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What is the X-Factor in the German Electricity Industry?

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Abstract

A new legislation in the German electricity market requires the implementation of an incentive-based regulation within the next years. In such a regime either prices or revenues are capped and grow with the inflation rate minus a factor, which accounts for productivity differences between the sector and the rest of the economy. This paper derives such an X-factor for the German electricity industry using a new productivity database and Growth Accounting methodology. Considering that several underlying assumptions are violated due to market imperfections, the calculated X-factor rises from 0.48 to a modified value of 2.15.

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1 Introduction

The European electricity industry, one major guarantor for the efficiency and functioning of mainly all other economic sectors, is under reconstruction. EU-regulation has made sure that electricity markets all over the EU, which were monopolistically organized for decades, are about to be liberalized and set up for competition. In Germany, the market for electricity has been opened up for competition in 1998 to 100 percent, meaning that all (industry and private) customers can choose their individual provider freely. This might suggest that Germany was leading the way in the liberalization of European electricity markets. However, after a couple of years it turned out that the German way of organizing the access to the transport and distribution network has not been favorable for competition.[1] In the regime of negotiated third party access (nTPA) the rules concerning the access to the network have been designed by the former monopolists themselves in a so called association agreement between energy producers and industrial consumers.[2] In these proceedings not a single stakeholder of the potential competitors was involved. It is therefore not surprising that after an enthusiastic kick off period most new market entrants have left the stage and retail electricity prices have gone up again after an initial decline.[3]

Finally it was Brussels not Berlin that took the decision to end this unfavorable nTPA regime - in June 2003 the European Commission decided that in all member states a national regulator has to be established until July 2004. The new law came with a nine-month-delay, but it brought actually a couple of significant modifications to the German electricity market.[4] Beside a legal and operational unbundling of generation and transmission, a regulatory agency was charged with the supervision of the electricity sector.[5] The new duties for the regulatory agency include the supervision of network access charges and the introduction of an incentive based regulatory regime. In such a regime either prices or revenues are capped and are only allowed to grow with the inflation

[1] The network is still an essential facility with natural monopoly characteristics; every potential energy provider willing to sell electricity needs access to the grid.

[2] Germany was the only country in Europe to choose negotiated third party access instead of a regulated one (rTPA).

[3] This price increase is certainly not only due to a lack in competition - energy taxes and resource prices also play an important role in this context - but it can still serve as an indicator for the effectiveness of all these agreements.

[4] For a more detailed description of the German electricity market and an assessment of the changes of 2005 see Kuhlmann and Vogelsang (2005).

[5] The already existing agency for the regulation of telecommunications and postal markets (RegTP) got an extended scope of duties and took over the supervision of the electricity, gas, and railway sector and was consequently renamed to “Federal Network Agency” (“Bundesnetzagentur”).

rate minus a factor (X), which accounts for productivity differences between the relevant sector and the rest of the economy. This paper derives an estimate for the X-factor in the German electricity industry – the crucial variable for any incentive based regulatory regime.

For this purpose detailed productivity measures on the industry and aggregate level are necessary. Parametric or non-parametric methods, which are most commonly used for a detailed productivity assessment on the firm level, require large datasets covering company-specific data that are not available yet. The German regulatory authority just began monitoring the electricity sector and started only recently to collect detailed firm-level data. But a different methodology allows a sector specific productivity measurement without relying on company specific data, namely Growth Accounting.

The utilized data stem from a newly constructed productivity database for the German economy, which is unique in its coverage. This database contains sector and asset specific capital stock and capital services data for the German economy, relies on survey data and provides (in contrast to official data) information on sector specific asset investments according to the economic usage concept, which is the relevant concept for industry-level capital analyses. Thereby it is possible to measure sector specific total factor productivity (TFP) values using a Growth Accounting methodology as used in Jorgenson and Stiroh (2000).

The paper is structured as follows. In section 2 the general framework of RPI-X regulation is presented as well as the Growth Accounting methodology, which is used to measure productivity in the relevant sector and in the total economy. Section 3 presents the dataset, which is used, followed by the productivity analysis in section 4. Subsequently in section 5 I correct the computed X-factor for several market imperfections and accordingly violated assumptions (following Bernstein and Sappington (2000)) These include a limited span of regulatory control, structural changes in the industry, imperfect competition in the rest of the economy, and endogeneity in the economy wide inflation rate. Section 6 concludes.

2 Framework

This chapter describes the methodology of an incentive-based RPI-X regulation as well as the Growth Accounting methodology, which is used for the productivity measurement.

2.1 The RPI-X Regulation

The purpose of price-cap or RPI-X regulation, like many forms of regulation, is to replicate the discipline that market forces would impose on the regulated firm if they were present, which limits the rate of growth of a firm's profit. It provides stronger incentives for cost reduction and technological innovation than rate-of-return regulation does. Price-cap regulation typically specifies a rate at which the prices (P) that a regulated firm charges for its services must decline (X), on average, after adjusting for inflation (RPI), and with an adjustment for exogenous cost changes (Z), as depicted in Equation (1).

$$(1) \qquad P_t = P_{t-1}(1 + RPI_{t-1} - X) + Z$$

A separation of the required rate of price decline from the firm’s production costs and earning has the effect that reduced operating costs result in direct financial benefits for the firm, which justifies the term “incentive-based-regulation”. This is not the case under a rate of-return regulation plan that consistently links authorized prices to realized costs. The rate at which the firm's inflation-adjusted output prices must decline under price-cap regulation is commonly referred to as the X-factor, which is typically the industry-level productivity margin with respect to the total economy.

But why is a relative and no absolute productivity measure used? If the regulated firm were just like the typical firm in a competitive economy, competition would limit the rate of growth of the firm's prices to the economy-wide rate of price inflation. This requires the regulated industry to realize the same productivity improvements as in other sectors of the economy, to adjust for the input price inflation and to pass the remaining gains on to consumers As a result, the X-factor should reflect on the one hand the extent to which the regulated firm is capable of increasing its productivity more rapidly than are other firms in the economy, and on the other hand it should reflect whether the prices of inputs employed by the regulated firm grow less rapidly than the input prices faced by other firms in the economy.[6] This does not necessarily mean that regulated indus-

[6] See Bernstein and Sappington (2000).

tries always realize higher efficiency gains than competitive industries (whereas in the early years of liberalization there are often high efficiency potentials)[7].

If the regulated industry is able to realize more rapid productivity growth than other industries or if it can realize lower input price inflation, then the industry should be forced to pass the associated gains to customers in the form of lower prices. This is reflected in a positive X-factor, which is the relative productivity advantage compared to the total economy.

An obvious method to calculate an appropriate X-factor is to compute historical values and to take an average of these values as a proxy for the current X-factor. But the sole adoption of the historical productivity differential entails some difficulties, in particular if the incentive based regulatory regime shall be introduced for the first time. It is therefore necessary to modify the X-factor, which results from the analysis of the historical productivity data, according to several criteria that are discussed in section 5.

As regards the price inflation, I follow the suggestion of Armstrong, Cowan, and Vickers (1994) to use a retail price index for the price cap rather than an industry-specific cost index. This is useful as it cannot be manipulated by the regulated firm and it gives consumers clear and predictable signals about prices.

2.2 Productivity Analysis

In principle several different methods can be used for productivity analyses – the main concepts with their respective assets and drawbacks will be discussed here very briefly. Subsequently the Growth Accounting concept, which is used for the current analysis, is presented in more detail.

2.2.1 Conceptual Overview

On the one hand productivity can be measured with parametric approaches like simple or corrected OLS regressions or a stochastic frontier analysis (SFA).[8] On the other hand there are non-parametric-approaches like a data envelopment analysis (DEA), where a production possibility frontier is derived by linear optimization, or the use of index numbers.

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[7] In the British water industry for example the system is called RPI + K (instead of RPI – X), reflecting a negative X-factor, where real prices are scheduled to increase. See Armstrong, Cowan, Vickers (1994), Ch.6

The main advantage of the parametric approaches is that they relax the assumption that observable factor prices have to be identical with the factor social marginal products.[9] This assumption is generally necessary as the social marginal product, which is needed in any standard growth equation (see section 2.2.2), is generally not observable. In a regression it can be estimated. Furthermore the assumption of constant returns to scale is no longer necessary.

However, the disadvantages of a growth regression are several. First of all the growth rates of labor and capital cannot usually be regarded as exogenous with respect to variations in g. The factor growth rates would receive credit for correlated variations in unobservable technological change. If the growth rates of labor and capital are measured with error, then standard estimates of the coefficients of these variables would deliver inconsistent estimates of the factor shares (denoted v_i in equation (3) below). Furthermore the usual regression framework does not allow for time variations in factor shares. Due to these shortcomings, a non-econometric approach is usually the preferred method of TFP estimation (see Barro (1998)).[10]

Another major reason for using a non-parametric-approach is due to the data requirements of the respective method. The German regulatory authority has just recently started to collect detailed firm-level data in the electricity industry. All parametric approaches require a certain number of observations. This requirement cannot be satisfied without reliable data on the firm-level for a couple of years. The non-parametric-DEA-approach also requires firm-level-data and only the index number approach can provide useful results with aggregate data. Therefore the Growth Accounting measure of productivity growth, which is in fact an index number, has been chosen for deriving an X-factor for the first regulatory period in the German electricity industry.

2.2.2 Growth accounting

Growth accounting involves breaking down growth of gross output into the contributions of labor-, capital-, and intermediate-input as well as total-factor productivity. The growth accounting model is based on the microeconomic theory of production and rests on a number of assumptions

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[8] In a simple OLS regression an efficiency frontier is estimated reflecting the average performance of the respective industry. The corrected OLS regression (COLS) shifts the same regression line upwards in order to measure optimal instead of average performance. In SFA the regression's residual is split into an error term and an inefficiency term.

[9] This would be equivalent to $F_K = r$ and $F_L = w$ with r as the rental price or cost of capital and w as the wage rate.

[10] Albeit these drawbacks a parametric approach might still be a valid and useful complement in a TFP-analysis. Also in the current analysis a parametric approach is used in order to validate the robustness of the non-parametric results.

such as constant returns to scale and perfect competition. The methodology is based on the *production possibility frontier* concept going back to Jorgenson (1966) and Solow (1957) and used by various researchers, among others Jorgenson and Stiroh (2000) who analyze aggregate and industry productivity in a similar way as it is done here.

The Growth Accounting concept basically rests on a standard neoclassical production function of the form Y = F(A, K, M, L). Inputs can be decomposed by capital services (*K*), intermediate inputs (*M*), and labor input (*L*), capturing a substitutability among these inputs. Output is given by *Y* and *A* serves as parameter for productivity improvements. Deriving this general production function with respect to time and dividing it subsequently by *Y* yields the following equation

$$(2) \qquad \frac{\dot{Y}}{Y} = \frac{F_A A}{Y} * \frac{\dot{A}}{A} + \frac{F_K K}{Y} * \frac{\dot{K}}{K} + \frac{F_M M}{Y} * \frac{\dot{M}}{M} + \frac{F_L L}{Y} * \frac{\dot{L}}{L}$$

Growth rates can be represented as differences in logarithms (Δ ln) and the first term on the right hand side can be interpreted as growth in total factor productivity and rewritten as Δ ln TFP. Assuming constant returns to scale[11]: implies that the sum of the input shares (subsequently termed *v*) equals one. Furthermore it is assumed that product and factor markets are competitive, which allows to substitute the non-observable factor social marginal products (F_K, F_M, and F_L) with observable prices (as the rental price of capital, the wage rate and intermediate input prices). With these assumptions the preceding expression can be transformed into an equation that accounts for the sources of economic growth:

$$(3) \qquad \Delta \ln Y = \overline{v_K} \Delta \ln K + \overline{v_M} \Delta \ln M + \overline{v_L} \Delta \ln L + \Delta \ln TFP$$

The average input shares $\bar{v}$ are calculated as the respective value share in capital services (K), intermediate inputs (M) and the wage sum (WS): $\overline{v_i} = \frac{i}{K + M + WS}$ with *i* = *K*, or *M*, or *WS*. The share-weighted growth rates in Equation (3) represent *contributions* of the inputs to the industry-level output. The growth in total factor productivity is then calculated as a residual. It represents efficiency gains, technological progress, scale economies, and measurement errors (see Coelli et

[11] Up to this point no specific requirements were necessary for the production function. The subsequent constant returns to scale assumption rests on practical reasons in the empirical analysis.

al. (1998)). These efficiency gains allow more measured gross output to be produced from the same set of measured inputs. Labor input is the product of hours worked (H) and labor quality (LQ) as proposed in Jorgenson, Ho, and Stiroh (2003).

Equation (3) displays the output growth decomposition according to the ***gross output concept***, which includes intermediate inputs in the analysis and delivers widely unbiased estimates of industry-level TFP growth. Such a decomposition of growth components can also be done according to the ***value added concept***, which is most appropriate for productivity comparisons at the aggregate level (as it can be derived with relatively low data requirements and it avoids double counts of intermediate products). However, at the industry level the value added concept can be criticized as providing at best an ambiguous picture of the actual productivity, due to its abstraction from intermediates, and due to the fact that no real world analog to value added is actually produced by a plant. Since value added is the difference between separately deflated gross output, and intermediate inputs, the concept requires an additively separable production function, which imposes strong restrictions on generality and on the role of technological change. For industry specific analyses the gross output concept should therefore be the preferred concept.

In the case of an X-factor determination both a industry-level and an aggregate TFP-value have to be determined and related to each other. In order to avoid a mixture of inconsistent approaches both TFP values are calculated according to the gross output concept. At the industry level this is the obvious choice. For the total economy analysis it is in the current context also appropriate. This bottom-up approach, where industry-level data are added up to an aggregate picture, allows to calculate a *TFP-value for the total economy excluding the energy sector* – and this is exactly what is needed for the current analysis. In this case the total economy TFP is not computed as a residual, but as a weighted sum of industry-level TFP-values. The respective weights are calculated according to the Domar approach of TFP aggregation (see Domar (1961)).

3 Data

3.1 Capital Stocks

Capital stocks data are derived from the Ifo Capital Stock and Investment Database (Ifo Investorenrechnung), which relies on official and on survey data, and provides industry- and asset-specific capital stocks data for 1970 until 1990 for West Germany. From 1991 onwards, industry-and asset-specific capital stocks for unified Germany are calculated according to the perpetual inventory method using investment data:

$$S_{i,j,t} = S_{i,j,t-1}\left(1-\delta_{i,j}\right)+I_{i,j,t} \quad (4)$$

$S_{i,j,t}$ is the capital stock in industry i of the investment asset j in period t. $I_{i,j,t}$ is the corresponding investment in industry i of investment asset j in period t and $\delta_{i,j}$ is the industry and asset specific depreciation rate. For the capital services calculations, the Ifo Productivity Database parallels the method in Jorgenson and Stiroh (2000).These data can be found in the Ifo Productivity Database[12].

3.2 Capital Services

For the capital services calculations, the Ifo Productivity Database parallels the method in Jorgenson and Stiroh (2000). Capital services $K_{i,j,t}$ of asset j in industry i during period t are assumed to be proportional to the average capital stock $S_{i,j,t}$ used in one sector with $q_{i,j}$ denoting a constant of proportionality. The capital services are therefore proportional to the average capital stock, where the constant of proportionality q_i is set equal to unity.

$$K_{i,t} = q_i \frac{\left(S_{i,t}+S_{i,t-1}\right)}{2} \quad (5)$$

The price of capital services (the costs of capital), which is necessary for the value share computation of capital services, is computed via a rental price formula, which is based on an arbitrage condition for capital services. It is assumed that an investor is indifferent whether he invests at the capital market and earns a nominal interest i_t for his investment or whether he invests in an asset of price P and earns a rental fee $c_{i,j,t}$ less the depreciation $\delta_{i,j}$ of the asset.

$$\left(1+i_t\right)P_{i,t-1} = c_{i,j,t}+\left(1-\delta_{i,j}\right)P_{i,t} \quad (6)$$

Which can easily be solved for the costs of capital:

[12] This database is currently restricted for internal use, but will presumably be accessible for external researchers in 2007. The Ifo Capital Stock and Investment Data are already accessible in the Ifo Data Pool (under specific security precautions). For more detailed descriptions of the computation method and other data sources see Kuhlmann (2005).

(7) $$c_{i,t} = (i_t - \pi_{i,t})P_{i,t} + \delta_i P_{i,t+1}$$

where the industry and asset-specific capital gains $\pi_{i,j,t}$ in period t are given by the percentage change of the asset prices in industry i during period t: $\pi_{i,t} = \left(P_{i,t} - P_{i,t-1}\right) / P_{i,t-1}$

3.3 Output and Labor

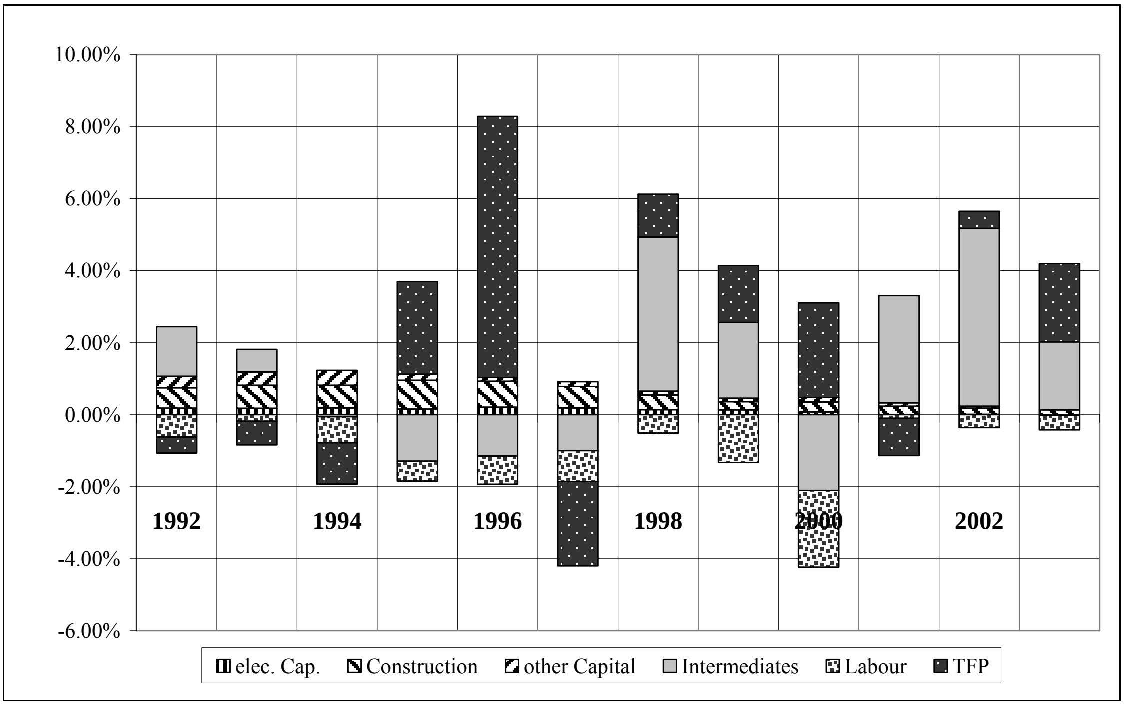
The main data source for the remaining data requirements is the German Federal Statistical Office (GFSO) with its time series database Genesis. The data on output (Y) and intermediate input (M) originate from Genesis time series 81000BJ321, the wage sum from time series 81000BJ323. Total hours worked (H) are virtually in the same data source as the wage sum, but in case of electricity only the superordinate class “energy and water supply” is available. Therefore the ratio of employees in the electricity sector to employees in the superordinate class is used to estimate hours worked in the subcategory. Labor quality (LQ) is taken from the Groningen Growth and Development Center (GGDC) that provides data on growth in labor quality from 1980 to 2001. The missing values for 2002-2003 are estimated as the average of the preceding five years.

4 Productivity Analysis

The Growth Accounting analysis of the German electricity sector reveals a relatively high volatility in the industry-level output in the period 1992-2003 that can only partly be explained by changes in capital, intermediates and labor input. Exogenous output shocks are predominantly captured by high TFP-changes as Figure 1 demonstrates.

In the early years of liberalization (1998-1999) the noticeable consolidation and corresponding reduction of jobs is associated with positive output growth. This might be an indication of efficiency gains in the early years of liberalization where competition was (at least partially) working. The subsequent decline in output and TFP is on the one hand induced by economic decline but on the other hand it might also be the case that the incumbent players were finally able to drive most new entrants out of the market, which meant less competition and less pressure on efficiency improvements.

Figure 1 Sources of Economic Growth in the German Electricity Industry (1992-2002)



Source: own calculations based on Ifo Productivity Database, German Statistical Office, GGDC

The output-outlier in 1996 is a statistical artifact without real economic causation. Therefore the TFP (which is measured as a residual) captures the whole effect.[13] The reason for the shock in real output is that an important tax, the "coal penny" (Kohlepfennig), which was used as a subsidy for the coal industry and which was part of the industry-specific price-deflator, has been abolished in 1995.[14] The resulting price decline drives the noticeable increase in real output in 1996. Repeated increases in this tax have systematically reduced TFP-values in the years before 1996. The subsequent abolishment had a one-time effect in the opposite direction. As an isolation of this effect is not possible, these systematic TFP-distortions in both directions are assumed to cancel out each other and are therefore ignored in the X-Factor determination.

4.1 X-Factor determination

Table 1 lists the annual and average figures on output growth and TFP within the energy sector. The fourth column shows TFP values for the total economy. The fifth column lists the differ-

[13] Underlying economic reasons for an output shock would be visible in input variations.
[14] In 1995 it averaged 8.5% of the price of electricity, see Storchmann (2005).

ence of TFP in the energy sector to TFP in the total economy or the productivity margin of the energy sector with respect to the total economy. This is nothing else than an ex-post annual X-factor.

Table 1 Annual X-Factors from 1992-2002 – Gross Output Concept

Year	Output Growth Energy Sector	TFP Growth Energy Sector	TFP Growth Total Economy	X-Factor
1992	1.38%	-0.44%	-0.34%	-0.11%
1993	0.97%	-0.66%	-1.01%	-0.35%
1994	-0.70%	-1.15%	1.35%	-2.49%
1995	1.86%	2.57%	0.85%	1.73%
1996	6.35%	7.25%	0.62%	6.63%
1997	-3.29%	-2.35%	1.38%	-3.72%
1998	5.61%	1.19%	-0.01%	1.20%
1999	2.81%	1.58%	0.04%	1.55%
2000	-1.13%	2.64%	1.92%	0.71%
2001	2.17%	-1.04%	0.93%	-1.97%
2002	5.29%	0.48%	0.74%	-0.27%
2003	3.77%	2.17%	0.08%	2.10%
Ø 92-03	**2.09%**	**1.02%**	**0.55%**	**0.48%**

Source: own calculations based on Ifo Productivity Database, German Statistical Office, GGDC

Taking the average of this whole period yields an ex-post X-factor of 0.48% for 1992-2003. However, a certain volatility is apparent in the above set of yearly X-factors, which is mainly due to the high volatility in the TFP-growth in the electricity sector. In order to validate the results of the chosen approach it seems useful to conduct a robustness check. Despite the shortcomings of parametric approaches (see the discussion above – in particular the limited number of observations poses some problems) an OLS-regression as well as a stochastic frontier approach are carried out for this purpose.

4.2 Robustness check

Performing an OLS-regression of output with respect to the several inputs, the residual is the equivalent measure of TFP – very similar to the growth accounting setup. The main difference is that the constant returns to scale assumption is suspended in the OLS-framework. In a stochastic frontier approach the efficiency measure would be the TFP-equivalent. In this framework the residual is split up to a real error term σ_v and an inefficiency term σ_u. The efficiency measure results from subtracting the inefficiency component u from potential (frontier) output $\hat{x}$ divided by potential output: $\frac{\hat{x}-u}{\hat{x}}$

In order to see whether the different approaches provide similar or rather unequal TFP-measures, a correlation or covariance matrix is calculated for the respective TFP measures. The matrix is displayed in Table 2.

Table 2 Covariance Matrix of different TFP-measures

	OLS-Residual	SFA-efficiency	GA-TFP
OLS-Residual	1.0000		
SFA-efficiency	0.9878	1.0000	
GA-TFP	0.8754	0.8340	1.0000

The matrix shows that the different productivity measures are to a large extend correlated with each other. The stochastic frontier efficiency measure is correlated with a coefficient of 83.4 percent[15] with respect to the growth accounting TFP-value. The OLS-residual exhibits an even higher correlation of 87.5 percent.

This robustness check shows that the volatile development of the yearly X-values is widely independent of the chosen method of productivity-measurement. The above discussion therefore suggests that the X-value of 0.48% could in principle be used as an X-factor for the first regulatory period of the coming incentive regulation. However, the problem is, that such a calculation depends on a couple of assumptions that are typically violated in practice. This requires a modification of the result.

5 Modification of estimated X-factor

The calculated productivity difference is only an appropriate measure for the X-factor if several conditions are satisfied[16]. It is necessary that (1) all services of the regulated firm are subject to price cap regulation, (2) structural changes (as a shift in the regulatory regime) do not occur, (3) the economy-wide inflation rate is not affected by the prices set in the regulated industry, and (4) the economy outside of the regulated industry is competitive. The following subsections will dis-

[15] Despite the high correlation of the SFA-efficiency-measure and the growth accounting TFP-measure, one should bear in mind that efficiency-improvement is just one of three possible reasons for productivity growth. Technical change and the exploitation of scale economies are additional factors.

[16] See Bernstein, Sappington (2000).

cuss to what extend these assumptions are violated (in the German context) and how the result of the preceding section has hence to be modified.

5.1 Accounting for a limited span of regulatory control

In most regulated industries only a part of the value chain is regulated. This is normally the monopolistic bottleneck. In the electricity industry the distribution and transmission network represent this bottleneck – and in the German case this is indeed the regulated part of the industry. Joint products and common factors of production generally make it impossible to determine TFP-growth for specific network services. If a TFP measure for the sector's entire operation has to be used for defining an X-factor for the sector's capped services, the general guideline from equation (1) has to be modified. If, for example, prices of uncapped services are rising more rapidly than they would be rising if they reflected only anticipated productivity gains and unavoidable cost increases, then the firm is passing on fewer benefits to customers of uncapped services than price cap regulation of the firm's entire operation would dictate. Therefore the X-factor should be decreased in a magnitude corresponding to the fraction of the firm's revenue derived from uncapped services. It is implicitly assumed that competition works in the remaining, unregulated parts of the value chain. Bernstein and Sappington (1999) derive a modified price cap formula in order to account for such a limited span of regulatory control:

$$(8) \qquad \Delta \ln P_t = RPI_{t-1} - \left[x^b + x^l\right]$$

with a composite X-factor, which is composed of x^b, the basic X-factor, and x^l, an additional factor, which is computed in the following way:

$x^l = -\left[\frac{1-\alpha^C}{\alpha^C}\right]\left[RPI - x^b - \Delta \ln P^U\right]$ with α^C as the fraction of revenue derived from the sale of capped services, which is approximately 0.4 in Germany, and P^U as the price of uncapped services. Assuming an average growth rate of uncapped services of 2.4 percent[17] and a retail price index of

[17] This is a quite conservative estimate - retail electricity prices for households grew during the liberalization years 1998-2005with an average rate of 2.35 percent. Considering the years 2000-2005, when market consolidation has already occurred, the average yearly price increase is considerably higher (4.1% for households and 9.6% in the industry). Source: Bundesministerium für Wirtschaft und Technologie, Energiedaten, update 07-02-2006

2.1 percent (which is the average value of 1991-2003) yields an additional X-factor component (x^l) of 1.17.

5.2 Accounting for structural changes in the regulated industry

Absent structural changes in the industry, historic productivity and input price growth rates can serve as reasonable estimates of corresponding future growth rates, which can be used to derive a reasonable value for the basic X factor that is imposed in price-cap regulation plans. A structural change means in this context primarily a shift from rate-of-return regulation to performance-based regulation and a corresponding introduction (or intensification) of competition. Such a regime shift can have two possible implications for the future productivity development, which cannot be derived from historical data. Both effects are working in opposite directions.

When a new regulatory regime becomes effective and competitive pressures increase in the respective market, it can reasonably be expected that these circumstances motivate the regulated firm to enhance its realized productivity. Therefore historic growth rates typically understate a reasonable X factor, which has to be imposed on the regulated firm. To account for this fact, the basic X factor can be (and often is) augmented by what is called a customer productivity dividend (CPD) or a stretch factor. As stretch factors are designed to reflect the enhanced incentives that a *new* regulatory regime provides, it is appropriate to implement a stretch factor that declines in magnitude over time.[18]

On the other hand there is also an indirect effect of increased competition. Due to a higher number of competitors some of the sales are likely to be shifted from an incumbent supplier to new entrants and this reduces the incumbent supplier's scale economies. This is particularly the case in the short run when the presence of fixed inputs limits the incumbent supplier's ability to reduce inputs at the same rate that outputs decline. The reduction of the scale economies reduces TFP and thereby the X-factor, which thwarts (to a certain extend) the need for a customer dividend, but in case of network access regulation this indirect effect is negligible. The reason is that

[18] The productivity stretch factor can also be used to tailor the regulatory regime to the circumstances of each particular firm. If the regulated firms differ to a large extend in productivity levels, it might be necessary to use a firm specific stretch factor to account for these level-differences. Laggard firms normally have low productivity levels but are potentially capable of high productivity growth rates. In a regulatory context, where a firm is a long way from best practice, a positive stretch factor may be applied to allow for the fact that the firm should be able to make some easy ‘catch up’ gains and exceed the average industry productivity growth rate.

in the current German context only network access is subject to incentive regulation and the network is still a natural monopoly. Therefore it is unlikely that new network providers will appear, built up a new infrastructure, and compete with the network of the respective regional incumbent.

Unfortunately there is little conceptual and empirical basis for choosing appropriate customer dividend levels. In the UK, where such a regime shift already happened in 1990, the relevance of a stretch factor has been underestimated (in telecommunications as well as) in electricity.[19] One example of a positive stretch factor gave the U.S. Federal Communications Commission, which imposed a customer productivity dividend of 0.5 percent annually in its price-cap plan for AT&T. For the North American gas industry (Canada and the United States) Kaufman (2004) computed a similar average CPD of 0.56 percent for nine gas providers – all within a narrow range.

Due to the lack of a reliable empirical CPD-value within the electricity sector (or a clear theoretical approach for the computation of this value), I do assume that the best practice examples from telecommunication and gas are a good proxy for the electricity sector. As a result the computed X-factor should (for the first regulatory period) be increased by 0.5 percent due to structural changes in the industry.

5.3 Accounting for imperfect competition in the economy

A modification to the basic X-factor is also necessary, when some of the industries outside the regulated sector are not competitive – even if output price inflation in these industries is not affected by the prices set in the regulated industry. In such a case price inflation outside of the regulated sector typically exceeds the rate of price inflation in a competitive environment. In order to account for this market failure, the X-factor has to be increased accordingly.

Here (as well as in the case of a regime shift) there is little conceptual and empirical basis for a clear procedure to address this problem. It is not only conceptually unclear how a measure for the economy-wide deviation from perfect competition should be seized. It is also from a data-

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[19] In the first regulatory period Ofgem (the UK Office of Gas and Electricity Markets) set negative X-factors for the majority of distribution companies (RECs) and an X-factor of zero for transmission companies (see Armstrong, Cowan, Vickers (1994), p.177). This step was justified by the need for investment in the sector and ignored the scope for cost-cutting. As a result pre-tax operating profits for distribution more than doubled in the proximate four years. The X-factor therefore had to be readjusted in 1993 to a (positive) value of 3. In the telecommunication sector the British Office of Telecommunications ("Oftel", in the meantime "Ofcom") even had to correct the first X-factor of 3 percent to a magnitude of 7.5 in the second regulatory period due to enormous efficiency improvements and excess profits. Both cases reveal an ex-post correction of at least 3 percentage points.

perspective quite unrealistic to get a comprehensive, sector-overlapping measure for this. Therefore it should only be remarked that the overall X-factor tends to be slightly higher than the result of the current analysis would suggest.

5.4 Accounting for endogeneity in the economy-wide inflation rate

The logic that underlies the simple X-factor calculation presumes that the economy-wide rate of price inflation is not affected directly by the prices set in the regulated industry. This is in particular the case if the output of the regulated sector is not an intermediate good for the rest of the economy, as firms typically adjust their output prices in response to changes in the input price they face. In practice this assumption is violated for many network industries; for electricity this is all the more the case. Therefore an increase in the economy-wide inflation rate should not authorize a full one to one increase in the inflation rate of the regulated industry. The difference between the two inflation rates should generally be greater the larger is the regulated sector relative to the economy as a whole and the larger is the fraction of regulated revenues derived from the sale of intermediate goods (that are used as inputs for other goods). Hence a central modification is necessary to weaken the link between the realized rate of price inflation in the economy and the authorized rate of price increase in the regulated industry:

Equation (1) can be rearranged to $\dot{P} = RPI_{t-1} - X$ with $\dot{P} = \frac{P_t - P_{t-1}}{P_t}$ and Bernstein and Sappington (1999) show that this expression can (under the assumption that the regulated services are intermediate goods, which is the case for network access charges) be transformed to the following expression:

(5) $$\dot{P} = \beta^{NR}\left[RPI - X\right] - \left[1 - \beta^{NR}\right]\dot{Q}$$

with β^{NR} as share of revenues (or gross output) of the non-regulated sector on total output and with $\dot{Q}$ as the growth in output (of the regulated sector). Thus, when regulated services are intermediate goods, a unit increase in the economy-wide inflation rate authorizes less than a unit increase in the growth rate of regulated prices, ceteris paribus. Since β^{NR} decreases as the output of the regulated sector increases, the reduction in the sensitivity of $\dot{P}$ to RPI is more pronounced the greater is the ratio of regulated revenue to total revenue in the economy. For Germany the average β^{NR} for the years 1991-2003 is 0.98 and the average $\dot{Q}$ is 2.1 percent. This implies for an X-factor of 2.15 (which results from the base X-factor of 0.48 and the other modifications that add up an additional markup of 1.67 percentage points) and an average RPI of 2.1 percent an annual approved price increase of -0.09 percent (or an annual price reduction of about 0.1 percent - the adjustment for exogenous cost changes is not included here).

6 Conclusions

Germany is supposed to form the centre of a common European electricity market, but the network usage costs are currently still 70 percent above the EU average and electricity retail prices are among the highest in the whole EU. A new energy law should now perform the balancing act between the retention of a stable and sustainable system and the containment of excessive market power on the part of the incumbent players. Particularly the latter task has not been accomplished by the previous regulatory regime. In the context of rising prices for primary energy carriers and high environmental taxes the need for competitive pressure on energy prices and the need for productivity improvements within the energy sector is urging.

The German regulatory authority is supposed to come up with a new system of incentive based regulation in the course of this year. This new regime might indeed achieve both: a non-discriminatory access to the electricity network for new energy providers at lower prices (which is a precondition for functioning competition), and a regulatory framework that favors or rewards firms which achieve above-average productivity improvements.

The aim of this paper is to compute a reasonable value for the x-factor, which is needed for the introduction of an incentive-based RPI-X regulation. The associated productivity analysis is pursued within the Growth Accounting framework, resorts to a newly constructed database and provides results on the industry (and not on the company) level. The main reason for this approach is that data on the firm level are not available yet. The regulatory authority has started to collect firm specific data only recently, which might rule out any parametric approach within the first years. The analysis reveals that the average productivity margin with respect to the rest of the economy (the X-factor) was 0.48 within the preceding decade. Several modifications were necessary to account for a limited span of regulatory control, anticipated structural changes in the industry, the endogeneity of the economy-wide inflation rate, and imperfect competition outside the regulated sector. These modifications resulted in a modified X-value of 2.15, which seems a reasonable value for the first regulatory period in the new German electricity regime that will arise soon (in particular as exogenous cost changes are not included in the X-factor). When accounting for endogeneity in the economy-wide inflation rate this would imply an average annual decline for network access charges of 0.7 percent.

Despite the obvious policy conclusion that can be drawn from this result (in terms of a clear efficiency goal for the first regulatory period) this result can only be a rough indicator for the real efficiency differential of the network operators. Even if the data that are used for this analysis exhibit more details than official national accounts data, they are still on an aggregate level. Therefore the findings of this study are indeed useful for an adoption in the first regulatory period where detailed firm-level-data are not available. However, this cannot belie the necessity of a detailed multi-dimensional data collection on the firm level, which can be used for future parametric analyses, which provide a more accurate and reliable efficiency estimate than aggregate capital data ever can do. Further research will also be necessary to improve the conceptual approach towards the two modifications that are necessary due to a lack of competition in the rest of the economy and due to the regime shift.

Last but not least a short remark should be made that the sole focus on cost-cutting is not unambiguous as it raises legitimate concerns for the quality of service. It therefore seems to be a good option for the German regulator to review the British experience with a new aspect in the price regulation that has been introduced in 2003. By measuring the quality of service in terms of the number of interruptions of supply, the duration of these interruptions, and the information service provided in connection with these interruptions, failures to perform according to acceptable standards could lead to a reduction of prices of up to 1.75%[20]. Such an extension to standard RPI-X-regulation could achieve noticeable efficiency improvements without the risk of infrastructure-deterioration, which is the main reproach against incentive-based regulatory regimes.

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[20] See OECD (2005) Annex 1

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