believe – the key point of Roeger's contribution comes out better in our presentation. The key point is that Roeger has developed a way of estimating the average Lerner index that circumvents the direct determination of the level of capital cost. As will become clear in the remaining chapters, this is a crucial insight, since it enables us to uncover an anomaly in the results of the original version of Roeger's method.

Our presentation is also different from the one used by Oliveira Martins et al. (1996). In an appendix, they present a derivation that starts from the average markup, m^{AC}. Although in this regard our derivation resembles that of Oliveira Martins et al. (1996), we believe that the crux of Roeger's method comes out better in our presentation: both the essentiality of the constancy assumption and the close resemblance Roeger's method bears to the profit-sales ratio are obvious from the way the method is presented in this paper. Furthermore, our derivation is the shortest one available.

In sum, Roeger's method uses the assumption of a constant markup as a substitute for data on the level of capital cost, that he takes to be unobservable. The parameter that is estimated only equals the Lerner index if the returns to scale are in fact constant. Contrary to the method to be discussed next, Roeger's method does not require the imposition of a specific functional form.

[1] Roeger gives a fairly trivial reason for why he assumes a constant markup: 'Since I want to demonstrate that even a simple variant of imperfect competition can help to reconcile price- and quantity-based productivity measures, I follow Hall and assume constant markups.' (1995, p.318) In a footnote, he defends the assumption as follows: 'Given the weak empirical evidence in favor of pronounced cyclical markup fluctuations … my simplifying assumption seems not too strongly at odds with the data.' (Roeger 1995, p.318n1)

[2] Hall (1988), the predecessor of Roeger (1995), uses a primal productivity growth measure only. The basic insight behind Roeger's equation as derived from productivity measures and as compared to Hall's equation is that a dual measure can be subtracted from the primal one. If this is done, productivity growth drops out of the equation, which makes the use of potentially unreliable instrumental variables unnecessary and, hence, the estimation procedure more straightforward. More on the relation between Roeger's and Hall's methods can be found in appendix A.

2.3 The Structural Method

2.3.1 Modelling Supply and Demand

The structural *method* proceeds by modelling supply (cost structure and firm behaviour) and demand. The models of Bresnahan (1982) and Appelbaum (1982) belong to this type. Because of the modelling of demand, it is possible to include the *elasticity-adjusted* Lerner index, also known as the conjectural elasticity, as a parameter to be estimated.[1] This measure has the advantage over the Lerner index that it captures the behaviour of producers only. It adjusts the Lerner index for consumer behaviour. The *elasticity-adjusted* Lerner index for firm i, q_i, equals:

(9) $q_i = -e\, L_i$,

where e is the elasticity of demand. In contrast to the previous two methods, the structural method allows for variable returns to scale. This means that a genuine attempt is made to estimate marginal cost, whereas the previous two methods circumvent this by equating marginal to average cost. However – again in contrast to the two other methods – it requires the imposition of a functional form.

The model starts with an inverse demand curve (assuming a homogeneous product):

(10) $P = D^{INV}\left(Q\right)$

– where P and Q are defined at the industry level and $Q = \sum_i Q_i$ – and a cost curve:

(11) $C_i = C_i\left(Q_i\right)$.

The first-order profit-maximising condition is given by:

(12) $P + \dfrac{\partial P}{\partial Q_i} Q_i = MC_i$.

Rewriting this in terms of the Lerner index leads to the following equation:

(13) $L_i = -\dfrac{\partial P}{\partial Q}\dfrac{\partial Q}{\partial Q_i}\dfrac{Q_i}{P}$.

Because of the familiar definition of the elasticity of demand and the definition of the conjectural elasticity:

(14) $q_i = \dfrac{\partial Q}{\partial Q_i}\dfrac{Q_i}{Q}$,

[1] If q is designated as the conjectural elasticity, it is commonly interpreted as a variable that measures the expectations or conjectures of firms about the behaviour of their rivals. This interpretation, however, is highly controversial (Bresnahan 1989, 1029; Krouse 1998, p.688; Kadiyali et al. 1999, pp.360-61).

equation (9) follows from multiplying both the numerator and the denominator of equation (13) by Q and some rearrangement.

2.3.2 Specification of the Structural Method

As noted above, the structural method requires the imposition of a functional form. We use the specifications of Bresnahan (1982) and Appelbaum (1982) as the basis for our own specifications.

Bresnahan

Bresnahan (1982) has proven that if marginal cost is dependent on Q, both a variable that shifts the demand curve (Y) and a variable that rotates it (Z) are needed in order to achieve identification of the conjectural elasticity. Lau (1982) has established that identification is not achieved if a log-linear specification of demand is used. The specification that Bresnahan uses in his paper is given in appendix B. We refer to this original version as Bresnahan (1).

If marginal cost is assumed to be independent of Q – an assumption that seems plausible, at least locally – it is not necessary for identification purposes to include a variable that rotates demand (Carlton and Perloff 1994, p.379). Hence, a second version of the model – Bresnahan (2) – can be formulated that assumes marginal cost to be constant and does not include Z. Bresnahan (3) follows from including technical change in the model.[1]

Appelbaum

A second consequence concerning the identification of structural models follows from taking marginal cost to be independent of Q. Apart from the fact that Z does not have to be included anymore, the model is still identified if a log-linear specification of demand is used. Appelbaum (1982) does exactly this. In addition to this, he includes factor demand functions. By doing this, he attempts to take full advantage of the information contained in the data. Theoretically, certain cross-equation restrictions should hold between these factor demand equations and the supply relation.

Appelbaum proposes the following specification of demand:

(15) $\ln(Q) = a_0 + e\ \ln(P/PI) + r\ln(Y/PI) + i$,

where PI is a suitable price index and i is an error term. He uses a generalised Leontief cost function (which takes marginal cost to be independent of Q_i):

[1] This is done in analogy to the way in which technical change is included in Appelbaum (see below). The details for Bresnahan are not presented in the main text because the quality of the results discussed in chapter 3 is poor.

(16) $C\left(W_j, Q_i\right) = \sum_{j-}\sum_{j+} b_{j-j+}\sqrt{W_{j-}}\sqrt{W_{j+}}Q_i + \sum_{j-} b_{j-}W_{j-}$,

where j_-, j_+ ={N, M, K} for the inputs labour, material, and capital respectively, and W_j is price of input *j*.

This leads to equation (17) as the supply relation:

(17) $P = \dfrac{\sum_j b_{jj}W_j + 2b_{NM}\sqrt{W_N W_M} + 2b_{NK}\sqrt{W_N W_K} + 2b_{MK}\sqrt{W_M W_K}}{1 + q/e} + w$

and - using Shephard's lemma - to (18) - (20) as input demand functions:

(18) $X_{iN}/Q_i = b_{NN} + b_{NM}\sqrt{W_M/W_N} + b_{NK}\sqrt{W_K/W_N} + b_N/Q_i + n$.

(19) $X_{iM}/Q_i = b_{MM} + b_{NM}\sqrt{W_N/W_M} + b_{MK}\sqrt{W_K/W_M} + b_M/Q_i + h$.

(20) $X_{iK}/Q_i = b_{KK} + b_{MK}\sqrt{W_M/W_K} + b_{NK}\sqrt{W_N/W_K} + b_K/Q_i + z$,

where X_{ij} is quantity of firm i and input *j*.

The model that is to be estimated consists of equations (15), and (17) – (20). The cross-equation restrictions are contained in those parameters that occur in both equation (17) and equations (18) – (20). This original version is referred to as Appelbaum (1). The model without demand curve is designated as Appelbaum (2). Both versions assume technology to be constant. The model can easily be adapted to include technical change. Making some simplifying assumptions, it suffices to add $\sum_j b_{jt}W_j t\ Q_i$ to the cost function. This last version – Appelbaum (3) – is presented in appendix B.

The Lerner index can be calculated from the estimated models. In addition, the *elasticity-adjusted* Lerner index or conjectural elasticity is estimated as a parameter.

2.4 The (Elasticity-Adjusted) Lerner index

The relationship between the Lerner index and the *elasticity-adjusted* Lerner index or conjectural elasticity – equation (9) – deserves some further attention. The Lerner index captures both producer and consumer behaviour. Hence, it represents the outcome of the market process as a whole. It depicts the consequences of both the responsiveness of consumers to price changes and the market power of producers. Furthermore, it is a measure of the actual rents that accrue to the producers because of a deviation from perfect competition. Hence, it is a measure of *performance* in terms of *non-competitive rents* (Appelbaum, 1982).[1]

The *elasticity-adjusted* Lerner index captures the behaviour of producers only. Because of this, it is a *conduct* parameter and can be used as a measure for oligopoly or *market power*. A related advantage of this variable is that its values have a clear interpretation. Both the Lerner index and the *elasticity-adjusted* Lerner index equal 0 in case of perfect competition. However, whereas the *elasticity-adjusted* Lerner index equals 1 in case of a monopoly, the Lerner index equals $-1/e$. Depending on the value of the elasticity of demand - in a monopoly $e < -1$ - this can be anywhere between 0 and 1.

In intermediate cases, the value of the *elasticity-adjusted* Lerner index can be interpreted relative to the equivalent number of firms, whereas the Lerner index lacks a straightforward interpretation. The equivalent number of firms is defined as the number of firms that is consistent with the value of the *elasticity-adjusted* Lerner index on the assumption that it represents a Cournot oligopoly. This number can serve as a benchmark figure, which is to be compared to the actual number of firms in the industry.

If the actual number is larger (smaller) than the equivalent number, market power is higher (lower) than in a Cournot oligopoly.[2] Apart from the interpretation of these parameters, it is a wholly different matter whether they can be estimated in a satisfactory way. Answering this question is the focus of the remaining chapters.

2.5 Versions and Assumptions

We are now ready to summarise the assumptions made by the three methods. All of the presented methods assume perfect competition on the markets for inputs. In addition to this, the benchmark and Roeger's method result in values of the average Lerner index, and assume constant returns to scale in order to arrive at the Lerner index as a markup of price over marginal cost. Neither the benchmark nor Roeger's method make any assumptions with respect to technical change.

[1] Some use the terms market, oligopoly, or monopoly power for the Lerner index, while others use them for the conjectural elasticity. For reasons explained in the text, we adopt the convention to see the conjectural elasticity as a measure of market power and the Lerner index as a measure of non-competitive rents (see also Hindriks 1999, chapter 2).

[2] This interpretation has originally been suggested by Sullivan (1985).

Table 2.1 Versions and assumptions

	Version	CRS* / CMC	Peculiarities
Benchmark	1	CRS	Based on *reported* profits
	2	CRS	Based on *constructed* capital cost
Roeger**	1	CRS	As Roeger (1995)
	2	CRS	Estimated parameter is m^{AC} instead of L^{AC}
Bresnahan	1	neither	As Bresnahan (1982)
	2	CMC	Without price of substitute
	3	neither	With technical change
Appelbaum	1	CMC	As Appelbaum (1982)
	2	CMC	Without demand curve
	3	CMC	With technical change

* Note that constant returns to scale (CRS) implies constant marginal cost (CMC). ** Technical change does not have to be taken into account, as it drops out of the model (as in Roeger's derivation, see appendix A) or does not occur in the model at all (as in our derivation).

The structural method does not necessarily assume constant returns to scale. Appelbaum assumes marginal cost to be constant (which is less restrictive than the CRS-assumption), while this assumption can be imposed on Bresnahan. In contrast to this greater flexibility with respect to the returns to scale, the structural method requires the choice of specific functional forms of demand, supply, and technology. Furthermore, the assumption of profit maximisation is imposed.

Appelbaum uses a log-linear specification of the demand curve. Bresnahan's model is not identified if a log-linear specification is used. As the structural methods have been proposed, technical change is not modelled, and, hence, is implicitly assumed to be constant. However, since not modelling technical change would put the structural method at a disadvantage with respect to the other two methods, we also consider versions that include technical change.

With respect to capital data requirements, data on the rate of change suffices for Roeger's method. The benchmark requires levels of total capital cost. The structural method requires data on levels of price of capital (Bresnahan), or on levels of both price and quantity (Appelbaum).

An overview of the versions explicated in previous sections along with their main assumptions is given in table 2.1. These versions are applied in the next chapter.

3 Empirical Results

3.1 Data and Estimation Techniques

The data set concerns Dutch manufacturing industries. A description of the data can be found in appendix D. The results presented below pertain to 3 (11) out of 16 (79) two (three)-digit industries on which data are available (see table 3.1). The industries considered are clothing (SBI 23), printing (SBI 27), and construction material (SBI 32). They have been selected by the degree of non-competitive rents we expect to find. Previous research suggests that non-competitive rents in Dutch manufacturing are lowest in the clothing industry, and highest in the industry for construction material.[1] The printing industry is thought to exhibit a degree of non-competitive rents that is about average for Dutch manufacturing. Hence, a wide range of performances - and most likely of behaviour as well - is covered.[2]

Table 3.1 Selected Industries and Number of Firms

Two-digit SBI	Three-digit SBI	# of firms	Nobs	Industry
23	231	21	336	Manufacture of ready-made clothing
Clothing	232	5	80	Contract manufacture of ready-made clothing
27	271	181	2896	Printing industry
Printing	272	33	528	Publishing industry
	273	34	544	Bookbinding industry
32	321	13	208	Manufacture of bricks and tiles
Construction	322	8	128	Manufacture of earthenware
Material	323	8	128	Manufacture of sand lime bricks
	325	66	1056	Manufacture of concrete and cement products
	327	10	160	Manufacture of other minerals
	328	8	128	Manufacture of glass and glass processing plants

Nobs: number of observations.

The period that is considered starts in 1978 and ends in 1993. Since yearly data are used, this implies that for each variable available for a certain firm 16 observations are available. In applications of Roeger's method, this number decreases by one, since first differences are used. As a variable that rotates the demand curve – required for Bresnahan's model – we use the price of import products based on the SGN-classification, which differs only slightly from the SBI-classification of industries. Unfortunately, data for this variable are only avail-

1 See Hindriks (1999a). This paper applies Roeger's method using a different data set covering a slightly different period (1978-1991). The degree of non-competitive rents was actually found to be highest in SBI 39 (miscellaneous). However, the data set used here does not contain data for that industry.

2 It is conceivable that the conjectural elasticities are equal between industries with different performances. In case of identical producer behaviour, the difference in performance is due to differences in consumer behaviour as measured by the elasticities of demand (see equation (9)).

able for 1980-1991. Hence, the number of observations decreases from 16 to 12 for each firm in case of the non-constant marginal cost version of the structural method. The number of observations is given in the fourth column of table 3.1.

All data are at the lowest level of aggregation that *Statistics Netherlands* supplies, which is the firm level in case of the quantities of the inputs and of output, and a meso-level (three-digit SBI) in case of the other variables.

For the benchmark and the application of Roeger's method, only data on revenue, and on total labour, material, and capital cost are required. With respect to capital cost, data on the rate of change suffice for Roeger, if the income share of capital has been eliminated (as is done in equations (7) and (8)). For the structural method, both prices and quantities of output and prices of inputs have to be known. Apart from that, variables that influence demand have to be available, as well as a price index. For Y we use Gross National Product, while we use prices of imports for Z.

We use ordinary least squares and correct for heteroskedasticity (see White 1980), just as Roeger (1995) does. With respect to the models of Appelbaum and Bresnahan, the estimation procedure used is full information maximum likelihood. This is the preferred method for estimating a simultaneous model that has been fully specified.

3.2 The Benchmark Method

The results for the benchmark method are presented in table 3.2. For both versions of the benchmark method, averages over both years and firms within three-digit industries are presented. Apart from the values of the average Lerner index, the values of the capital income share are reported. They are mutually dependent once the income shares of labour and material are available, as can be seen from the equation for the average Lerner index – equation (4). In other words, the one implies the other. Since both the Lerner index and the capital income share differ between versions and methods, the plausibility of both will be considered.[1]

We start by considering what we have called the *reported* benchmark. As explicated in chapter 2, this is the profit-sales ratio as given in equation (3). The value for SBI 232, -0.02, is the lowest and it is the only one that is negative. The other values are within the interval [0.02, 0.14], SBI 321 being the highest one. Price approximately equals average cost for three industries, as the values for the Lerner indices of SBI 231, 232, and 328 are within the interval [-0.03, 0.03].

[1] One can determine the sum of the Lerner index and the capital income share from data on the income shares of labour and material, since the following equation follows from equation (4): $L^{AC} + a_K = 1 - \sum_{j \neq K} a_j$. The fifth column of the table in appendix D reports this sum for the selected industries. This sum provides an upper bound for both the capital income share. If the average Lerner index is assumed to be nonnegative, the sum provides an upper bound for it as well.

The capital income shares that are implied by the Lerner index in the second column are reported in the third column of table 3.2. The capital income shares are within the interval [0.02, 0.13].

Table 3.2 The *Constructed* and the *Reported* Benchmark

	Benchmark (1)		Benchmark (2)	
SBI	L	a_K	L	a_K
231	0.026	0.029	0.014	0.042
232	-0.023	0.033	-0.059	0.068
271	0.044	0.074	-0.009	0.127
272	0.087	0.016	0.056	0.048
273	0.046	0.098	-0.019	0.162
321	0.135	0.120	0.044	0.210
322	0.043	0.054	0.011	0.086
323	0.093	0.128	0.011	0.209
325	0.058	0.075	0.027	0.107
327	0.095	0.065	0.065	0.096
328	0.029	0.097	-0.016	0.142

The second version of the benchmark method, i.e. the *constructed* benchmark, calculates the average Lerner index according to equation (4). The resulting values are presented in the fourth column of table 3.2 (see appendix D for the income shares of the inputs). Of the calculated benchmark values of the average Lerner index, 4 out of 11 are negative, none of them being smaller than -0.06. The largest value is 0.07 (SBI 327). Price approximately equals average cost in most industries, as 7 out of 11 of the benchmark values are within the interval [-0.03, 0.03]. The capital income shares – presented in the fifth column – are within the interval [0.04, 0.21].

The values of the constructed benchmark are on average 4.6 percentage points lower than the reported benchmark, while the order of the sectors is quite different if they are ranked according to the value of the Lerner index. SBI 232 ends last in both cases, while SBI 328 is ranked 9th for both benchmarks. Five industries are ranked lower in case of the reported benchmark as compared with the constructed one, while four are ranked higher. The average change in ranking for all industries is two positions.

Since the only difference between the two versions of the benchmark method resides in the capital cost, the capital cost as calculated by the firms themselves must be lower on average than the capital cost as constructed by us. This is indeed the case. However, there does not seem to be a fixed relation between the two ways of calculating capital cost, since the ordering of the industries that results for the two versions if ordered according to the values of the Lerner index is different. This difference in ordering implies that there is a different in method of determining capital cost: either the firms use a method that is fundamentally different from ours, or different firms use different methods of calculating profits.

3.3 Roeger's Method

Since Roeger estimates the average Lerner index as well, again both the Lerner index and the capital income share are reported. The results of Roeger's method are presented in table 3.3. Apart from the Lerner indices and the capital income shares we report the significance level and the (adjusted) explained variance. With regard to the first version, almost all estimates are significant at the one percent level, and the (adjusted) explained variance varies from 0.06 to 0.62. The values of the Durbin-Watson statistic indicate that there is no serial correlation. The estimates are within the interval [0.05, 0.33]. All estimates are considerably higher than those of the two versions of the benchmark, and price is always higher than average cost.

The values of the capital income shares that are implied by the estimates of the Lerner indices range from –0.08 to 0.01. Note that in 9 out of 11 industries the implied capital income shares are negative. Negative capital income shares are impossible in fact. The results of the first version of Roeger, then, should be considered anomalous.

The second version of *Roeger* – reported in the last three columns of the table – results in an estimate of the markup m^{AC} instead of the average Lerner index. The estimated values are transformed according to the following equation:

(22) $$L^{AC} = 1 - \frac{1}{m^{AC}}.$$

Just as was done with respect to the benchmark, the returns to scale are assumed to be constant in order to equate the average Lerner index to the genuine Lerner index that is based on marginal cost. The reported significance and explained variance pertain to the m^{AC} estimates.

All estimates of Roeger (2) – except for the one for SBI 327 – are lower than the Roeger (1) estimates. On average the difference is 5.5 percentage points. The interval is [0.00, 0.23]. All of them are significant at the one percent level. The explained variance is much higher than that of Roeger (1), starting at 0.85 instead of 0.06. There is no serial correlation. Finally, only one of the implied capital income shares is negative, while the others range from 0 to 0.09.

Table 3.3 Two Versions of Roeger's Method

	Roeger (1) = L – based			Roeger (2) = m – based		
SBI	L	a_K	R^2_{adj}	L	a_K	R^2_{adj}
231	0.071a	-0.016	0.18	0.046a	0.009	0.97
232	0.050c	-0.041	0.06	0.002a	0.008	0.95
271	0.120a	-0.002	0.26	0.073a	0.044	0.95
272	0.129a	-0.026	0.43	0.103a	0.000	0.97
273	0.136a	0.007	0.39	0.103a	0.040	0.96
321	0.330a	-0.076	0.62	0.228a	0.026	0.87
322	0.101a	-0.004	0.33	0.078a	0.019	0.98
323	0.261a	-0.040	0.42	0.133a	0.088	0.85
325	0.147a	0.014	0.33	0.097a	0.036	0.95
327	0.209a	-0.083	0.57	0.168a	-0.007	0.95
328	0.151a	-0.025	0.37	0.106a	0.021	0.95

Estimates are significant at the a: 1 percent, b: 5 percent, or c: 10 percent level.

The order of the results does not change as much between the two versions as was the case with respect to the two versions of the benchmark. Five industries – SBI 231, 232, 273, 321, and 328 – are ranked the same for both versions. The average difference in rank is less than one position.

3.4 The Structural Method

We now turn to the structural method. First, Bresnahan's model is considered. The original version as Bresnahan proposed it – i.e. Bresnahan (1) – has been estimated. Apart from the original version, a version that assumes marginal cost to be constant - Bresnahan (2) - as well as a version in which technical change has been modelled - Bresnahan (3) - have been applied. The estimates that come forward are quite disappointing. Most parameter estimates are insignificant. Furthermore, some of the significant parameter estimates fall outside the domain in which they should be, according to economic intuition. For instance, elasticities of demand lower than -100 and conjectural elasticities larger than 1 or even 2 are found. Because of this, the results are not presented here.

However, this is not a devastating result. Bresnahan (1982) notes that the model of any actual application will be more complicated than the one he himself presents (p.92). The main point of his paper is a theoretical one: the conjectural elasticity is identified in a structural model that allows for variable returns to scale if both a variable that shifts and a variable that rotates the demand curve are incorporated in the model. The reason why the results are so poor may be that the model is too simplistic to capture actual behaviour in a certain industry.[1]

As will be shown below, the results of the application of Appelbaum's model are more plausible. This holds not only for the original model, but for the model without demand curve as well. Combining this with the poor results of the Bresnahan-model, it can be concluded that positing a more complex cost function and imposing cross-equation restrictions by including the input demand functions improve the significance and plausibility of the resulting estimates.[2]

Table 3.4 Appelbaum (1) : The original model.

SBI	*e*	*r*	*q*	***L***	*b* **s**
231	-0.40a	-0.24a	0.01a	0.03	4
232	-0.46b	0.42a	0.01	0.03	8
271	0.40a	0.46a	-0.00	0.00	8
272	-0.99a	0.66a	0.11a	0.11	8
273	0.79a	0.09	-0.00	0.00	6
321	-0.18c	0.36	0.05c	0.27	9
322	-1.07a	0.28a	0.00	0.01	2
323	0.18	0.35a	-0.01	0.09	8
325	-0.47a	0.44a	0.02a	0.06	8
327	0.47a	0.47a	-0.01b	0.02	5
328	-1.85a	0.69a	-0.04a	-0.02	4

ε, ρ, and θ are estimated directly; estimates are significant at the a: 1 percent, b: 5 percent, or c: 10 percent level. L is an unweighted average calculated from the estimated model; βs: number of cost parameters that are significant at the 10 percent level or higher (out of 9).

The results for the original model, Appelbaum (1), are presented in table 3.4. The Lerner index ranges from -0.02 to 0.27. In 6 of the industries, the number of significant cost parameters is 8 or 9 out of a total of 9 while in 2 industries this number is still 5 or 6. This seems a fairly reliable base for the calculated values of the Lerner indices. However, note that three of the elasticities of demand are (significantly) positive, while 1 of the income elasticities is negative.[3] Four of the elasticities of demand are between -0.5 and 0, which seems to be relatively high. It seems save to conclude from these facts that the elasticities

1 Other explanations of the disappointing results range from questioning the appropriateness of imports as an appropriate substitute, to the claim that marginal cost is in fact constant.

2 This is the case in spite of the low explained variance of the input demand equations, which is on average 0.25, 0.14, and 0.08 for labour, material, and capital respectively.

3 Apart from GDP, we have used quantity produced by other OECD countries for Y. The results were qualitatively similar.

of demand are not very reliable. It is not clear, however, what this means for the Lerner indices.[1, 2]

Table 3.5 Appelbaum (3) : Taking technical change into account

SBI	ε	ρ	θ	***L***	β**s**
231	-0.38b	-0.24a	0.01c	0.03	6
232	-0.37	0.43b	0.00	0.01	4
271	1.19a	1.43a	-0.03a	0.02	8
272	1.20a	0.03	-0.13a	0.11	4
273	1.65a	-0.33a	-0.10a	0.06	5
321	-0.89a	0.32a	0.23a	0.25	5
322	-1.01a	0.31a	0.01	0.01	1
323	-0.94a	0.23a	0.06	0.07	2
325	-1.00a	0.36a	0.05a	0.06	6
327	0.66a	0.51a	-0.02b	0.03	3
328	-1.44a	0.68a	-0.03b	-0.02	5

ε, ρ, and θ are estimated directly; estimates are significant at the a: 1 percent, b: 5 percent, or c: 10 percent level. L is an unweighted average calculated from the estimated model; βs: number of cost parameters that are significant at the 10 percent level or higher (out of 9). Detailed results are presented in appendix D.

In order to find out to what extent the poor estimates of the elasticity of demand influence the values of the Lerner index, the model has been estimated without the demand curve. In this version – Appelbaum (2) – only equations (21) – (24) are estimated. Although the number of significant cost parameters drops from more than 6 to 5 on average, the calculated values of the Lerner index are hardly any different, except for SBI 321 (manufacture of bricks and tiles) for which an implausibly large Lerner index of 0.92 is found. If this industry is excluded from our consideration, the Lerner index found by the four-equation version is on average 0.001 lower than that of the complete model, the standard deviation of the decrease being 0.005. This largely invalidates the suggestion of Hindriks et al. (1999, p.29) that 'prob-

1 In chapter 1, we present reasons why the version that incorporates technical change, Appelbaum (3), is to be preferred over Appelbaum (1). Only the details of the estimates from Appelbaum (3) are reported in appendix D.

2 This model has been applied to the same data set in Hindriks et al. (1999) to all of the 79 industries of Dutch manufacturing on which data are available. In 34 out of 79 industries to which the model has been applied, the elasticity of demand was positive. Apart from slight differences in data definitions, the main difference between the present application and the one in Hindriks et al. (1999) is the fact that in the latter the conjectural elasticity is endogenised. It is made dependent on the export share of total production, the import share of total sales, and the degree of concentration in terms of the Herfindahl index. Of the key variables of the model, the changes in the estimates of the elasticity of demand are most notable (this also holds if there are no differences in data definitions). In case of SBIs 271, and 272 the signs even change. The values of the Lerner indices, however, are remarkably similar.

lems in estimating the elasticity of demand [may] spread out into the supply relation, which in turn will have consequences for the estimation of the input demand function.'[1]

However, neither the five-equation nor the four-equation version takes technical change into account. Including technical change in the model as a whole – i.e. estimating Appelbaum (3) – makes a difference, as can be seen from table 3.5. On average, the value of the Lerner indices increases by 0.004, the standard deviation of the difference being 0.023. With respect to the four-equation version, the incorporation of technical change has an even larger impact yet, the average value increasing by 0.015, the standard deviation being 0.081. It is, however, not clear whether incorporating technical change improves the quality of the results. The explained variance does not increase. Furthermore, the number of significant cost parameters decreases, while the technical change parameters themselves are frequently insignificant.[2]

Table 3.6 Sensitivity of estimates to the incorporation of technical change. Appelbaum (1) and (3).

	Elasticity of Demand		**Income Elasticity**		**Conjectural Elasticity**	
SBI	(1)	(3)	(1)	(3)	(1)	(3)
231	-0.40	-0.38	-0.24		0.01	0.01
232	-0.46	-0.30	0.42	0.50		
271	0.40	1.19	0.46	1.43		-0.03
272	-0.99	1.20	0.66	1.01	0.11	-0.13
273	0.79	1.65		1.11		-0.10
321	-0.18	-0.89		0.47	0.05	0.23
322	-1.07	-1.01	0.28	0.36		0.01
323		-0.94	0.35	0.59		
325	-0.47	-1.00	0.44	0.73	0.02	0.05
327	0.47	0.66	0.47	1.65	-0.01	-0.02
328	-1.85	-1.44	0.69	0.68	-0.04	-0.03

Appelbaum (1): original model. Appelbaum (3): model including technical change. Only estimates that are significant at the 10 percent level or higher are included.

Including technical change in the full model has profound implications for the estimates of the elasticity of demand, the income elasticity and the conjectural elasticity, as can be gathered from table 3.6. In the case of SBI 272 (publishing industry), a perfectly plausible estimate of the elasticity of demand (-0.99) changes into a positive, and - hence - highly implausible estimate (1.20). Other less extreme cases underscore the conclusion that can

1 The results of Appelbaum (2) are not reported because of the fact that simultaneity of supply and demand is not taken into account if demand is not included in the model.

2 The technical change parameters are cost parameters. The real number of cost parameters of Appelbaum (3), then, is 12. The 9 original cost parameters and the three additional ones are discussed separately in order to make the comparison of Appelbaum (1) and Appelbaum (3) as transparent as possible. The last column of table 3.5 refers only to the 9 original cost parameters.

be drawn from this: the estimates of the various elasticities are quite sensitive to changes in specification (cf. footnote 1 on p.29).

This is less so with respect to the Lerner index, as can be seen from the results presented in table 3.7. Neither the value of the Lerner index implied by the estimated model, nor the number of significant cost parameters changes dramatically if technical change is included. The range of the estimates is comparable to that of Roeger's method.

Summing up the results for Appelbaum's model, the most obvious flaw in the results consists of the implausible estimates of the elasticity of demand.[1] The other striking observation is that the estimates of the Lerner index do not change much as a result of differences in specification. These experiences warrant the following conclusion. Whereas the estimates of the three elasticities are likely to be unreliable – because of some implausible values that are found and their sensitivity to changes in the model – the values of the Lerner index that are calculated from applications of the structural method may be relatively reliable, since they are fairly robust to differences in specification.

Table 3.7 Effects of the incorporation of technical change on the Lerner index

	Appelbaum (1)		**Appelbaum (3)**	
SBI	Lerner index	βs	Lerner index	βs
231	0.03	4	0.03	6
232	0.03	8	0.01	4
271	0.00	8	0.02	8
272	0.11	8	0.11	4
273	0.00	6	0.06	5
321	0.27	9	0.25	5
322	0.01	2	0.01	1
323	0.09	8	0.07	2
325	0.06	8	0.06	6
327	0.02	5	0.03	3
328	-0.02	4	-0.02	5

Appelbaum (1): original model. Appelbaum (3): model including technical change. βs: number of significant (at the 10 percent level) cost parameters (out of 9). The specification of Appelbaum (3) is given in appendix B. Detailed results of Appelbaum (3) are presented in appendix D.

Although estimates of applications of all methods have now been presented, no method has come forward as the obviously best one. However, comments concerning the quality of the results have been kept to a minimum thus far. A thorough evaluation of the comparative advantages of the methods is given in the next chapter.

[1] Of course, there are more sophisticated ways of estimating demand. In this report, however, we stick to the parsimonious approach to the structural method as announced in the introduction.

4 Evaluating Comparative Advantages

4.1 Introduction

In the previous chapter, the methods were primarily evaluated with respect to empirical and econometric criteria. The data requirements have been discussed, the usual test statistics, the sensitivity to changes in specification, as well as economic intuition concerning plausible signs and values of parameter estimates. A further discussion of these criteria is given in section 4.2. In addition to that, our results are compared to those found by others. Furthermore, the other more theoretical criteria are discussed: the amount of information revealed by the estimates, and the set of assumptions required.

Section 4.3 presents the evaluation of the versions within the three methods. For each method, one comes out as best and is put forward for participation in the final round. The selection of the best version with respect to Roeger's method is discussed somewhat more extensively, because of the anomaly of the application of the original version.

Section 4.4 provides an evaluation of the three methods. The versions that have come out as the best ones in the previous section are compared and we give an overall judgement about the relative quality of the methods. In line with the perspective outlined in the introduction, our conclusions are sensitive to the purposes, the prior information, and the resources that one may have in research on competition. As such, the outcome of our investigation will be a judgment concerning the comparative advantages of methods that can be used to estimate markups.

4.2 Discussing the Criteria

4.2.1 Data Requirements

The data requirements of the reported benchmark are the least demanding. Apart from data on sales, Roeger requires data on the level of labour and material cost as well as data on the rate of growth of capital cost. The constructed benchmark is more demanding than Roeger's method, as it requires data on the level of capital cost.

The structural method requires more data than the other two methods. For instance, price and quantity of inputs have to be known separately in case of Appelbaum's model. The additional data are usually available in the case of manufacturing industries. Acquiring data on the price of a substitute product – as needed for the application of Bresnahan – may be more difficult. However, resorting to the price of imports, as has been done by us, may provide for a satisfactory option. Still, the benchmark and Roeger's method have a slight edge here over the structural method.[1]

[1] If one were to investigate service sectors, the fact that Roeger's method requires only nominal variables is a large advantage, since statistical information on prices in the service sector is often poor (Oliveira Martins et al. 1996, p.81).

4.2.2 Test-Statistics

Test-statistics are not relevant with respect to the benchmark, since it is based on an unweighted average. The µ-based version of Roeger's method fares very well both with respect to significance, and with respect to explained variance, the latter of which is 0.94 on average. The L-based version performs worse on both counts, although its results are still reasonable. Average explained variance equals 0.36.

Many parameter estimates found by the structural method are insignificant (remember that most meaningless estimates – such as those based on Bresnahan's model – have not even been reported). Several of the reported estimates of key variables for which one expects nonzero estimates, such as the elasticity of demand and the income elasticity, are insignificant. Furthermore, quite a few cost parameters are insignificant. The average explained variance of the equations is substantial for the demand curve, 0.52 (0.51), and supply 0.87 (0.86). The explained variance of the input demand equations is fairly low: 0.25 (0.28) for labour, 0.14 (0.15) for material, and 0.08 (0.11) for capital.[1]

4.2.3 Economic Intuition

Looking at the constructed benchmark values from the perspective of economic intuition, it may be noted that they are unusually low. Especially the four negative values are implausible, since it is not likely that revenues are smaller than costs for an extended period. The reported benchmark comes out better in this regard, since only one value is negative.

The Lerner index values of Roeger's method are plausible. However, the capital income shares of the L-based version are anomalous, as most of them are negative. The µ-based version fares better in this respect, because only one capital income share is negative here.

With respect to the structural method, economic intuition is important to the extent that some parameter estimates found by the structural method are highly implausible, as is evidenced by positive elasticities of demand (for industries which do not evidently produce Giffen goods), negative income elasticities, and a Lerner index of 0.92. What may be added here is that in previous research we have determined that applications of the structural method (Appelbaum) lead to estimated equations that sometimes violate basic desiderata such as input demand functions (especially capital) that decrease in their own price (Hindriks et al. 1999).

As has been noted in section 3.4, the most striking clash with economic intuition is provided by the positive elasticities of demand. A possible explanation for these implausible estimates may be that not enough relevant information is contained in the demand equation. Especially the omission of product characteristics may be important here. We will return to this issue later on.

[1] Figures between brackets apply to the version that models technical change, i.e. Appelbaum (3).

4.2.4 Comparison with the Results of Others

The results for both versions of the benchmark are in line with those usually found.

The results of Oliveira Martins et al. (1996, pp.79-80) can be used for comparison purposes with regard to Roeger's method, because they present gross output estimates, just as we do. Our results are in line with those of Oliveira Martins et al. (1996). Unfortunately, a direct comparison to estimates for Dutch manufacturing is not possible.[1]

With respect to the structural method, some evidence concerning the 'normal range' can be found in Bresnahan (1989, p.1051). Restricting the analysis to the conjectural elasticity and the Lerner index, none of the estimates lie outside of the range that is in line with the estimates found by others, except for the conjectural elasticities that are found for SBI 272 (publishing industry) and 273 (bookbinding industry) in the version of Appelbaum that takes technical change into account. The estimated values are -0.13 and -0.10 respectively. These estimates, however, seem to be artefacts of the positive elasticities of demand that have been found for these industries, and, therefore, they were already ruled out by economic intuition.

4.2.5 Sensitivity to Specification

We now move on to consider how sensitive the methods are with regard to changes in specification. Sensitivity to specification is not always a vice. The general principle is that if changes in results can be explained, sensitivity is no problem. In case of ignorance – no sufficient explanation is available for the differences in results – robustness is a virtue.

The benchmark is either specified in terms of reported profits or constructed capital cost. The results of these different specifications are large enough to deserve our attention. However, they are perfectly intelligible: one may reasonably conclude that firms use a method for calculating capital cost that is different from ours.

Roeger's method turns out to be quite sensitive to differences in specification. The estimates based on the L-based version differ considerably from the results from the μ-based version. In section 4.3.3 we provide an explanation for this. Since the differences in results can be satisfactory explained in terms of differences in specification, sensitivity to changes in specification is not a real issue with respect to either the benchmark or Roeger's method.

With regard to the structural method, a lot of different specifications are possible, and most key variables are very sensitive to these different specifications. Not all the changes in es-

[1] There are two reasons for this. First, other estimates that apply to Dutch manufacturing are usually done at a higher level of aggregation. Second, many applications of Roeger – including the one provided by Van Dijk and Van Bergeijk (1997) – use value added data instead of gross output. Both features follow from the use of national accounts data. If revenue and material cost grow strict proportionally, a straightforward formula can be used to transform value added estimates to gross output estimates. However, as is shown in Hindriks (1999, pp.37-41), even relatively small deviations from a perfect correlation may lead to heavily biased results if the transformation equation is used.

timates are well understood. For instance, including technical change in Appelbaum's model leads to changes in signs of the elasticity of demand and the *elasticity-adjusted* Lerner index, whereas this was in no way expected. Furthermore, it is not certain whether the fact that the quality of the estimates improves if marginal cost is assumed to be constant is a sign that marginal cost is constant in fact. Other explanations are possible. One might for instance appeal to the appropriateness of the data that have been used for the price of a substitute in Bresnahan's model that does not assume constant marginal cost (cf. footnote 1 p.28). Furthermore, one might argue that the results improve just because of the imposition of more structure.

The necessity of choosing a specific functional form for demand and the cost function, then, is a serious drawback of the structural method. It may very well be that demand and/or cost structure is misspecified. Hyde and Perloff (1995, p.471) use simulations, and conclude that the structural method does not work well if the functional form is misspecified. This is an indication of the risks involved of having misspecified the model. These risks seem to be considerably high. It should be noted, however, that the values of the Lerner index are very robust with respect to differences in specifications.

4.2.6 The Amount of Information Revealed

The benchmark method and Roeger's method result in estimates of the average Lerner index. Conditional on the truth of the constant returns to scale assumption, this allows one to draw conclusions about the non-competitive rents. In contrast, the structural method leads to genuine Lerner indices in terms of marginal cost. In addition to that, it provides parameter values for the *elasticity-adjusted* Lerner index, the elasticity of demand, and – possibly – the returns to scale as well. Hence, one can draw more definite conclusions about market power on the basis of applications of the structural method. From the perspective of how much information is contained in the model, the structural method is clearly superior to both Roeger's method and our benchmark.

4.2.7 Assumptions

With respect to the assumptions made, all methods share the assumption of perfect competition on input markets. Both the benchmark method and Roeger's method estimate the average Lerner index, and, hence, assume constant returns to scale. This is a bit disappointing, because the possible divergence between average and marginal cost is the most interesting aspect of estimating the Lerner index.[1] In addition to that, Roeger assumes a constant markup. Whether markups are in fact constant over the business cycle is a controversial issue. Only the structural method presupposes profit maximisation.[2]

[1] Morrison (1990), Schmitt-Grohé (1996), and Bhuyan and Lopez (1997), for instance, argue that the returns to scale are frequently not constant.

[2] As is explicated in appendix A, profit maximisation is assumed in the historical derivation of Roeger's method. Our derivation does not need this assumption.

The structural method does not require the assumption of CRS, which may be seen as a virtue. Our empirical findings show that imposing constancy on marginal cost improves the performance of the models (in terms of significance of the estimates). Allowing for non-constant marginal cost does not seem to be of great value if one is not interested in short-run marginal cost, but in medium or long-term instead.

Table 4.1 Assumptions and capital data requirements of the three methods

Benchmark method	Roeger's method	Structural method
Shared assumption: perfect competition on input markets		
CRS / L^{AC}	CRS / L^{AC}	CMC / L
Data on C_K required	Data on Δc_K required	Data on W_K and X_K required
a_K constructed or reported	a_K determined by $\Delta c = \Delta pq$	W_K and X_K constructed
	Specification in terms of π or m^p	Profit maximisation
		Functional specifications required
		With or without technical change

We now turn to the assumptions that are made concerning capital cost. The reported benchmark assumes that the reported profits – and hence the capital cost implied by these – are correct. The constructed benchmark relies, among other things, on depreciation data provided by the firms.

Roeger relies on constructed rates of growth of capital cost. If a consistent method is used over time for the construction of capital data, the rate of change in capital cost that follow from the constructed capital data may be quite reliable, even if the levels themselves are not. Apart from that, he uses the assumption of a constant markup as a substitute for data on the level of capital cost. Subsequently, the income share of capital can be inferred from the markup estimates.

The structural method relies on constructed data on price and quantity of capital.

The assumptions and the data requirements concerning capital cost made by the three methods and their versions are summarised in table 4.1.

4.3 A Battle Between Versions

4.3.1 Introduction

The discussion of the criteria has paved the way for a thorough evaluation of the various methods that have been applied. We start by evaluating the versions within each of the three methods. A preferred version will come out of this evaluation for each method. These preferred versions are evaluated in section 4.4, and an overall judgement about the methods is given.

4.3.2 The Reported versus the Constructed Benchmark

The results of the reported and the constructed benchmark have been presented in table 3.2. The criterion of test-statistics does not apply, since there are none. The criterion of sensitivity carries no weight, since the changes in results caused by different specifications are well understood. Save for assumptions concerning capital cost, the assumptions for the two versions are the same, as is the amount of information revealed.

Fisher (1989) argues that profits as reported by firms are not reliable because firms may not calculate capital cost in the right way. We apply the user cost of capital appraised by Fisher in constructing capital cost data. Therefore, our constructed benchmark is theoretically superior. Although Fisher's arguments are powerful, we believe that they should not carry too much weight, since firm data on depreciation are needed to calculate the user cost of capital and they may not be completely reliable either. It is hard to draw a definite conclusion about relative reliability here.

A remaining criterion is that the data requirements of the reported benchmark are less demanding than those of the constructed benchmark. Finally, the plausibility of the values of the Lerner index and the capital income share should be considered. The values for the constructed benchmark are lower than those of the reported one. The number of negative values is four versus one. It is fairly implausible for price to be below average cost over an extended period of time. However, for a large part of the period considered – especially the early eighties – there was a recession that makes the finding of negative Lerner indices less implausible. Furthermore, slightly increasing returns to scale imply that in contrast to the average Lerner indices the real Lerner indices are positive.

Our overall conclusion is that the key issue in the choice between the two benchmark versions should be the assessment of the effort needed for calculating either version of the benchmark in terms of data collecting and constructing on the one hand and the plausibility of total capital cost versus depreciation as reported by the firms on the other. Giving Fisher's arguments relatively much weight, we weakly prefer the constructed to the reported benchmark.

4.3.3 An Anomaly for Roeger's method

Introduction

The data requirements of the L-based and the μ-based version of Roeger's method are the same. A comparison of the markup estimates is indifferent with respect to the two versions as well. Most assumptions are the same, as is the amount of information revealed.

With respect to test-statistics, the μ-based version outperforms the L-based one. The t-statistics average 54.52 for the μ-based set-up over 8.94 for the Lerner index version. The explained variance of the μ-based estimates is much higher than that of the L-based estimates – with an average of 0.94 compared to 0.35 for Roeger.

The issue considered next is what role economic intuition and sensitivity to specification play a role in determining the relative quality of the two versions.

The Anomaly

In section 2.2.3, it was said that the crux of Roeger's method is that the level of capital cost can be inferred from data on revenue and labour and material cost by making an assumption about the relation between the growth rates of sales and cost. The assumption made is that the two growth rates are equal to one another. Roeger needs this assumption, because he assumes the level of capital cost to be unobservable.

Since the Lerner index and the capital income share are co-determined, we have presented the estimated Lerner index as well as the implied capital income shares. As was noted in section 3.3, this reveals the anomalous character of the results for the L-based version of Roeger's method: most capital income shares are negative, and it is impossible for a capital income share to be negative. The anomaly sheds considerable doubt on the quality of the estimates based on the original version of Roeger's method.[1]

The most obvious explanation for this is that the constancy-assumption about the markup is invalid. If this is the right explanation, the assumption of a constant markup is not as innocuous as Roeger presents it (see footnote 1 p.**Error! Bookmark not defined.**). However, another answer is available that – in addition to explaining the anomaly – may provide a solution as well.

Towards a Solution

One may wonder why Roeger formulates the estimation equation in terms of the average Lerner index instead of the average markup, i.e. why he estimates equation (7) instead of equation (8). The reason may have been that the Lerner index version of the equation is less sensitive to measurement errors, since normally the Lerner index falls within the interval [0,1], whereas the interval for the markup μ is $[1,\propto]$.[2] In spite of this, we have proceeded to estimate equation (8) – i.e. the μ-based version of Roeger – as well. As can be seen from

1 The anomalous result of negative capital income shares is not a mere coincidence of the data set we use. The results of both Hall (1988), and Roeger (1995) suffer from the same problem. They use value added data. Consequently, information on the income share of material is not available. Hall (1988, p.936) only reports the labour income share for nondurables, which is larger than 0.7 (on average). The estimate of the average markup ratio is 3.096. The capital income share implied by this is -0.377. Both implied income shares are negative, and, hence, anomalous. Roeger's estimate of 1.48 implies a capital income share of -0.024 for nondurables. Note that the derivation of this result does not rely on an assumption concerning returns to scale in Roeger's case, whereas it does in Hall's case. This asymmetry is explained in appendix A.

2 Another reason why one may prefer the formulation in terms of the profit-sales ratio is related to the investigation of the impact of the business cycle on the markup, performed by Oliveira Martins et al. (1996) and Hindriks (1999a). The equation, which is able to account for demand effects, is only linear in its parameters if formulated in terms of the Lerner index instead of the markup μ. Thanks to Marcel Lever for pointing this out to us.

table 3.3, the estimates for this version are much more plausible than those of the L-based version. The results turn out to solve the anomaly, except for one industry, SBI 327, which still has a negative implied capital income share.

The question arises what the difference is between equations (7) and (8) that makes the results so different. The answer most likely resides in the assumptions made about the error term in the respective equations. The estimates that result from equation (7) may be biased due to a correlation between the error term and the exogenous variables that has not been properly taken into account, i.e. the independence principle is violated. In other words, the equation may be incorrectly specified. Presumably, equation (8) does not suffer from this problem or less so.

In sum, the results of the original version of Roeger's model should be considered as unreliable, due to the negative implied income shares for capital. The set-up of this method in terms of the markup m, however, results in estimates that do not imply such an anomaly, or in any case less so. Hence, the μ-based version of Roeger is to be preferred over the L-based version.

4.3.4 Technical Change and the Structural Method

We now turn to the selection of the preferred model within the structural method. The model proposed by Bresnahan has already been dismissed because of the insignificance of the estimates. The four-equations version of Appelbaum can be dismissed, because it does not take the simultaneity between supply and demand into account.[1] The remaining issue is whether technical change is to be included or not.

The versions of Appelbaum with and without technical change have been presented in tables 3.4 – 3.7. The data requirements are the same for both versions. Economic intuition has it that both versions fail in important respects, since elasticities of demand are positive and *elasticity-adjusted* Lerner indices are negative. Comparisons with results of others are not illuminating either concerning a choice between versions, as economic intuition has ruled out the most implausible results and results found by others cover a broad range. Sensitivity to specification counts against both versions, since changes in specification have an implausibly large effect on the estimates, as has been noted before.

The criterion of test-statistics points in different directions depending on the parameters considered. On the one hand, more of the key variables of the technical change version of the model are significant, as can be seen from table 3.6. On the other hand, less of the cost parameters that are included in both are significant. However, the significance of these parameters in the version that does not consider technical change may be an artefact of this exclusion. Furthermore, the explained variance of the input demand functions is larger

[1] See p.30 for why this version has been estimated in the first place.

for the model with technical change. Overall, this criterion seems to favour the technical change version.

Other arguments more convincingly favour this version. The set of assumptions of this version is less restrictive, since it allows for technical change. As a consequence, the amount of information revealed is more as well, since it becomes clear whether and to what extent technical change plays a role in the industries considered. Overall, the technical change version of the structural method is to be preferred over the one without.

4.4 A Battle Between Methods

4.4.1 Introduction

We are now ready to present the final evaluation. The preceding sections have led to a choice *within* the three methods. The final evaluation now involves a competition *between* methods. The models that figure here are the *constructed* benchmark (benchmark (2)), the μ-based version of Roeger's method (Roeger (2)), and the technical change version of the structural method (Appelbaum (3)). For short, these preferred versions are from now on designated as the benchmark, Roeger, and Appelbaum.

The results of the application of these preferred versions of the three methods to the selected industries in Dutch manufacturing are summarised in tables 4.2 and 4.3. Table 4.2 presents the values of the capital income shares of the three methods. With respect to the structural method, the income share that can be constructed from the data on price and quantity of capital used in the application of the model is presented in order to ease the comparison. Table 4.3 presents the respective Lerner indices.

Table 4.2 Capital income shares (a_K) of preferred versions

SBI	Benchmark & Appelbaum	Roeger
231	0.042	0.009
232	0.068	0.008
271	0.127	0.044
272	0.048	0.000
273	0.162	0.040
321	0.210	0.026
322	0.086	0.019
323	0.209	0.088
325	0.107	0.036
327	0.096	-0.007
328	0.142	0.021

Constructed benchmark; μ-based Roeger; technical change version of Appelbaum.

4.4.2 Description of Results

A consistent pattern can be detected from table 4.2. For all industries considered, the capital income share implied by Roeger is lower than the one that was constructed for the benchmark and Appelbaum. The capital income share of SBI 327 is negative for Roeger's method. As has been noted, anomalous results have not been banned completely by the alternative that we proposed for Roeger. Furthermore, the capital income share of SBI 272 equals 0, whereas those of SBI 231 and 232 are smaller than 0.01.

The ordering that results for the industries according to the Lerner indices differs substantial between the three methods. With respect to the benchmark and Roeger's method only the ranking of SBI 232 and 327 is identical: they end as lowest and second respectively. On average the ranking of an industry differs three positions between these two methods. In case of the benchmark in relation to Appelbaum, only the ranking of SBI 271 is identical, as it ends as the eighth industry for both methods. On average, the ranking of an industry changes a bit over two positions. With regard to Roeger's method and Appelbaum, two industries share their position in the ranking: SBI 321 and 323 that finish as first and third respectively. On average, the change is more than four positions. All in all, in spite of the fact that the benchmark method and Appelbaum rank only one industry the same, the overall ranking is most similar between these two methods.

Table 4.3 Lerner indices of preferred versions

SBI	Benchmark	Roeger	Appelbaum
231	0.014	0.046	0.030
232	-0.059	0.002	0.006
271	-0.009	0.073	0.022
272	0.056	0.103	0.110
273	-0.019	0.103	0.062
321	0.044	0.228	0.255
322	0.011	0.078	0.013
323	0.011	0.133	0.066
325	0.027	0.097	0.058
327	0.065	0.168	0.033
328	-0.016	0.106	-0.021

Constructed benchmark; μ-based Roeger; technical change version of Appelbaum.

4.4.3 Roeger's method versus the Benchmark Method

In the comparison between Roeger's method and the benchmark method, test-statistics are irrelevant. Roeger's test-statistics are good, whereas there are none in case of the benchmark.

Roeger's method is quite sensitive to how the estimation equation is specified – i.e. whether the μ-based version or the L-based version is estimated. However, the reasons for this are fairly well understood. With respect to the benchmark method, the origin of the differences between the reported and the constructed version is crystal-clear. Since differences in results of different versions are well understood, sensitivity to specification is not a distinguishing criterion concerning the relative quality of the two methods considered here.

Both methods result in an estimate of the average Lerner index. There is no difference in this regard either.

The methods differ with respect to the assumptions that are made in order to determine capital cost. The constructed benchmark assumes that the data on depreciation are correct. Roeger relies on constructed rates of growth of capital. Furthermore, he uses the assumption of a constant markup in order to reveal the value of the capital income share. In relying on a constant markup, he presupposes that this assumption is an adequate one for determining the capital income share. As a means to calculate capital cost, the assumption seems arbitrary. The benchmark method seems superior in this respect.

With respect to the benchmark, it is guaranteed that all capital income shares are positive, whereas some of them might still turn out to be negative for the preferred version of Roeger's method and one of them in fact is negative. In addition to this, values below 0.01 – perhaps along with those of SBI 321, 322, and 328 – are implausibly low, which is not very reassuring with respect to the remaining industries. In light of these observations, it can be concluded that the capital income shares of Roeger are less plausible than those of the benchmark. In section 4.3.2, we saw that the four negative values of the Lerner index in case of the constructed benchmark are not much of a problem. In short, the benchmark method has a significant advantage with respect to Roeger's method in relation to economic intuition.

In addition to this, the constructed benchmark requires less data and less effort as compared to Roeger's method. All in all, we may conclude that the benchmark method is better than Roeger's method.

4.4.4 The Structural Method and the Benchmark Method

The benchmark method results in negative values for four industries, whereas the Lerner index is negative only for SBI 328 in case of the structural method. However, this difference – as well as the difference in ordering between the two methods – can plausibly be explained in virtue of actual deviations from the assumption of constant returns to scale that is used in case of the benchmark method. The range of the values for the other industries is comparable to the values that are commonly found by others. With respect to economic intuition concerning the Lerner index, then, these two methods fare equally well.

The benchmark method requires less data than the structural method. The test-statistics of the structural method are poor, while there are no test-statistics in case of the benchmark method. The benchmark method comes out best with respect to these two criteria.

The structural method reveals more information than the benchmark method, as it results in estimates of the elasticity of demand and the elasticity-adjusted Lerner index. However, there are two related disadvantages. First, the estimates of these additional variables are unreliable, as – for instance – several elasticities of demand are positive. Second, the estimates are very sensitive to small changes in specification. More specifically, allowing for technical change leads to changes in the estimates that are larger than one may reasonably expect, as – for instance – several elasticities change signs. From this, we feel justified in concluding that the advantage and the two disadvantages cancel each other out.

Finally, the structural method is more ambitious than the benchmark method, because it aims at estimating marginal cost instead of average cost. In other words, whereas the benchmark method assumes constant returns to scale, the technical version of the structural method as applied by us uses the less stringent assumption of constant marginal cost.[1]

All in all, the structural method has as a comparative advantage in that it aims at estimating marginal cost, whereas the benchmark method has better test-statistics and a few pragmatic plusses, as it requires less data and less effort. It is hard to draw a definite conclusion here. In the final chapter we propose a strategy that is meant to do justice to all these considerations.

4.4.5 Roeger's Method and the Structural Method

From the previous comparisons, it can be inferred how Roeger's method and the structural method relate to one another. The four most important considerations are highlighted here. Roeger's method fares better than the structural method with respect to data requirements, and test-statistics. On the criterion of assumptions, the structural method comes out best, as it allows for variable returns to scale. From the perspective of economic intuition, the structural method again fares better because of the implausible values of the capital income shares implied by Roeger's method. All in all, the structural method is superior to Roeger's method.

[1] How important this is depends on what the returns to scale are in fact. This has not been investigated extensively within this project. A first idea about this can be formed by considering the parameters of the Appelbaum-model that represent fixed costs, i.e. $b_{NN}, b_{MM}, \text{and} b_{KK}$ that are given in appendix D. In several industries all three of these parameters are insignificant, whereas one or more of them are significant in other industries. The latter provides an indication that the returns to scale are not constant in a subset of the industries that were considered. From the former result no definite conclusions can be drawn, since it may be that the set of these three parameters is significant although none of them is significant on its own. This has not been tested.

5 Conclusion

5.1 Introduction

We are now ready to present our final evaluation of the methods. In doing this, we link our conclusions to the results of others. We end this paper by discussing the question whether the sophisticated methods are to be preferred over our simple benchmark and by giving some suggestions for further research.

Our conclusions largely mesh with those of Hyde and Perloff (1995). They regard the imposition of the assumption of constant returns to scale as a disadvantage of what they call the reduced form method, of which Roeger's method is an exemplification. As a major disadvantage of the structural approach, they point to the sensitivity of this method to small changes in functional specification and (hence) the dangers of misspecification. Hyde and Perloff (1995) do not consider our benchmark method. At a more detailed level, our conclusions concerning these matters go beyond those of Hyde and Perloff (1995) and others, while they contradict them on other aspects.

5.2 The Benchmark Method

The profit-sales ratio is the first version of our benchmark. Fisher (1989) shows that the profit-sales ratio does not equal the Lerner index if firms fail to take proper account of the user cost of capital. Apart from the profit-sales ratio, we have introduced a second version of the benchmark. This second version takes the user cost of capital into account, as it is based on capital cost constructed according to Hall and Jorgenson (1967) – appraised by Fisher (1989, p.384). Although this constructed benchmark has disadvantages of its own as, for instance, we need to rely on firm data on depreciation, we prefer it to the reported benchmark.

5.3 Roeger's method

In contrast to Hyde and Perloff (1995), we use Roeger (1995) as the representative of the reduced form method instead of Hall (1986, 1988). This makes a substantial difference, since Roeger's method is clearly better than that of Hall. Roeger himself argues that '[p]oor instruments could be a main reason for a positive upwards bias with Hall's method.' (1995, p.325) This critique is shared by, for instance, Blanchard (1986) and Shapiro (1987). Hyde and Perloff do not comment on the sensitivity of the Hall-based estimates to the choice of instruments.[1]

Van Dijk and Van Bergeijk (1996) compare the models of Hall and Roeger for a set of Dutch industries. They find that the variation in estimates in the case of Hall's model is implausi-

[1] The instruments they use are 'a time trend and first differences of military expenditures, crude oil price, money supply, political party of the president, and U.S. population' (Hyde and Perloff 1995, p.479), most of which have been used by Hall as well.

bly large. Experimenting with various instrumental variables does not lead to an improvement of the results. Furthermore, the significance of the estimates is much smaller than that of the results of Roeger's model. Overall, they show that Roeger's model performs much better than Hall's.

The crucial difference between the models of Hall and Roeger is that the latter does not require the use of instrumental variables, the identifying assumptions of which are hard to satisfy. Instrumental variables must be outside determinants of output and employment, and must not be correlated to productivity shifts or variables that influence productivity shifts (Hall 1988, p.924). Roeger celebrates the fact that his method does not require instrumental variables that may fail to meet the 'strong identifying assumptions.' (Roeger 1995, p.328) A further comparison between the two methods can be found in appendix A.

Our first contribution with respect to Roeger's method is that we show that – in essence – his method is little more than another way of estimating the income share of capital. As noted in the introduction, reported or constructed capital cost cannot always be relied on. Apart from this, we point out an anomaly in the results: the estimates of the average Lerner index imply negative capital income shares. Finally, we suggest an alternative way of estimating the method that alleviates this problem. However, many implied capital income shares of this version – although positive in 10 out of the 11 industries – are still implausibly low.

5.4 The Structural Approach

The structural method requires more data than the reduced form method. On the positive side, it presents a genuine attempt of estimating marginal instead of average cost. As said above, the structural method requires the choice of functional specifications. In this regard, we have found that imposing the assumption of constant marginal cost on the structural method generally improves the significance of the estimates. In contrast to Hyde and Perloff – who use simulations – we cannot conclusively determine whether this is because marginal cost is in fact constant. Again because of the difference in methodology, we cannot (in)validate their conclusion that '[i]f correctly specified, [the structural method] is the most flexible and powerful approach' (p.465), although our results point into the same direction.

An important reason for this is that the structural approach contains more key variables, notably the elasticity of demand and the *elasticity-adjusted* Lerner index. These key variables allow one to draw more definite conclusions about welfare, competition, and market power. However, these variables are not identified for certain specifications – as acknowledged by Hyde and Perloff (1995) – and are hard to estimate – as our results substantiate.[1] Matters are even worse, since several utterly implausible estimates come forward. This calls for an explanation for the clash of our estimates with economic intuition. Before we

[1] In spite of this being a weakness, it should not count in favour of the benchmark method nor Roeger's method, because that method does not supply any information at all about these variables.

move on to provide such an explanation, we again want to emphasize that, in contrast to the other variables, the Lerner index is quite robust to changes in specification.

The most striking result – the positive demand elasticities – is likely to be a consequence of the simple way in which we try to estimate demand. They are likely to be a consequence of the omission of aspects such as product characteristics, as is argued by Goldberg: ‘Aggregate industry models must explicitly consider the endogeneity of prices. The demand equation error term includes unobserved (to the econometrician) product characteristics that are correlated with prices. By ignoring this correlation one obtains inconsistent parameter estimates and counterintuitive results, such as an upward-sloping demand curve.’ (1995, p.892)

This already points towards a possible cure of the problems associated with the structural method as we have applied it. As discussed in the introduction, we have used the “parsimonious” approach to the structural method. In spite of Bresnahan’s admonitions to the contrary (1989, p.1012), this parsimonious approach frequently does not pay enough attention to industry-detail. In contrast, papers such as the one by Goldberg pay a lot of attention to the peculiarities of industries concerning cost structure and demand characteristics.[1] We will refer to the latter literature as the “rich” version of the structural approach.

This “rich” approach invalidates Boyer’s claim that the structural method fails to capture the diversity and complexity of oligopoly pricing (1996, p.116), which is characterised as an “in principle criticism” by Krouse (1998, p.694). Instead, it supports Krouse’s (1998) analysis, according to which the problem lies in the usual empirical practice. Other demand, cost, and market properties *can* be incorporated, although there is an accompanying rise in cost involved, for instance in terms of additional data requirements. If we are right in our analysis, what is left for us to do is to provide a plausible explanation of why the parsimonious approach has been successful - an explanation of why it has become common practice, as claimed by Krouse (1998, p.695). We believe such an explanation can be given.[2]

It is quite clear why one would prefer the parsimonious approach to the rich one. The parsimonious approach requires data that are frequently available, whereas data required by the rich approach – for instance data on consumer preferences – are much harder to find. Furthermore, the effort that is required for applying the rich approach is much larger as compared to the parsimonious one. Apart from that, industries to which the parsimonious structural method has been applied successfully frequently have some peculiar features that make them especially suitable for this purpose.

On the supply side, these industries usually have a very simple technology or cost structure, on which information is available prior to the estimation process. This information is

1 Other important publications in this line of research are Morrison (1988), Morrison (1993), and Berry et al. (1995).

2 Of course, such an explanation should move beyond the claim that authors have been selective in presenting their results - a claim which is virtually impossible to back up by evidence.

taken into account by imposing additional restrictions on the cost function (Genesove and Mullin, 1998: sugar industry; De Mello and Brandão, 1999: milk industry). *On the demand side*, these industries share a fairly rare property in that they usually show a high degree of variation in prices over time (Shaffer 1993: banking industry; Wolfram 1999: electricity spot market).

In sum, the structural method is more ambitious than the other two methods discussed in this paper. It aims at estimating marginal instead of average cost and includes other important competition-related variables than the Lerner index. This higher level of ambition, however, comes at the cost of the need for functional specification, to which the method turns out to be quite sensitive. All in all, we conclude that results of the (parsimonious) structural approach can only be considered reliable if prior information about the industries that are investigated is available.

5.5 Intricate Versus Simple

Is our simple benchmark outperformed by one of the other more sophisticated methods? This does not seem to be the case. With respect to Roeger's method, it is questionable whether the assumption of a constant markup results in capital costs that are more plausible than those that follow from the profits reported by the firms themselves. The structural method is clearly the more ambitious one, because of the genuine attempt to estimate marginal cost. Whether it is able to live up to this ambition in its parsimonious guise remains to be seen. If the rich structural approach is not a feasible alternative, and no prior information is available, the (constructed) benchmark may be the best alternative.

As a general strategy for investigating markups, we propose the following. If only few resources are available, the benchmark method should be applied. In choosing a version, the low effort involved in calculating the reported benchmark should be weighted against a possible superiority of constructed capital cost data. If substantial resources are available, we suggest that the benchmark is used as a screening device for determining which industries most likely deviate from perfect competition.[1] The industries that come out of this selection process should then be investigated using the rich structural approach.

[1] If one only relies on this one risks missing industries that have a substantial markup and a low average Lerner index due to increasing returns to scale. In order to avoid this, the parsimonious approach can be used in addition to the benchmark for selecting the industries that are investigated more thoroughly. Although the results are likely to be unreliable and, hence, should not be reported, the values of the Lerner index – that turned out to be fairly robust to changes in specification – may still contain valuable information that can be used in the screening process. With respect to the industries that we have investigated here, this would have been unnecessary. Although the markups of SBI 272 and 321 are much higher in case of the structural method than in case of the benchmark – possibly due to increasing returns – they rank first and third in case of the benchmark and would have been selected for a thorough investigation based on this.

5.6 Suggestions for further research

With respect to the reduced form method, Klette (1999) forms an interesting alternative to Roeger, because he allows for variable returns to scale. Short-run considerations can be taken into account along the lines of Nishimura et al. (1999), who arrive at the markup using an identity that relates the markup to the short-run elasticity of outputs to inputs and factor shares. In relation to the structural method, more sophisticated cost functions can be estimated, such as the translog-cost function appraised by Greene (1997, pp.694-95). A comparison of these versions and methods may provide further insights in the comparative advantages of methods for estimating markups.

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Appendix A: Hall and the Historical Derivation of Roeger

Our derivation of Roeger's method is quite different from the original derivation presented by Roeger himself. Roeger builds on Hall for his derivation (cf. footnote 2 on p.16). Apart from that, it was noted that it is necessary to rely on the CRS-assumption in order to derive the anomalous result with respect to Hall's model, whereas this is not so with respect to Roeger's model (cf. footnote 1 on p.35). Since these two models are very much alike - Roeger's model can be seen as an improvement on Hall's model - one may wonder where this asymmetry comes from. This appendix presents the historical derivation of Hall and explains the asymmetry.

Derivation of Hall

Hall starts from a production function:

(i) $Q = Q\left(W_i, t\right) = Q\left(W_i\right)e^{r\,t}$,

which is transformed in terms of logarithms:

(ii) $\ln Q = \ln Q\left(W_i\right) + r\,t$

This, in turn, is differentiated into the following equation:

(iii) $d\ln Q = \sum_j \frac{\partial \ln Q\left(W_j\right)}{\partial \ln W_j} \cdot d\ln W_j + r\;dt$

Input cost shares can subsequently be introduced because of the following equation:

(iv) $\frac{\partial \ln Q\left(W_j\right)}{\partial \ln W_j} = \frac{dQ}{dW_j}\frac{W_j}{Q} = \frac{w_j W_j}{MC \cdot Q} = a_j^{MC}$

that holds if in addition to perfect competition on the market for inputs – an assumption that is also made with regard to the derivation in the main text – one assumes cost minimization (cf. Varian 1992, pp.49-50 and p.76).

By definition, a cost share equals the product of the markup µ and the income share:

(v) $a_j^{MC} = m a_j^{P}$.

In virtue of equations (iv) and (v), equation (iii) can be rewritten in such a way that the markup appears in it – using the same notational conventions as in the main text:

(vi) $\Delta q = m \sum_j a_j^{P} \Delta W_j + r\;dt$

The income share of capital can be eliminated according to:

(vii) $\frac{l}{m} = \sum_j a_j^P$,

with $l = \frac{AC}{MC}$ as the returns to scale parameter. This can be rewritten as:

(viii) $m\, a_K^P = l - m \sum_{j \neq K} a_j^P$.

The result of this elimination is:

(ix) $\Delta q = m \sum_{j \neq K} a_j^P \left(\Delta x_j - \Delta x_K \right) + l \;\Delta x_K + r\; dt$

As a result of the elimination of the capital income share, the number of unknown parameters increases by one. By assuming CRS $(i.e.\; l = 1)$, Hall brings the number of unknowns back to one again. He subsequently estimates a rearranged version of this equation, the difference between quantity produced and the quantity of capital being the independent variable. Since he uses the CRS-assumption, he estimates the average markup.[1]

It is not necessary to assume CRS, as is shown by Klette (1999) who estimates the markup and the returns to scale simultaneously. He does not need the assumption because he does not need the identifying assumptions used by Hall. This, in turn, he achieves primarily by expressing equation (4) in terms of deviations from a point of reference. As a consequence of this, he can use more general assumptions about technical change: 'By changing the estimated reference point from year to year, the model allows for unrestricted technical change' (Klette 1999, p.455).

Note that in case of a Cobb-Douglas production function $Q = \prod_j W_j^{a_j^{MC}}$, the CRS-assumption implies that the sum of the cost shares equals one, i.e. $\sum_j a_j^{MC} = 1$, which, in turn, implies equation (4) in the main text.

Derivation of the Dual

The dual of equation (iv) can be derived by starting from the following cost function:

(x) $C = C\left(w_j, Q, t\right) = G\left(w_j\right) Q^{1/l} e^{-1/l\, rt}$.

1 Hall (1988) attempts to counteract possible biases due to correlation between technical change and the independent variable by using instrumental variables. Whether the identifying assumptions he uses are satisfied by the instrumental variables that he uses is a contested issue (see Blanchard 1986, Shapiro 1987, and Roeger 1995).

Taking similar steps as was done with respect to the primal, equations (xi) and (xii) result:

(xi) $\ln C = \ln G\left(w_j\right) + \frac{1}{\lambda}\ln Q - \frac{1}{\lambda}\,\rho\, t$

(xii) $d\ln C = \sum_j \frac{\partial \ln G\left(w_j\right)}{\partial \ln w_j} \cdot d\ln w_j + \frac{1}{\lambda} d\ln Q - \frac{1}{\lambda}\,\rho\, dt$.

This can be rewritten as:

(xiii) $\Delta c = \frac{\mu}{\lambda}\sum_j \alpha_j^P \Delta w_j + \frac{1}{\lambda}\Delta q - \frac{1}{\lambda}\,\rho\, dt$,

because of equation (xiv):

(xiv) $\frac{\partial \ln G\left(w_j\right)}{\partial \ln w_j} = \frac{w_j}{G_j} \cdot \frac{\partial G\left(w_j\right)}{\partial w_j} = \frac{w_j}{C} \cdot \frac{\partial C}{\partial w_j} = \frac{w_j W_j}{C} = \frac{PQ}{C} \cdot \frac{C_j}{PQ} = \frac{\mu}{\lambda}\alpha_j^P$.

Historical Derivation of Roeger

Roeger (1995) takes the difference of the primal and the dual. In our notation, the estimating equation results if equation (xiii) is multiplied by λ and added to equation (iv):

(xv) $\lambda\ \Delta c = \mu \sum_j \alpha_j^P \Delta w_j W_j$.

From the assumption of a constant markup, it follows that $\Delta c = \Delta pq$. This can be used to transform equation (xv) into:

(xvi) $\Delta pq = \mu^P \sum_j \alpha_j^P \Delta w_j W_j$,

where the ratio of the markup and the returns to scale parameter is replaced by the average markup μ^{AC}. As is clear from this equation and the previous one, the markup and the returns to scale parameter are not independently identified.

Just as was done with respect to Hall's method, equation (viii) can be used to eliminate the income share of capital.

(xvii) $\Delta\ pq = \mu^{AC} \sum_{j \neq K} \alpha_j^P \Delta c_j + \mu^{AC}\left(\frac{1}{\mu^{AC}} - \sum_{j \neq K}\alpha_j^P\right)\Delta c_K$

Rearrangement results in the estimation equation (8):

(xviii) $\Delta pq - \Delta\ c_K\ = \mu^{AC} \sum_{j \neq K} \alpha_j \left(\Delta\ c_j - \Delta\ c_K\right) + \nu$.

Asymmetry and Anomaly

Data on the average markup and on the income shares of labour and material can be used for calculating the capital income share (cf. equation (vii)):

$$\text{(xii)}\quad \alpha_K^P \equiv \mu^{AC} - \sum_{j \neq K} \alpha_j^P$$

No assumptions with respect to the returns to scale are needed, if the average markup is available. Roeger estimates the average markup without assuming anything about the returns to scale. Hall, however, estimates the average markup using the CRS-assumption in order to eliminate the returns to scale parameter from the estimating equation. Hence, the CRS-assumption is needed in Hall's case in order to derive the anomaly.

This asymmetry is related to another asymmetry: the returns to scale parameter cannot be identified in Roeger's case (cf. equation (xv)), whereas it can in Hall's case (cf. equation (ix)) as has been shown in Klette (1999).

Appendix B: Bresnahan and Appelbaum

This appendix contains the specifications of Bresnahan (1) and Appelbaum (3). In addition to that, the difference in appearance between Bresnahan and Appelbaum is explained.

Bresnahan (1)

Bresnahan (1982) suggests the following specification of equations (21) and (23):

(i) $Q = \alpha_0 + \alpha_1 P + \alpha_2 Y + \alpha_3 PZ + \alpha_4 Z + \nu$.

(ii) $P = \frac{-\theta}{\alpha_1 + \alpha_3 Z} Q_i + \beta_0 + \beta_1 Q_i + \beta_2 W_N + \beta_3 W_M + \beta_4 W_K + \omega$.

Different Appearances

Both Bresnahan and Appelbaum specify a demand curve as well as a supply relation. The structure of the two supply relations seems to be different, since the conjectural elasticity appears in the numerator in one and in the denominator in the other. This appearance, however, is deceiving. The different presentations follow from the fact that Bresnahan's model is put in terms of the semi-elasticity, whereas Appelbaum's model is put in terms of the elasticity. More formally, equation (12) can either be written as:

(iii) $P = -\frac{\partial P}{\partial Q}\frac{\partial Q}{\partial Q_i}\frac{Q}{Q} Q_i + MC_i = \frac{-\theta}{\alpha} + MC_i$,

α being the semi-elasticity (Bresnahan) - or as:

(iv) $P = \frac{MC_i}{1 + \theta/\varepsilon}$,

ε being the elasticity of demand (Appelbaum).

Equation (iv) follows from (v) by dividing it by P:

(v) $1 + \frac{\partial P}{\partial Q}\frac{\partial Q}{\partial Q_i}\frac{Q}{P}\frac{Q_i}{Q} = \frac{MC_i}{P}$.

Appelbaum (3)

In contrast to Appelbaum (1), Appelbaum (3) allows for technical change. We use a simplified version of the cost function of Diewert and Wales (1987). Only the supply relation and the input demand curves change. The specification for these functions is:

(vi) $$P = \frac{\sum_{j} b_{jj} W_{j} + 2 \sum_{j-} \sum_{j+} b_{j-j+} \sqrt{W_{j-} W_{j+}} + b_{TN} W_{N} + b_{TM} W_{M} + b_{TK} W_{K}}{1 + q/e} + w \cdot$$

(vii) $$X_{iN} / Q_{i} = b_{NN} + b_{NM} \sqrt{W_{M} / W_{N}} + b_{NK} \sqrt{W_{K} / W_{N}} + b_{N} / Q_{i} + b_{TN} T + n \ .$$

(viii) $$X_{iM} / Q_{i} = b_{MM} + b_{NM} \sqrt{W_{N} / W_{M}} + b_{MK} \sqrt{W_{K} / W_{M}} + b_{M} / Q_{i} + b_{TM} T + h \ .$$

(ix) $$X_{iK} / Q_{i} = b_{KK} + b_{MK} \sqrt{W_{M} / W_{K}} + b_{NK} \sqrt{W_{N} / W_{K}} + b_{K} / Q_{i} + b_{TK} T + z \ ,$$

where T is a time index.

Appendix C: Data

The data set contain data for 79 three-digit industries in 16 two-digit industries, comprising approximately 2000 Dutch manufacturing firms. These industries have been selected on the basis of data availability and accessibility. The empirical results pertain to a sub-selection of 11 three-digit industries.

Sales (Q_i)

The volume of sales is obtained by deflating sales by a price index. The price index is a weighted average of the three-digit industry price indices for domestic and foreign sales. As export shares are available at firm level, a firm-specific deflator for sales can be constructed. The price indices for domestic and foreign sales are obtained from the Producer Price Statistics, while sales and exports have been taken from Production Statistics.

Total quantity (Q)

The quantity of production in a three-digit industry group (output), based on a summation of q_i over the firms within the three-digit group.

Employment (X_{Li})

The number of employees is obtained from the Production Statistics. The number of employees is restricted to those working fifteen hours per week or more.

Materials (X_{Mi})

The volume of materials is obtained by deflating the firm-specific value of materials by the sectoral price index for materials. The value of materials is obtained from the Production Statistics.

Capital stock (X_{Ki})

The amount of capital (input), see W_K.

Price of Labour (W_L)

Weighted industry wage. Wages of individual firms are averaged using the number of employees as weights. Source: Production Statistics.

Price of Material (W_M)

Price of intermediate inputs. Source: Producer Price Statistics.

Price of Capital (W_K)

The price of capital. This variable is defined jointly with X_K, according to Hall and Jorgenson (1967). Data on depreciation (source: Production Statistics) are used as a basis for constructing X_K. Depreciation is divided by the depreciation fraction δ (δ=0.058, see Nieuwenhuijsen et al. 1999, 86-88), assuming exponential depreciation. The investment price of the entire economy is used for deflation (source: National Accounts). The resulting variable is

X_K, in constant prices. Subsequently, W_K - the user cost of capital - is calculated using the following formula: $W_K = (r + d)INP - \Delta INP$, INP being the investment price and r being the cost of financing (long-term interest rate (source: “Centraal Economisch Plan”) plus a risk premium of 2 per cent).

Price (P)

The production price in one’s own industry group (selling price). Source: Producer Price Statistics.

Shift-Variabl (Y)

Gross Domestic Product of the Netherlands. Source: National Accounts.

Price Index (PI)

The production price of the entire manufacturing industry: a weighted average of the three-digit prices P (sales are used as the weights).

Import Price (IMP)

The import price of a product similar to the products produced nationally. In contrast to the other variables, this variable is based on the SGN-classification of industries, instead of the SBI-classification.

Appendix D: Empirical Details

Table D.1 Income shares of inputs

	Income shares			Total	Lerner	$1-a_N-a_M$
SBI	Labour	Material	Capital			$L^{AC}+a_K$
231	0.336	0.609	0.042	0.055	0.986	0.014
232	0.818	0.173	0.068	0.009	1.059	-0.059
271	0.373	0.509	0.127	0.118	1.009	-0.009
272	0.290	0.607	0.048	0.103	0.944	0.056
273	0.454	0.402	0.162	0.144	1.019	-0.019
321	0.237	0.509	0.210	0.254	0.956	0.044
322	0.536	0.367	0.086	0.097	0.989	0.011
323	0.255	0.525	0.209	0.220	0.989	0.011
325	0.271	0.596	0.107	0.133	0.973	0.027
327	0.262	0.577	0.096	0.161	0.935	0.065
328	0.322	0.552	0.142	0.126	1.016	-0.016
Average	*0.377*	*0.493*	*0.118*	*0.129*	*0.989*	*0.011*

Appelbaum (3)-estimates

Results of the model extended with technical change.

SBI 231

Parameter	Estimate	Standard Error	t-statistic		
BLL	-.010281	.750177E-02	-1.37049	R^2 = .15654	(labour)
BLM	.124406	.047227	2.63423	R^2 = .141661	(material)
BLK	-.032666	.022773	-1.43441	R^2 = .508359E-02	(capital)
BL	8.31162	2.16083	3.84650	R^2 = .940768	(supply)
BTL	.840676E-04	.739719E-04	1.13648	R^2 = .785526	(demand)
BMM	-.176994	.309017	-.572766		
BMK	.277328	.166701	1.66363	Lerner index	0.029603
BM	-255.785	91.8681	-2.78426		
BTM	-.232815E-02	.327561E-02	-.710752		
BKK	.033081	.269922	.122559		
BK	60.2574	89.3470	.674419		
BTK	.010133	.468699E-02	2.16189		
THETA	.010313	.726351E-02	1.41989		
ETA	-.375789	.224060	-1.67718		
A	17.1271	1.80399	9.49399		
RO	-.237011	.031655	-7.48720		

SBI 232

Parameter	Estimate	Standard Error	t-statistic		
BLL	-.531290E-02	.010192	-.521296	R^2 = .507369	
BLM	.121847	.059087	2.06215	R^2 = .298874	
BLK	.085061	.087814	.968656	R^2 = .383703	
BL	9.31114	1.54118	6.04158	R^2 = .936428	
BTL	-.889771E-04	.112476E-03	-.791074	R^2 = .788644	
BMM	-.269587	.516476	-.521973		
BMK	-.251594	.829622	-.303263	Lerner index	0.006322
BM	-156.877	36.2677	-4.32554		
BTM	-.101723E-02	.587686E-02	-.173091		
BKK	455815	1.66682	.273464		
BK	-365.748	195.544	-1.87041		
BTK	-.030564	.023147	-1.32044		
THETA	.186867E-02	.012823	.145731		
ETA	-368999	.331916	-1.11172		
A	-3.63030	1.82465	-1.98959		
RO	.426530	.034321	12.4277		

SBI 271

Parameter	Estimate	Standard Error	t-statistic		
BLL	.512890E-02	.115860E-02	4.42682	R^2 = .227483	
BLM	.016043	.847318E-02	1.89344	R^2 = .300763	
BLK	-.028167	.013223	-2.13019	R^2 = .041668	
BL	5.42801	.274388	19.7823	R^2 = .987044	
BTL	-.545699E-04	.104516E-04	-5.22118	R^2 = .700231	
BMM	.439361	.082736	5.31043		
BMK	-.144247	.142939	-1.00915	Lerner index	0.022306
BM	-420.125	16.9459	-24.7921		
BTM	.860042E-02	.909705E-03	9.45407		
BKK	1.47669	.372253	3.96691		
BK	1951.58	70.0135	27.8744		
BTK	.902818E-02	.436808E-02	2.06685		
THETA	-.025529	.348359E-02	-7.32828		
ETA	1.19339	.039843	29.9522		
A	17.5170	1.08427	16.1555		
RO	.108427	.035397	3.06322		

SBI 271

Parameter	Estimate	Standard Error	t-statistic		
BLL	.512890E-02	.115860E-02	4.42682	R^2 = .227483	
BLM	.016043	.847318E-02	1.89344	R^2 = .300763	
BLK	-.028167	.013223	-2.13019	R^2 = .041668	
BL	5.42801	.274388	19.7823	R^2 = .987044	
BTL	-.545699E-04	.104516E-04	-5.22118	R^2 = .700231	
BMM	.439361	.082736	5.31043		
BMK	-.144247	.142939	-1.00915	Lerner index	0.022306
BM	-420.125	16.9459	-24.7921		
BTM	.860042E-02	.909705E-03	9.45407		
BKK	1.47669	.372253	3.96691		
BK	1951.58	70.0135	27.8744		
BTK	.902818E-02	.436808E-02	2.06685		
THETA	-.025529	.348359E-02	-7.32828		
ETA	1.19339	.039843	29.9522		
A	17.5170	1.08427	16.1555		
RO	.108427	.035397	3.06322		

SBI 272

Parameter	Estimate	Standard Error	t-statistic		
BLL	-.783746E-03	.251060E-02	-.312174	R^2 = .214170	
BLM	.028210	.022320	1.26389	R^2 = .052155	
BLK	.565250E-02	.019547	.289169	R^2 = .264261	
BL	10.4783	1.20880	8.66836	R^2 = .978692	
BTL	.676999E-04	.257233E-04	2.63185	R^2 = .589388	
BMM	.438098	.220917	1.98308		
BMK	-.121724	.236374	-.514961	Lerner index	0.11034
BM	-321.402	87.9794	-3.65315		
BTM	.239116E-02	.232693E-02	1.02760		
BKK	.310042	.501225	.618569		
BK	2433.12	159.178	15.2855		
BTK	.575109E-02	.752539E-02	.764225		
THETA	-.131238	.014865	-8.82843		
ETA	1.20391	.109598	10.9847		
A	19.1820	3.54646	5.40878		
RO	.029011	.119751	.242264		

SBI 273

Parameter	Estimate	Standard Error	t-statistic		
BLL	.169704E-02	.358183E-02	.473792	R^2 = .378454	
BLM	.054609	.027300	2.00032	R^2 = .266357	
BLK	-.049787	.033268	-1.49657	R^2 = .031282	
BL	10.2982	.682387	15.0914	R^2 = .990556	
BTL	-.186677E-04	368533E-04	-.506541	R^2 = .573547	
BMM	.081239	.264718	.306889		
BMK	.296655	.416071	.712992	Lerner index	0.062230
BM	-670.580	49.4961	-13.5481		
BTM	.100170E-02	.292867E-02	.342033		
BKK	-.035686	.922315	-.038691		
BK	3154.61	240.720	13.1049		
BTK	.050093	.013062	3.83491		
THETA	-.101172	.017437	-5.80208		
ETA	1.64877	.109579	15.0463		
A	28.4821	3.08042	9.24617		
RO	-.328079	.102281	-3.20761		

SBI 321

Parameter	Estimate	Standard Error	t-statistic		
BLL	-.017152	.579351E-02	-2.96062	R^2 = .478428	
BLM	.102345	.036135	2.83230	R^2 = .694660E-03	
BLK	.141066	.070882	1.99015	R^2 = .110367E-03	
BL	21.7930	1.60128	13.6097	R^2 = .396692	
BTL	-.138636E-03	.496160E-04	-2.79419	R^2 = .097882	
BMM	-.322994	.302171	-1.06891		
BMK	.109381	.471468	.232002	Lerner index	0.25475
BM	449.645	141.183	3.18483		
BTM	-.146941E-02	.302313E-02	-.486055		
BKK	-1.70928	1.44552	-1.18247		
BK	-1442.47	1564.07	-.922256		
BTK	.032283	.019269	1.67538		
THETA	.228481	.070565	3.23790		
ETA	-.894459	.254484	-3.51479		
A	-.080080	2.04971	-.039069		
RO	.318345	.053818	5.91522		

SBI 322

Parameter	Estimate	Standard Error	t-statistic		
BLL	.769520E-02	.609054E-02	1.26347	R^2 = .062975	
BLM	.020614	.037284	.552881	R^2 = .126522	
BLK	.771695E-02	.035326	.218447	R^2 = .159318	
BL	2.00952	1.97542	1.01727	R^2 = .876000	
BTL	-.797998E-04	.820367E-04	-.972733	R^2 = .379548	
BMM	.120440	.249276	.483160		
BMK	.253544	.295428	.858228	Lerner index	0.013437
BM	-5.68247	83.4486	-.068095		
BTM	.611657E-02	.432514E-02	1.41419		
BKK	-.094236	.786262	-.119853		
BK	-746.612	277.445	-2.69103		
BTK	.991900E-02	.012880	.770111		
THETA	.010264	.014030	.731620		
ETA	-1.00966	.181814	-5.55325		
A	.764459	1.24338	.614825		
RO	.308128	.030467	10.1135		

SBI 323

Parameter	Estimate	Standard Error	t-statistic		
BLL	.458666E-02	.391893E-02	1.17039	R^2 = .378603	
BLM	.317083E-02	.026125	.121372	R^2 = .042106	
BLK	-.309852E-02	.044414	-.069764	R^2 = .527477E-02	
BL	.510717	2.52442	.202311	R^2 = .642262	
BTL	-.546191E-04	.407104E-04	-1.34165	R^2 = .268553E-02	
BMM	.389705	.282822	1.37792		
BMK	.561629	.525502	1.06875	Lerner index	0.065576
BM	312.473	438.212	.713064		
BTM	-.514179E-02	.366320E-02	-1.40363		
BKK	-.085532	1.56541	-.054639		
BK	3143.16	1682.88	1.86772		
BTK	.579515E-02	.022119	.262003		
THETA	.060054	.051188	1.17320		
ETA	-.936435	.434466	-2.15537		
A	2.18597	2.72912	.800981		
RO	.225428	.069932	3.22355		

SBI 325

Parameter	Estimate	Standard Error	t-statistic		
BLL	-.101642E-02	.361730E-02	-.280988	R^2 = .225421	
BLM	.082670	.028047	2.94751	R^2 = .169757	
BLK	-.118787	.029003	-4.09571	R^2 = .845455E-02	
BL	7.76716	.557128	13.9414	R^2 = .911410	
BTL	.296797E-04	.171986E-04	1.72571	R^2 = .160783E-02	
BMM	-.035395	.248835	-.142241		
BMK	.288376	.261877	1.10119	Lerner index	0.058338
BM	-436.395	37.4672	-11.6474		
BTM	-.402445E-03	.119099E-02	-.337909		
BKK	2.52338	.521087	4.84253		
BK	1391.32	164.387	8.46371		
BTK	-.037854	.581786E-02	-6.50648		
THETA	.054413	.739410E-02	7.35896		
ETA	-1.00270	.070210	-14.2815		
A	.761203	.615910	1.23590		
RO	.361591	.015052	24.0233		

SBI 327

Parameter	Estimate	Standard Error	t-statistic		
BLL	-.611282E-02	.566477E-02	-1.07909	R^2 = .430597E-02	
BLM	.082629	.041304	2.00050	R^2 = .279485	
BLK	.451728E-02	.044128	.102367	R^2 = .056173	
BL	1.53721	4.27961	.359195	R^2 = .938677	
BTL	.405978E-04	.612135E-04	.663217	R^2 = .872864	
BMM	-.225854	.361128	-.625414		
BMK	.525763	.414470	1.26852	Lerner index	0.032897
BM	-258.960	161.166	-1.60679		
BTM	.767546E-02	.366680E-02	2.09323		
BKK	-.823926	.759536	-1.08478		
BK	-879.125	491.518	-1.78859		
BTK	.023802	.975171E-02	2.44076		
THETA	-.019827	.010448	-1.89763		
ETA	.664800	.113996	5.83181		
A	1.83120	1.90863	.959432		
RO	.509939	.058260	8.75289		

SBI 328

Parameter	Estimate	Standard Error	t-statistic		
BLL	.723050E-02	.260504E-02	2.77558	R^2 = .456029	
BLM	-.028237	.024408	-1.15689	R^2 = .748256E-03	
BLK	.070258	.034829	2.01725	R^2 = .211340	
BL	-.887802	1.71225	-.518500	R^2 = .835191	
BTL	-.223764E-03	.371812E-04	-6.01820	R^2 = .813856	
BMM	.903563	.307109	2.94216		
BMK	-.362877	.491923	-.737670	Lerner index	-0.021377
BM	203.143	151.954	1.33687		
BTM	.852927E-02	.446878E-02	1.90863		
BKK	.636176	1.07252	.593163		
BK	-1527.45	544.325	-2.80613		
BTK	-.010686	.018826	-.567614		
THETA	-.033975	.017870	-1.90117		
ETA	-1.43916	.260636	-5.52174		
A	-5.69227	1.41630	-4.01911		
RO	.526770	.041702	12.6317		

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