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Removing policy based comparative advantage for energy intensive production

Necessary adjustments of the real exchange rate and industry structure

Abstract:
National and international expansion of transmission networks and diminishing returns to scale in hydropower capacity expansion has raised the opportunity cost of electricity. The resulting changes in comparative advantage between industries have in many countries been counteracted by government assistance to energy intensive industries. A good example is the implicit electricity price subsidies offered to energy intensive manufacturing in Norway through the state owned power company Statkraft. We use firm data to assess the share of firms that will survive in the long run when these subsidies are removed, highlighting that large cost heterogeneity within the industries may imply diminishing returns to scale at the industry level. This feature is incorporated in a multisectoral CGE model, which is used to estimate the equilibrium adjustments of the industry structure and relative prices of removing the subsidies. Such a policy will lead to a less specialised industry structure and reduces gross trade. The positive public budget effect allows the government to cut other taxes, which fuels the real exchange rate depreciation necessary to meet the national budget constraint.

Keywords: Industry policy, Comparative advantage, Structural change

JEL classification: D21, E23, E27, E62, F13, F18, F41, F43

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1. Introduction

The Heckscher-Ohlin-Samuelson model predicts that open economies specialize production of traded goods according to resource based comparative advantages. International trade in products compensates for the non-tradability of primary factors. The specialization in energy intensive manufacturing found in some countries is consistent with this theory. Specifically, the strong position of highly export oriented and energy intensive manufacturing industries in Norway has typically been explained as a result of the access to low cost hydropower. However, comparative advantage for electricity intensive production has faded as the expansion of the hydropower production capacity has run into diminishing returns to scale, exacerbated by environmental concerns. The expansion of the transmission network has also turned electricity from a non-tradable resource into a tradable, which implies an increase in the opportunity cost of using electricity as a production factor..

Assistance to specific firms or industries in the traded goods sector has often been used to counteract reduced competitiveness due to changes in comparative advantages. Such assistance has typically been launched as a temporary way of reducing adjustments costs, but it has turned out to be hard to reverse. Thus, industry assistance tends to be more permanent than intended, and it has to some extent conserved a specialization of the traded goods sector, which reflects comparative advantages that no longer exists. Often, the motivation for permanent industry assistance is not corrections of market failures, but rather the misconception explained in Krugman (1996, pp. 17): "…the view that nations compete for world markets in the same way as corporations do, that a nation which fails to match other nations' productivity or technology will face the same kind of crisis as a company that cannot match the costs or products of its rivals." Despite this focus on international competitiveness, the last decades have witnessed a change in industry policies from a high degree of government interference to indirect policy measures based on a stronger trust in market mechanisms. The policy change accords with the view held by many economists that industry policies should be confined to correction of market failures.

This paper estimates the effects of removing electricity price subsidies given to the highly energy intensive and export oriented manufacturing of *Metals*, *Chemicals* and *Pulp and paper* in Norway. The subsidies are an implicit consequence of long-term electricity contracts signed between firms in these three industries and the government owned company Statkraft 45-55 years ago, when the mobility of electricity were low. Electricity was then transported from the neighbourhood of power stations by "packing" it into energy intensive products. The negotiated electricity prices then reflected the low opportunity cost, but today these prices average about half the market price. This implicit subsidy applies to hydropower deliveries up to about 30 percent of the present total electricity consumption in Norway. Thus, whereas the strong competitiveness of energy intensive manufacturing once reflected a resource based comparative advantage, it is now to a great extent based on an industry policy, which "purchases" the same comparative advantages by subsidies. The government has recently signalled an intention to prolong the contracts beyond expiration in 2008-2011, but a statement from the European Surveillance Agency makes permission of continued subsidization unlikely. For the power industry the market price at the power exchange in the Nordic countries (NordPool) is a relevant reference price when negotiating new contracts.

This paper makes two contributions. First, we estimate equilibrium effects of removing assistance to energy intensive manufacturing, using the Norwegian electricity price contracts as a case. We provide estimates on the effects at both the micro and the macro level. Such estimates should be key premises in the heated debate in Norway on prolonged subsidisation, but have so far not been made. Our second contribution is methodological in combining a detailed analysis of the effects on firm specific profitability and exits of the subsidized firms with a multisectoral CGE analysis of the adjustments of relative prices and the industry structure. A key element is that cost heterogeneity within the industries normally implies diminishing returns to scale at the aggregate industry level. This property, which is ruled out by assumption in most CGE models, turns out to have complex but important implications for the re-specialisation of the traded goods sector and the real wage adjustment.

Although the three subsidized industries employed only 1.4 percent of total man-hours in Norway in 2005, a partial equilibrium analysis would miss three potentially important mechanisms: First, the main products from the three subsidized industries contributed by 19 percent of total exports except oil and gas in 2005. Thus, restoring the long run trade balance after removing the subsidies may require significant real exchange rate depreciation. Second, the subsidized industries absorbed about 35 percent of the total electricity demand (some of their electricity is not subsidized), and downsizing these industries may cause significant repercussions through the electricity market. Third, the government budget effect of removing the electricity price subsidies may be used to reduce other tax rates.

Since we study the effects of removing subsidies to highly export oriented industries, our study obviously relates to the voluminous literature on CGE analyses of trade liberalization and economic integration, see e.g. Kehoe and Kehoe (1995), Hertel (1997), Kohler and Keuschnigg (2000, 2001), Madsen and Sørensen (2002), Heijdra, Keuschnigg and Kohler (2002), Dimaranan and McDougal

(2002) and Francois, van Meijl and van Tongeren (2003). Compared to most of these studies, our approach is significantly more disaggregated. In addition to our analysis at the firm level, our CGE model specifies 40 production sectors and 60 products. Thereby it is able to capture industry heterogeneity important for the changes in industry structure, including differences in electricity price subsidization, factor intensities and market structure, which affect the incidence effects of higher electricity costs on product prices. The paper by Bjertnæs and Fæhn (2004) relates to our paper by using the same CGE model to study the effects of extending the Norwegian electricity tax to cover manufacturing industries. Their study differ from our since it does not study the removal of the subsidies implicit in the long-term hydropower contracts, it focuses on aggregate efficiency effects rather than changes in industry structure, and it does not include any estimates of the profit effects at the firm level.

Kehoe (2003) evaluates the performances of three prominent multisectoral CGE models in estimating the impact of NAFTA on the economies of Canada, Mexico and the US.[1] He concludes that these models drastically underestimated the impact on North American trade, and that they failed to capture most of the relative impacts on different sectors. Partly, he attributes the poor performance to the modelling approach based on the Dixit-Stiglitz specification of preferences over home goods and imports. Instead, he suggests that a Ricardian model specification, emphasizing productivity heterogeneity within the specified industries, will do a better job. The approach in our paper represents an answer to this challenge to applied model builders. Indeed, our simulated industry effects, especially on exports, are to a large extent determined by diminishing returns to scale at the industry level resulting from productivity heterogeneity. This logic was explored in the pioneering work on the correspondence between micro and macro production functions by Houthakker (1955-56), Johansen (1959, 1972) and Salter (1960).

Large and persistent productivity differences even within narrowly defined industries have been well documented; see e.g. Sutton (1997), Baily, Hulten and Campbell (1992) and Klette (1999). Firm heterogeneity with respect to international trade has been uncovered by e.g. Bernard and Jensen (1999, 2001), Aw, Chung and Roberts (2000), Clerides, Lack and Tybout (1998), Bernard and Wagner (2001). The implications of productivity heterogeneity for the trade and industry structure has been analysed in, among others, Bernard, Eaton, Jensen and Kortum (2003), Merlitz (2003) and Ghironi and Merlitz (2005). Klette and Raknerud (2005) surveys theoretical models focusing on firm

[1] The three evaluated models include the Brown-Deardorff-Stern model, the Cox-Harris model and the Sobarzo model, separately presented in Kehoe and Kehoe (1995).

heterogeneity. Specifically, these models produce results consistent with the observed positive correlation between productivity and exports at the firm level, and they predict that increased exposure to trade leads to a disproportionate growth in output and exports in the relatively most efficient firms. The aggregate industry behaviour in our CGE model is consistent with these stylised facts.
Our policy experiment is of the balanced budget type; the revenue effect of removing subsidies is assumed to finance a reduction of the labour taxation. This relates our paper to the "double dividend literature" surveyed in e.g. Goulder (1995), Bovenberg (1999), de Mooij (1999) and Schøb (2003). Since the subsidies do not correct any market failure, they represent a pure distortion, corresponding to the lack of taxes on polluting activities. An additional social dividend is likely to follow from cutting the marginal tax on labour, which is rather high in Norway. Compared to most applied studies in this literature, we are able to capture more accurately the effects of the energy related tax (subsidy) due to our detailed representation of heterogeneity among firms and industries with respect to subsidization, productivity and export orientation.

Assistance to manufacturing industries has gained particular support in economies having found rich natural resources, although these resources make it rational to reduce the traditional traded goods sector. The hypothesis presented in e.g. Sachs and Warner (2000) that rich petroleum resources may turn out to be a curse rather than a blessing, has played an important role in the Norwegian policy debate on the use of the petroleum wealth, see e.g., Holden (2003) and Holmøy and Heide (2005). This debate has focused on irreversibility problems associated with real exchange rate appreciation and deindustrialization beyond certain thresholds labelled the “manufacturing base” and “critical mass”, see e.g. Krugman (1987, 1991) and Venables (1996).[2] Our study does not explicitly capture such types of irreversibility, but our results provide information on to what extent removing the electricity price subsidies is likely to make hard equilibrium adjustments necessary.

The rest of the paper is organised as follows. Section 2 provides some background information on the magnitude of the electricity price subsidies and the production structure of firms in the three subsidised energy intensive industries. Section 3 employs a partial equilibrium framework to examine the effects on firm exits and output and inputs in these industries of removing the electricity price

[2] Another aspect of the deindustrialization associated with the Dutch Disease concept is that manufacturing generates growth-stimulating externalities, see van Wijnbergen (1984), Krugman (1987), Matsen and Torvik (2003) and Torvik (2001). This view underlies the worries over the decline of manufacturing in the US expressed in Popkin and Kobe (2003) and Hersh and Weller (2003). Hausman and Rodrik (2003) and Hausman, Hwang and Rodrik (2005) point to another kind of knowledge spillover, referred to as "cost discovery", as a motivation for industry policy. In their framework government policy can improve static efficiency and growth by stimulating activities which imply relatively most discovery of the true costs of production.

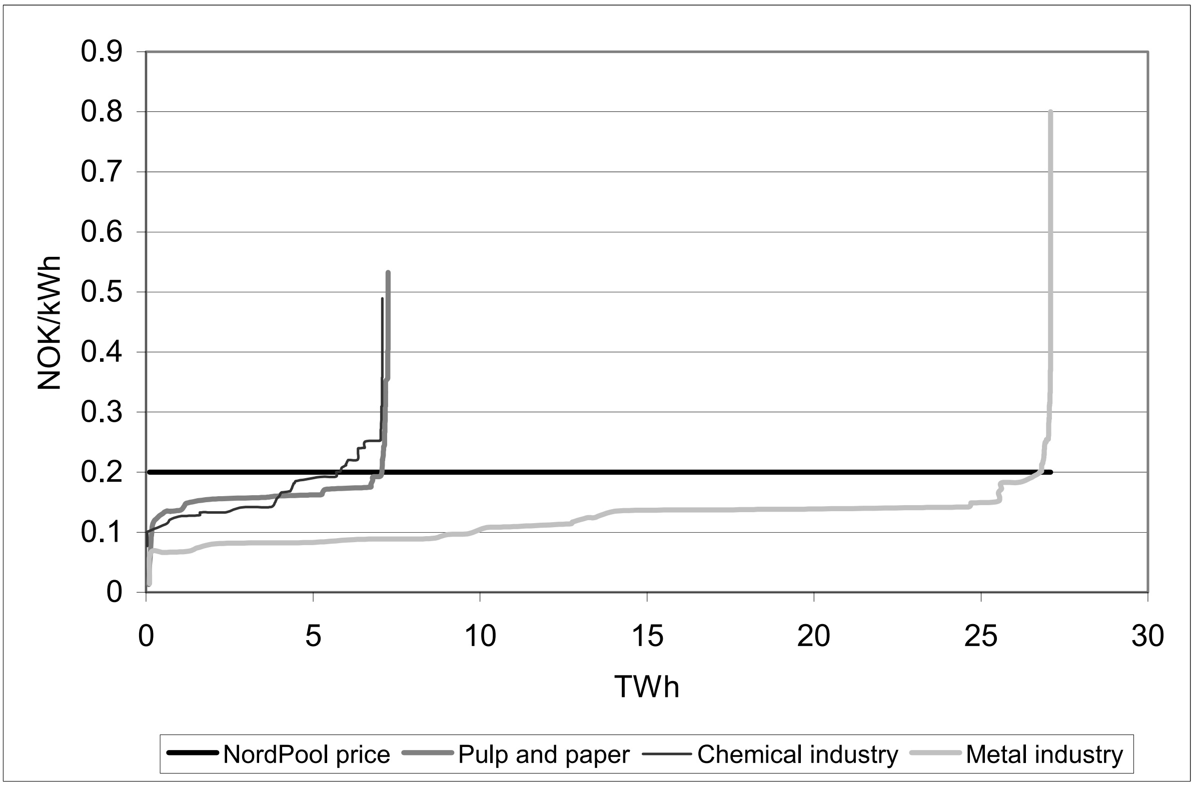
subsidies. Section 4 explains the results from a CGE simulation of removing the subsidies. Section 5 summarizes our findings.

2. Background: The current electricity price subsidies

Most of the energy intensive manufacturing industry production capacity in Norway was developed in the 1950s and 1960s. Then electricity production capacity was cheap to develop and the government - represented by the biggest, state owned electricity producer Statkraft - signed 50-60 year electricity price and volume contracts with the manufacturing industry, which expire in the period 2008-2011. The expansion of the power production capacity over the last five decades has faced diminishing returns to scale and increasing environmental costs. In addition, the expansion of the transmission network has turned electricity from a non-tradable resource into a tradable. For both reasons the market price for electricity has increased sharply, and so has the opportunity cost of the electricity consumed in the power intensive manufacturing industry. Figure 2.1 shows the average market price for electricity at the NordPool exchange[3] in 2000 compared to the prices actually paid by producers of Pulp and paper (ISIC 211), Chemicals (ISIC 241) and Metals (ISIC 27) and the accumulated volumes for each industry, i.e. the area under the price curve reflects the industry's total electricity cost. The year 2000 NordPool price equated approximately the cost of expansion of the capacity through new gas power plants. Due to the long-term contracts most of the firms, especially in the metal sector, pay prices much below the market price for large volumes. Effectively, the negotiated prices include a substantial subsidy as they imply a loss of government revenue through lower profits in Statkraft.

[3] By market price we refer to the average annual system price at the Nordic electricity market exchange NordPool.

Figure 2.1. Price and volume of electricity in the pulp and paper industri, the chemicals industry and the metals industry. The market price at NordPool. TWh and NOK/kWh. 2000



The total electricity consumption in the energy intensive industries constituted 33 per cent (41.4 TWh) of total electricity consumption in Norway in 2000. In 2005 the share was 32 per cent (40.5 TWh). The average annual NordPool price for electricity in 2000 was 20 øre/kWh[4] while the average purchaser price (net of taxes and transmission) in the three sectors was 13.5 øre/kWh. The purchaser price in the Pulp and paper and the Chemical industry was about 35 per cent lower than the market price while close to 85 per cent lower in the metal industry, see table 2.1.

[4] 1 USD = 6.5 NOK, 1 cent = 6.5 øre, 1 NOK=100 øre.

Table 2.1 Electricity consumption, electricity cost and alternative value. 2000

	Volume of electricity, TWh	Average purchaser price øre/kWh	Total cost of electricity, Bill. NOK	Market value of electricity, Bill. NOK	Implisit subsidy, Bill. NOK
Pulp and paper	7.2	16.1	1.2	1.6	0.4
Chemicals	7.1	16.5	1.2	1.6	0.4
Metals	27.1	12.0	3.3	6.0	2.7
Total	41.4	13.5	5.6	9.1	3.5

The implicit price contract subsidy, if prolonged, sums to a total of 3.5 billion NOK each year. This amounts to approximately 63 per cent of the industry's total present electricity costs. The average electricity cost share for these industries is 6-7 per cent, which implies a large initial increase in total cost if contract prices in the future will reflect the electricity market price.

3. Expiration of electricity price contracts: Partial effects

As a first order approximation of the effects of increasing electricity prices, we calculate the change in net profits of individual firms, contingent on other prices being constant, no factor substitution and no change in output. Although the subsidised energy intensive industries are quite narrowly defined, they exhibit significant heterogeneity with respect to output composition, electricity price subsidies and technologies reflecting capital vintages[5]. Investments at a certain time reflect both present factor prices and expectations about factor prices development[6].

[5] This part of our paper thematically has much in common with a recent Swedish study of the effects of the Kyoto agreement on the competitiveness of the Swedish energy intensive manufacturing industries (ITPS A2004:019). However, the Swedish study does not discuss this in a broader comparative advantage aspect and thereby disregards any general equilibrium effects.

[6] From 2000 to 2006 some of the included firms have exited the market due to profitability considerations in line with our analysis in Section 3 and 4. Over time firms have to maintain or update the production plant. In their considerations the possibility of sharply increasing electricity prices in the medium term (2008-2001) is one important factor that may redeem these exits. In our base line scenario in Section 4 these firms keep their long-term price contracts, which could have kept them in business also in the short/medium term. In the real world, and our alternative scenario, the contracts expire and firms face market prices for electricity.

Figure 3.1 The price of electricity, the electricity input coefficient and the electricity cost share by firm. Pulp and paper industry

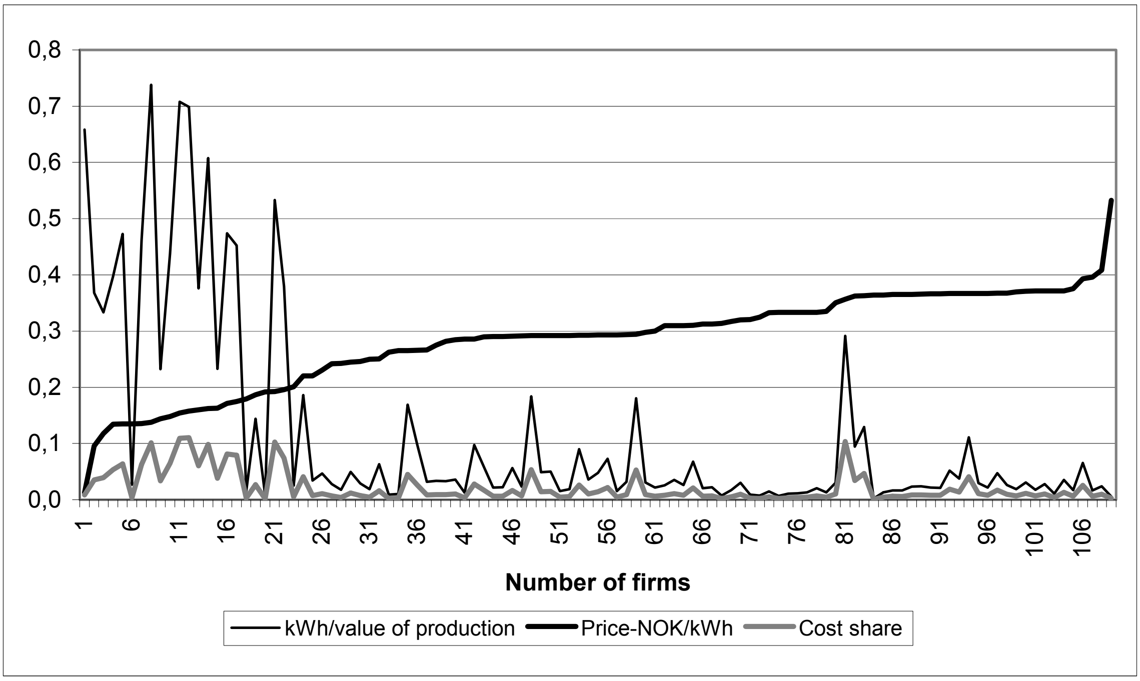


Figure 3.1 to 3.3 depict the heterogeneity with respect to the input share of electricity in the three emphasised industries. As expected, firms facing the lowest electricity price have invested in the most electricity intensive technologies. The highest electricity shares are as much as 10-20 times the lowest shares.

The negative correlation between negotiated electricity prices and electricity shares makes the cost shares more evenly distributed among firms, although differences are still important.

Figure 3.2 The price of electricity, the electricity input coefficient and the cost share by firm. Chemical industry

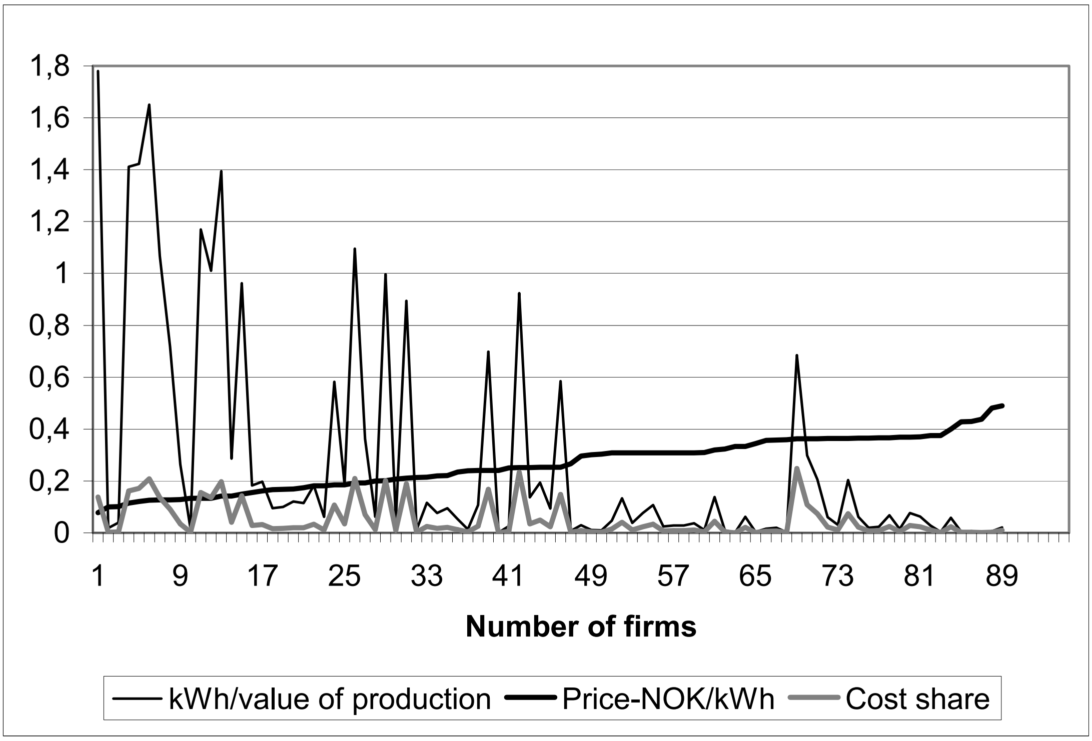
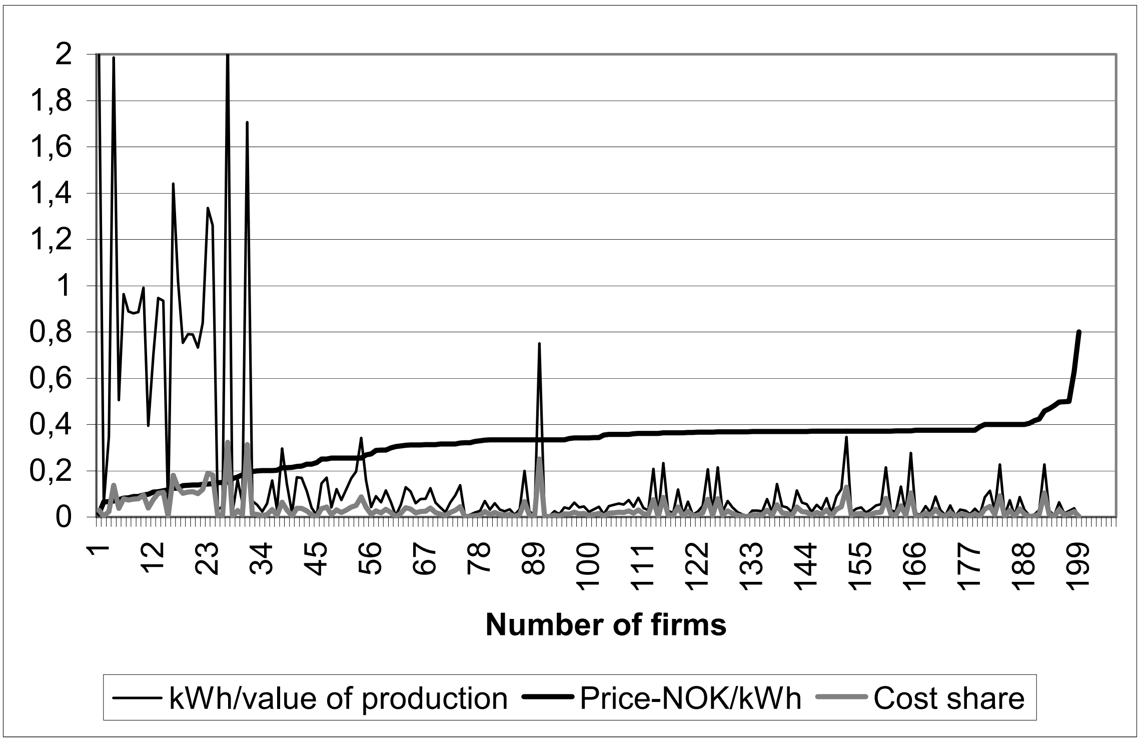
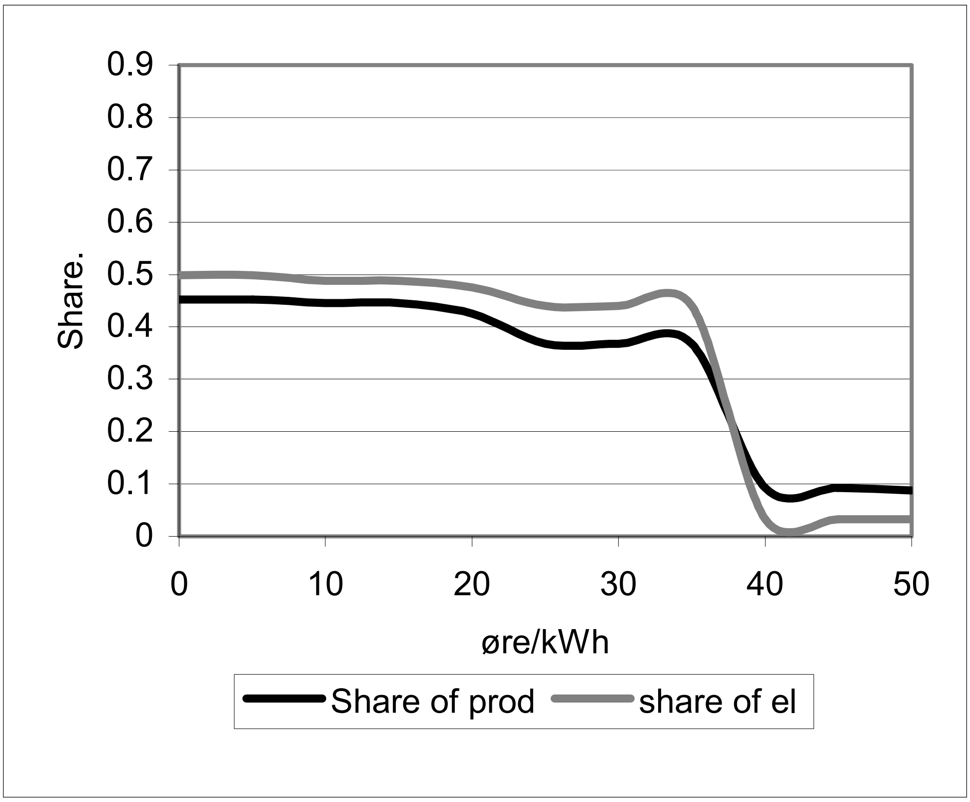


Figure 3.3 The price of electricity, the electricity input coefficient and the cost share by firm. Metal industry



In our base year (2000) 83, 89 and 91 per cent of the Pulp and paper industry, the Chemical industry and the Metal industry, respectively, produced a positive operating surplus. The surplus in these industries varies a lot year by year and the average surplus then depends on the evaluated period. The surplus in 2000 was slightly higher than average surplus for the last ten years in the pulp and paper industry and the metal industry, and a bit lower in the chemical industry. This implies an underestimated profit effect for the pulp and paper industry and the metal industry, and an overestimated profit effect for the chemicals industry, given that the last ten years average reflects a good estimate of the future product prices in the representative markets. To survive in the long run operating surplus must cover all capital costs, including depreciation and the risk adjusted internal rate of return[7]. In the base year 45, 57 and 55 percent of the production in the three respective sectors achieved at least this return on capital, see figure 3.4-3.6.

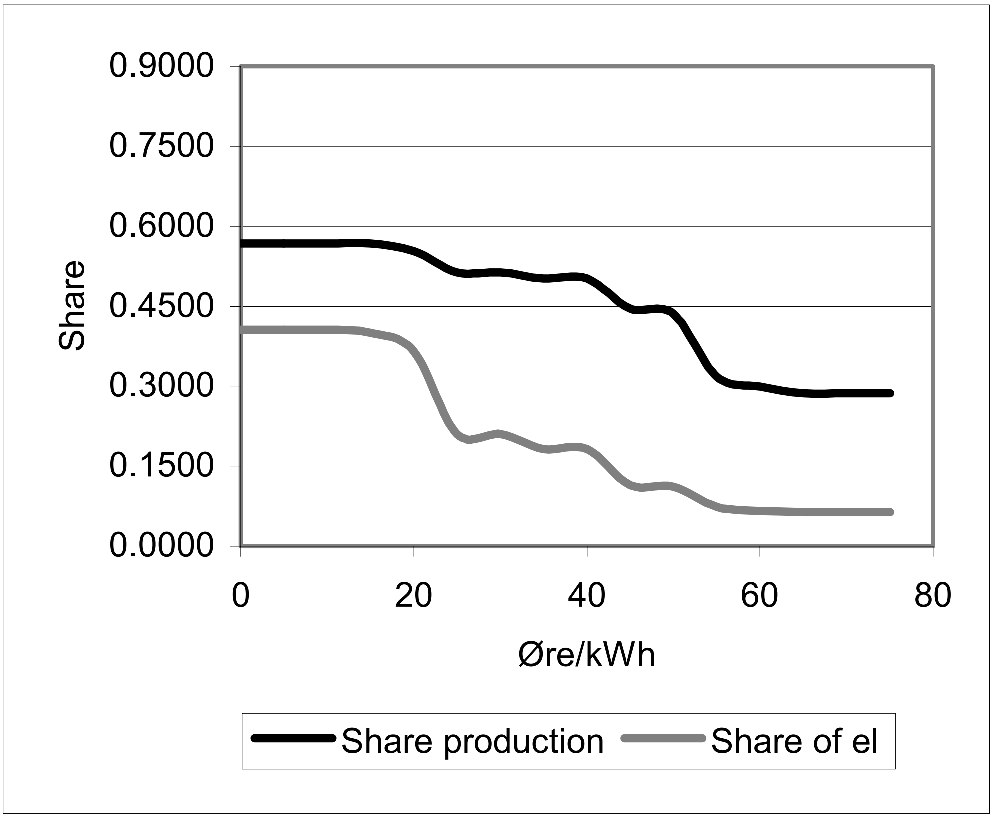
Figure 3.4 Electricity and production share of total as the minimum electricity price increase and a sufficient long term surplus is presupposed. Pulp and paper industry



[7] We assume an average depreciation rate of 6 percent on the aggregate of machinery and buildings and a long-term nominal interest rate of 5.5 per cent.

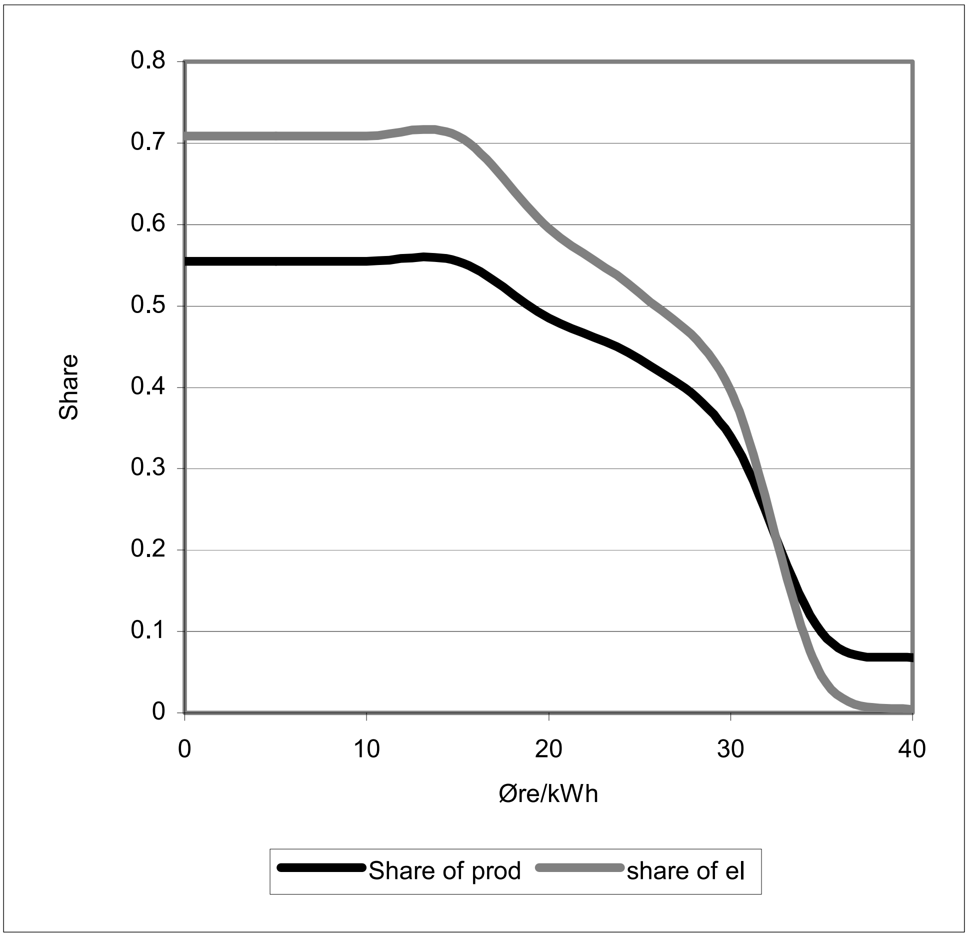
Although the Pulp and paper industry is heterogeneous, the mix of non-profitable firms has a close to average electricity intensity, cf. that the share of production and share of electricity input changes approximately proportionally in figure 3.4.

Figure 3.5 Electricity and production share of total as the minimum electricity price increase and sufficient long term surplus is presupposed. Chemical industry



In the Chemical industry, figure 3.5, the most energy intensive firms are the least profitable and would exit, cf. that the energy share decreases faster than the production share.

Figure 3.6 Electricity and production share of total as the minimum electricity price increase and a sufficient long term surplus is presupposed. Metal industry



For the Metal sector, figure 3.6 the opposite happens, as the most energy intensive firms are the most profitable ones.

Figure 3.4 to 3.6 also show the share of production and use of electricity in firms able to cover capital costs as a function of a common market-clearing price for electricity.

Ex ante removal of the price subsidies, the pulp and paper industry is the least profitable, whereas the metal industry is the most profitable of the energy intensive industries. The figures indicate that the Pulp and paper industry will earn a competitive profit for electricity prices well above the 2000 NordPool market-clearing price, i.e. 20 øre/kWh. For the Chemical industry firms will gradually exit from about 20 øre/kWh, the most energy intensive firms vanish first. For the Metal industry almost half of the industry will not be sufficiently profitable when electricity prices reaches the NordPool market clearing prices.

Factor substitution would modify the profit reduction, but this would be a second order effect. However, the panel data study of Lindquist and Skjerpen (1995) suggests that relative factor price variations have limited effects on conditional factor demands in the Norwegian primary aluminium industry, which accounted for 54 percent of gross production in the metal sector in 2003.

4. Removing electricity price subsidies: General equilibrium effects

A CGE analysis should capture at least, the following effects of removing the electricity price subsidies:

- Reduced exports of energy intensive products must be compensated by increased net exports of other products. This requires labour cost adjustments.
- International trade in electricity is still mostly limited to the Nordic countries, and the electricity price cannot be assumed to be independent of the large demand from the Norwegian energy intensive industries (10 percent of the Nordic market). Due to increasing marginal costs in expanding electricity supply in the relevant market, reduced electricity demand from these industries result in lower electricity prices, which raises demand from other industries.
- Removing the subsidies on 30 percent of the total use of electricity increases government revenue through higher profits in the state owned company Statkraft. Payroll tax rate reduction neutralizes the positive budget effect, which contributes to reduce costs in all industries.

4.1 The CGE-model

The applied CGE model, MSG6, is described in detail in Heide, Holmøy, Lerskau and Solli (2004). Here we confine the description to the characteristics most important for our analysis. The model describes the Norwegian economy as small and open: All world prices and the interest rate are exogenous. The nominal exchange rate is fixed and normalised to unity. Labour is internationally immobile.[8] All goods, services and production factors are perfectly mobile between industries within the economy. Supply equals demand in all markets in all periods. A representative consumer maximizes an intertemporal utility function, and producers maximize the value of firms. MSG6

[8] The model includes exogenous immigration and emigration.

includes backward looking dynamics related to accumulation of fixed capital and financial assets, as well as forward looking dynamics derived from intertemporal behaviour of producers and consumers with perfect foresight. A non-Ponzi game condition on net foreign debt implies an intertemporal constraint on aggregate consumption. This budget constraint is met by endogenous wage adjustments ensuring profitability in a sufficiently large production of traded goods. Aggregate consumption will basically be determined from the supply side, basically by total factor productivity (TFP) growth, demography and profitable reserves of oil and gas, as well as terms-of-trade and the international interest rate.

The model is explicitly designed to analyse long run changes in the industry structure, including Rybczynski effects on the industry structure to changes in relative factor prices. It specifies 32 private business industries, 8 government sectors and 60 commodities. Most industries produce tradables, and most tradables are produced in several industries. The multi output production structure makes the concept "Tradables (T) *sector*" superfluous. However, an industry will be more vulnerable to a rise in costs the higher are the output shares of exported products, and the more exposed the outputs are to import competition. The model singles out the three industries benefiting from electricity price subsidies, i.e. the main producers of, respectively, *Metals*, *Chemicals* and *Pulp and Paper*. The model also describes markets for energy goods in relatively great detail.

Agents consider imports of manufactures and services as close but imperfect substitutes for the corresponding deliveries from Norwegian firms, which makes import shares decreasing functions of the import price relative to the price index of corresponding domestic deliveries.[9] Producers of manufactures and tradable services allocate their output between the domestic and the foreign market.[10] It is costly to change the output composition between these markets. Domestic firms are price takers in the export markets, whereas they participate in Large Group Monopolistic Competition with free entry/exit in the domestic markets.[11] The model deviates from the textbook model of a small open economy by assuming decreasing returns to scale in the private industries. This property is both consistent with the aggregate effects implied by the significant cost heterogeneity within industries

[9] The estimates of the elasticities of substitution between Norwegian and imported products are taken from Naug (1994).

[10] Holmøy and Hægeland (1997) provide a detailed analysis of the production model in MSG-6. Below we summarise the features most relevant for our projections.

[11] Bowitz and Cappelen (2001) find empirical support for these (common) assumptions about the market structure facing Norwegian firms in the export and the domestic markets. The same pattern was also found by Aukrust (1977). The mark-up ratios between the output price and marginal costs are less than 5 percent, which is consistent with the estimates in Klette (1999).

reported in Section 2 and 3, as well as econometric studies[12]. Decreasing returns implies a more diversified traded goods sector than in the case of constant returns, dependency between prices of factors and non-tradables and the production level in domestic industries, as well as adjustment costs related to real capital formation. Firms are price takers in the factor markets when they combine labour, 3 types of fixed capital and 8 composites of intermediate inputs (including two kinds of energy – fossil fuel and electricity).[13]

Real government consumption and the real value of government transfers to households are exogenous. We assume that the fiscal policy rule adopted in 2001 is followed strictly throughout both scenarios.[14] This assumption is fundamental in the analysis and implies a constraint on the *annual* government budget surplus, which is met by pay-as-you-go adjustments of the payroll tax rate. All other tax rates are constant from scenario to scenario.

4.2 Two scenarios

We compare two general equilibrium growth scenarios over the next forty-five years:

- A reference scenario in which the relative electricity price subsidies of the three emphasised energy intensive industries are maintained at the present level. Appendix 1 describes its macroeconomic aspects.
- A "non-subsidy" scenario in which the electricity price subsidies are removed, and the emphasised industries face the common market price of electricity.

As a first result we find very small macroeconomic effects, see Table 4.1. In the long run there is room for a slight increase in consumption and a negligible decline in labour supply (-0.007). Labour supply falls despite an increase in the consumer real wage rate, due to increased non-labour real income. The increase in consumption and leisure reflect a small long run utility gain of equalizing the purchaser prices of electricity across consumers. This is a non-trivial result, because the price distortions throughout the economy deviate from those that would be second best optimal, given the MSG6 model.

[12] The scale elasticities range from 0.85 - 1.00. Evidence of decreasing returns to scale at the firm level is presented in Klette (1999), whereas Biorn, Lindquist and Skjerpen (2002) find constant or moderately increasing returns to scale for the average plant in Norwegian manufacturing. However, increasing returns at the plant level is compatible with decreasing returns at the aggregate industry level.

[13] Most of the elasticities of substitution between input factors have been set in accordance with estimates presented in Alfsen, Bye and Holmøy (1996, Ch. 3).

[14] A strict interpretation of the fiscal policy rule implies that the time path of the government budget surplus should be equal to the real return on the financial assets accumulated in the Central Government Pension Fund. In real terms, the accumulation of this fund equals the net cash flow from the petroleum sector accruing to the government, which is exogenous in the model.

The empirically most significant effects are related to adjusting the general international competitiveness when the policy based comparative advantage for electricity intensive production is removed. Higher electricity prices shift the marginal costs upwards in the three affected industries, which are highly export oriented. They reduce their export supplies along the new marginal cost curves. The export reduction violates the long run external balance constraint. This balance is restored by the real depreciation brought about by a 1.5 percent decline in the labour cost compared to the reference path.

Nominal wages are typically sticky downwards, see e.g. Bewley (1997), especially in highly unionised labour market such as the Norwegian. This suggests that the labour cost reductions will be hard to realize. However, even if the adjustment were to take place over a few years, only a slight reduction of the positive wage growth would be necessary, for given tax rates. More interestingly, the labour cost reduction can be combined with an *increase* in the consumer real wage rate. The positive fiscal effect of removing the subsidies allows the government to cut the payroll tax rate by 0.9 percentage points, which, *cet. par*, reduces labour costs more than what is necessary. The increase in the consumer real wage rate is reinforced by a reduction in the electricity price paid by consumers and firms outside the three subsidized energy intensive industries. This results from lower total electricity demand caused by the contraction of the three subsidized electricity intensive industries, combined with decreasing returns to scale in electricity production.

Despite small figures in our specific experiment, the opposite adjustments of labour costs and the consumer real wage rate illustrate the potential importance of taking the full fiscal effects of the reform into account. It resembles the "double dividend" discussed in the general equilibrium analyses of shifting the tax base from heavily taxed labour to pollutive emissions. Moreover, it is a general point with obvious policy relevance: The fiscal effect of removing policy based comparative advantages can finance both the necessary decrease in the producer prices of labour, as well as a popular increase in the consumer real wage rate.

Table 4.1. Macroeconomic effects of removing electricity price subsidies.Percentage deviations from the reference scenario

	2025	2050
Private consumption	0.1	0.1
Exports	-3.2	-5.3
Imports	-2.3	-2.3
GDP	-0.3	-0.5
Manufacturing industries	-2.8	-4.9
Employment	0.1	0.0
Manufacturing industries	0.3	-0.8
Fixed capital	-0,5	-0,5
Labour cost per hour/export price	-1.5	-1.5
Payroll tax rate, percentage points	-3.7	-0,9
Consumer real wage rate	-0.7	0.05

Table 4.2. Long run effects on industry structure of removing electricity price subsidies. Percentage deviations in 2050 from the reference scenario

	Employment	Capital	Production	Electricity
Total	0.0	-0.5	-0.8	-9.1
Mainland private industries	0.0	-0.5	-1.1	-24.6
Manufacturing	-0.8	-9.3	-5.3	-38.5
Pulp and paper	-14.2	-22.8	-18.9	-36.7
Chemicals	-11.9	-18.5	-15.7	-34.1
Metals	-40.0	-49.5	-46.5	-69.2
Machinery	2.5	2.1	2.0	2.2
Primary industries	1.4	1.0	2.8	2.0
Services	0.6	0.3	0.5	0.5

The combination of higher electricity prices and lower wage costs makes the specialization in the traded goods sector less based on selective industry policy and more in line with resource and technology based comparative advantages. Resources are reallocated from the relatively most electricity intensive to the relatively most labour intensive industries. Table 4.2 shows the following patterns of long run effects on the industry structure. The most dramatic change is the decline of the metal sector, in which production would be 46 percent lower in 2050 than in the reference scenario. The corresponding reductions of the *Pulp and* Paper and *Chemicals* industries are somewhat less pronounced, respectively, 19 and 16 percent. This reflects that the metal industry benefits from the highest electricity price subsidy in the reference scenario, that the cost share of electricity is significantly greater in this industry than in the other electricity intensive industries, and that the scope for passing higher costs over to consumers is relatively small since the export share of output is among the highest. In relative terms the strongest expansion among manufacturing industries takes place in Machinery production.

The changes in the broader patterns of the industry structure reflect that the economy becomes less open after the removal of the electricity price subsidies. All industries but the three subsidized electricity intensive ones, become more internationally competitive due to reductions in labour costs and electricity prices. This enables firms to gain market shares in their home markets, which reduces imports. The external balance constraint implies that the necessary exports will also be lower. Resources move from the traded goods to the non-traded goods sector. As industry specific subsidies are removed, the traded goods sector becomes less specialized.

The reallocation of resources is highly disproportionate. Whereas employment in manufacturing industries is 0.8 percent lower in 2050 compared to the reference scenario, the corresponding reductions in capital and electricity are, respectively, 9.3 and 38.5 percent. The reallocation of electricity is particularly strong due to the contraction of the subsidized electricity intensive industries. The total economy becomes less energy intensive, as only half of the disengaged electricity consumption in energy intensive industries is demanded from other consumers. The need for investment in electricity producing capacity is reduced. This reflects partly re-specialization within the traded goods sector in favour of the most labour intensive industries. The decrease in the relative price of labour also causes factor substitution. Capital is a complementary factor to electricity, which explains the strong decrease in the capital-labour ratio in the electricity intensive industries. The sharper decrease of electricity is due to the heterogeneity structure of the industries.

5. Conclusions

Expansion of the transmission capacity has transformed electricity from a non-tradable good to a tradable good. In result, the opportunity cost of using electricity as a production factor has increased, and the resource based comparative advantage of electricity intensive production has faded. For a period the market adjustments to this development have been slowed down by policy measures. In Norway this type of industry policy has taken place through a change in the real content of the long-term contracts between the state owned electricity producing company and the Norwegian producers of *Metals*, *Chemicals* and *Pulp and Paper*. Whereas the contracted electricity prices to these industries reflected the opportunity cost of electricity when the contracts were negotiated 45-55 years ago, they now imply a 50 percent subsidy compared to market prices. International competition rules make it harder to maintain industry assistance. Specifically, it is questionable whether the Norwegian price subsidies of electricity to the electricity intensive industries can or will be prolonged after the expiration of the contracts in 2008-2011.

We have analysed the effects on firm specific profits of removing this kind of policy based comparative advantage. The results show that several, but far from all, firms will face severe problems obtaining sufficient profitability to survive in a competitive world market. Both technologies and the subsidy element in the electricity price contracts differ significantly between firms within the same industry. The cost heterogeneity within each industry gives rise to significant diminishing returns to scale at the industry level. The most energy intensive firms are the most subsidised ones, so they will also face the largest increase in total cost when the contracts expire. The suggested market-clearing price for electricity will be most harmful for the metal sector.

The energy intensive industries contributed with 19 per cent of the total value of mainland exports in 2005. The growth in the traded goods sector required to make further growth sustainable with respect to external balance, must find new patterns of specialization compared to what has been witnessed so far. We have applied a CGE model to analyse this further. A crucial property of this model is that industry production functions exhibit diminishing returns to scale in accordance with results from the microanalysis of the three energy intensive industries, as well as other econometric evidence. Our results suggest that the necessary changes in industry structure can be obtained by small macroeconomic adjustments. Replacing the policy based comparative advantage for electricity intensive production by a more broad based international competitiveness, commands a 1.5 percent long run decrease in labour costs, which translates into a slight reduction of annual growth rates. This adjustment can be combined with a (popular) increase in the consumer real wage rate, because removing the subsidies allows a reduction in the tax on labour income. Lower labour cost enables Norwegian firms to gain domestic market shares. The resulting decrease in the import shares reduces the sustainable size of the traded goods sector. The traded goods sector becomes less specialized and less energy and capital intensive.

Norway is probably one of the economies that gains most from international trade, and the petroleum wealth (in the Petroleum fund and remaining reserves) is far below the present value of future imports. One should therefore be aware of Dutch Disease symptoms in the Norwegian economy. However, this macroeconomic challenge should not be used as an argument for not implementing efficiency improving industrial policies even if such reforms reduces the profitability of some existing firms in the traded goods sector. Removing specific electricity price subsidies to producers of Metals, Chemicals and Pulp and paper is a good example of efficiency improving industrial policy. It generates government revenue, which allows reduction of other taxes. This improves the general business conditions, also for producers of tradables. The policy improves aggregate production efficiency by adjusting the specialization of the industry structure more on resource and technology based comparative advantages, and less on discriminatory policy. Admittedly, our analysis does not account for short-term social costs related to the reallocation of resources. However, as the harmed industries employ relatively few workers, these costs are likely to be modest, especially when policy induced effects are compared with the normal annual adjustments in the Norwegian economy. Moreover, Huttunen, Møen and Salvanes (2006) find that the Norwegian economy is quite adaptive.

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Appendix 1

The reference scenario in the CGE-analysis

The following exogenous assumptions are most significant with respect to the wage growth. (All growth rates are *per annum* if nothing else is stated.)

- Based on historical trends Total Factor Productivity *(TFP)* grows by 1.3 percent.[15]
- Except for crude oil and natural gas, international prices, measured in NOK, grow by 1.5 per cent. The nominal interest rate is 5.5 percent throughout the simulation period.[16]
- We adopt the projections of future petroleum revenues reported in Holmøy and Heide (2005). Export of crude oil declines at an annual rate of 4.4 percent to 2010 in value terms. Thereafter the percentage annual decline will be approximately 5.4 per cent. Export of natural gas is projected to increase by an annual rate of 6.8 per cent to 2010 and thereafter to stabilise.
- The demographic development is based on the middle alternative in the population projections presented in Statistics Norway (2002). The labour force increases by 11 percent from 2005 to 2050. The old-age dependency ratio (those 67 and older relative to those of working age 20-66) is increases from 22 percent to about 36 percent in 2050.
- We have made the cautious assumption that no changes take place in standards and coverage ratios of Public services beyond already approved reforms. A plausible interpretation of our scenario is that the growth in private consumption per capita involves privatisation of services traditionally provided by the government sector in Norway. Ageing alone implies an annual growth in government employment of 0.6 percent from 2002 to 2020, 1.1 percent in 2021-2030 and 0.8 percent in 2031-2040. Thereafter government employment grows by 0.3 percent per year.

Table A.1 summarizes the growth picture in our baseline scenario. Growth in the labour force and TFP results in an average annual GDP growth of 1.7 percent over the period 2002-2050. The GDP effect of TFP growth is both direct and indirect through endogenous capital deepening. The sustainable growth in private consumption per capita averages 2.5 percent, and there is room for a sustainable constant growth rate of the nominal wage cost per hour equal to 4.1 percent. The projected growth is moderate

[15] Taking decreasing returns to scale into account, the TFP residual grows by approximately 1 percent when computed by the standard formula, which assumes constant returns. In government sectors labour productivity grows by 0.5 per cent per year, which is the standard assumption in the Norwegian National Accounts.

[16] Combined with the 1.5 percent growth in international prices, this assumption implies a real interest rate of 4 percent in terms of international purchasing power. This is in line with what has been assumed in the current fiscal policy guidelines, and with American interest rates in the second half of the 1990's.

compared to historical trends for the following main reasons: 1) The strong contribution from the petroleum sector to the aggregate growth over the last three decades will not continue; 2) the increase in labour force is moderate; 3) an increasing share of the labour force becomes employed in the government sector, especially in health and social care, in which productivity growth is significantly lower than in the private business sectors. The growth rate of private consumption declines over time because ageing raises government consumption related to health and social care.

Table A.1. Macroeconomic development in the reference scenario. Average annual growth rates in percent

	2002-2020	2021-2050
Man hours	0,3	0,0
Fixed capital	1,8	1,6
GDP	1,8	1,6
Off-shore industries	-3,0	-0,9
Mainland industries	2,4	1,7
Government sectors	0,9	1,1
Manufacturing	2,9	1,6
Pulp and paper		
Chemicals		
Metals		
Other mainland industries	2,6	1,9
Net disposable real income	2,0	1,8
Exports	0,6	0,9
Exports excl. petroleum	2,2	1,1
Imports	2,1	1,7
Private consumption	3,0	2,1
Government consumption	0,7	1,0
Gross fixed investment	1,5	1,3
Labour cost per hour/export price	2,6	2,6
Consumer real wage rate	3,2	1,8

Over time the growth rate for labour cost per hour deviates significantly from the growth rate for the consumer wage rate. The latter declines over time from 2.9 percent until 2020, to 1.8 - 1.9 percent in the subsequent three decades. This reflects basically the gradual increase in the payroll tax, which is required to meet the public budget constraint on a pay-as-you-go basis as ageing makes government expenditures grow faster than the tax bases after 2020. Since wage cost per hour is basically determined by the international competitiveness consistent with the foreign debt constraint, the surge in the payroll tax is almost completely paid by wage earners. Whereas the payroll tax rate averages 13 percent in 2005, it passes 31 percent in 2050.

Appendix 2

The determination of unit labour cost in MSG6

The most important general equilibrium effects of removing the price subsidies on electricity given to the three electricity intensive industries on real wage cost and private consumption can be explained by using Figure A2.1. The LL- and the BB-locus reflect reduced form relationships in MSG6. The LL-locus describes combinations of the real unit labour cost and average individual utility consistent with labour market equilibrium. The BB-locus describes the corresponding combinations consistent with the long run external balance requirement. The point where the two loci intersect represents the stationary general equilibrium.

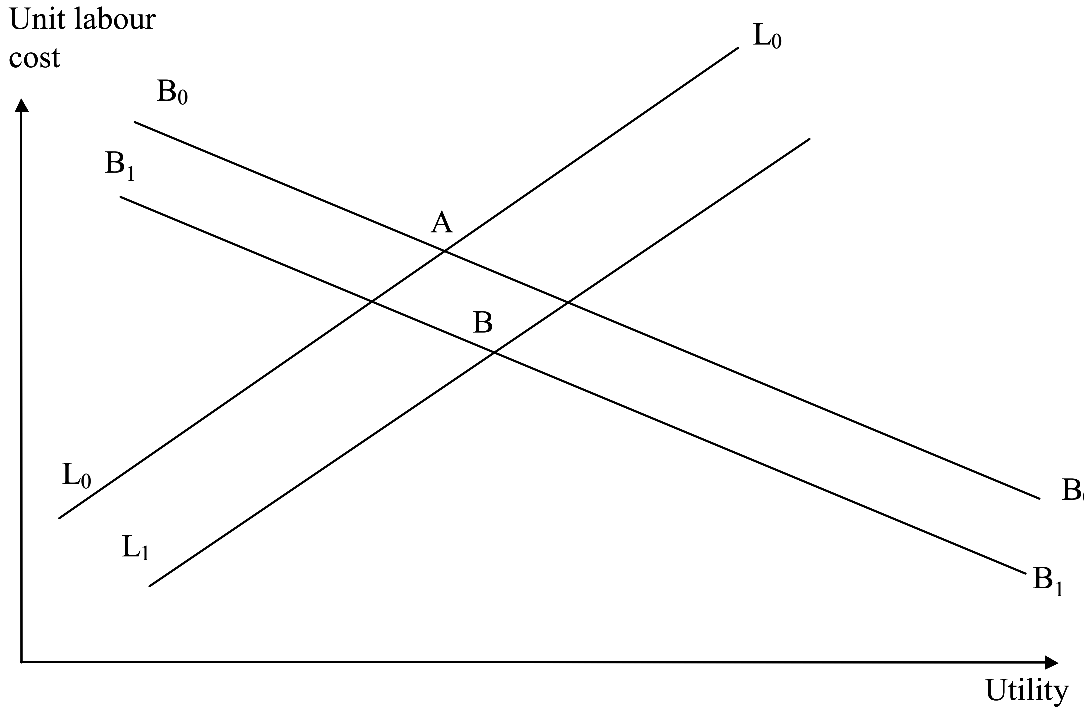
The LL-locus is upward sloping because a partial increase in the utility level causes households to decrease labour supply and increase consumption of goods, both contributing to excess demand for labour. Increasing the wage rate restores labour market equilibrium because 1) labour supply increases (as the substitution effect dominates the income effect), 2) firms substitute labour for other factors of production, 3) the aggregate production structure becomes less labour intensive due to a Rybczynski effect. The BB-locus is downward sloping because a partial increase in the utility level implies an increase in net imports. A fall in the wage rate restores the external balance through export expansion, substitution of domestic deliveries for imports, and substitution of leisure for consumption.

Removing the electricity price subsidies to the three electricity intensive industries causes a downward shift in the LL-locus for the following reasons: 1) Higher electricity prices faced by the previously subsidized industries imply lower labour demand in these industries. 2) Lower electricity demand from these industries causes a decline in the electricity prices facing other producers. This implies, *cet. par*, an increase in the relative factor price of labour, reducing labour demand. 3) Labour supply is stimulated by the increase in the consumer real wage rate, which reflects that the revenue from removing the subsidy is used to cut the payroll tax rate, as well as the drop in the consumer price of electricity. The three effects imply excess supply of labour. Restoring labour market equilibrium requires a reduction of the unit labour cost for a given utility level and a given payroll tax rate.

Removing the electricity price subsidies to the three electricity intensive industries causes a downward shift in the BB-locus because of a significant fall in exports from the previously subsidized industries. This effect dominates the increase in exports and decrease in import shares of other products due to lower electricity prices paid by other industries. A fall in the wage rate is necessary to restore the Non-

Ponzi Game condition for the accumulation of net foreign debt. The movement from A to B in Figure A2.1 illustrates the equilibrium adjustment of utility and the unit labour cost caused by removing the electricity price subsidies, given that the revenue is used to reduce the payroll tax rate. The pre-tax wage rate will unambiguously fall. The effect on utility is theoretically ambiguous, since the changes in the subsidy and tax rate do not remove all distortions in the economy, and these distortions do not reflect any second-best optimisation based on the MSG6 model. In the figure the shifts have been drawn so that utility increases, as it does in the long run in our simulations.

Figure 4.1. Long run equilibrium effects in MSG6 on the utility level and unit labour cost of removing the electricity price subsidies, combined with a budget neutral reduction of the payroll tax rate



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