Oil Price Shock, Energy Prices and Inflation – A Comparison of Austria and the EU

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The marked increase in the price of crude oil has also affected the prices of motor fuels, heating oil and other forms of energy. The extent and speed of these price reactions have varied widely in EU countries, and the accompanying inflationary effects have differed accordingly. For monetary and economic policy, it is important to know the channels through which oil price fluctuations are transmitted in order to assess their effects on inflation, economic growth and employment.

This study presents a current overview of oil and primary energy markets worldwide and estimates the elasticities and the speed of adjustment parameters of motor fuel and heating oil prices in response to oil price fluctuations in the EU-25. In addition, we test whether prices react asymmetrically to increases and decreases in crude oil prices and examine their transmission to other forms of energy, such as natural gas, electricity, solid fuels and district heating. We highlight the effect of volume-based excise taxes, which have a strong differentiating as well as dampening effect on prices, and address the issue of whether fiscal policy should cushion the impact of price increases, for example by lowering energy taxes or by providing energy subsidies. Then we quantify the direct inflationary effects of an oil price shock in Austria in a simple simulation using the OeNB's inflation forecasting model. Finally, we derive conclusions for monetary and economic policy.

JEL classification: E31, E52, E62, Q43
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1 Oil Price Development Reflects Worldwide Supply and Demand Situation

In the last few years, crude oil markets have mainly been characterized by a surge in the price of crude oil from approximately USD 10 per barrel of Brent in late 1998 to levels which sometimes exceeded USD 60 per barrel of Brent in the latter half of 2005. In real terms, the price of oil in Austria recently reached the highs seen in the first oil price shock of early 1974, but it is still considerably lower than the level after the second oil price shock in 1979 to 1980.

Price fluctuations on the crude oil markets are attributable to the interaction of supply and demand factors. Geopolitical crises can also have a significant impact on crude oil prices, at least temporarily. The most recent increase in oil prices, which at times exceeded USD 60 per barrel of Brent, can mainly be interpreted as a demand shock. Robust growth in the world economy and a highly dynamic increase in global demand for oil – mainly in a number of emerging market economies (especially China) – have diminished available capacities among crude oil producers. Moreover, exchange rate developments such as the relative weakness of the U.S. dollar in recent years may also play a role, as petroleum producers – who did not want to see their rising revenues from oil exports reduced by the weak dollar – sought higher oil prices in U.S. dollars.[3]

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[3] *As many oil-producing countries have an exchange rate regime which pegs their currency firmly to the U.S. dollar, for example in the Middle East (Saudi Arabia, etc.), or at least a regime which is heavily oriented toward the U.S. dollar (e.g. Russia), a weak dollar mainly diminishes the positive terms-of-trade shock arising from higher oil prices, that is, the relationship between export prices (oil in U.S. dollars) and import prices (some of which are not denominated in U.S. dollars) becomes less favorable.*

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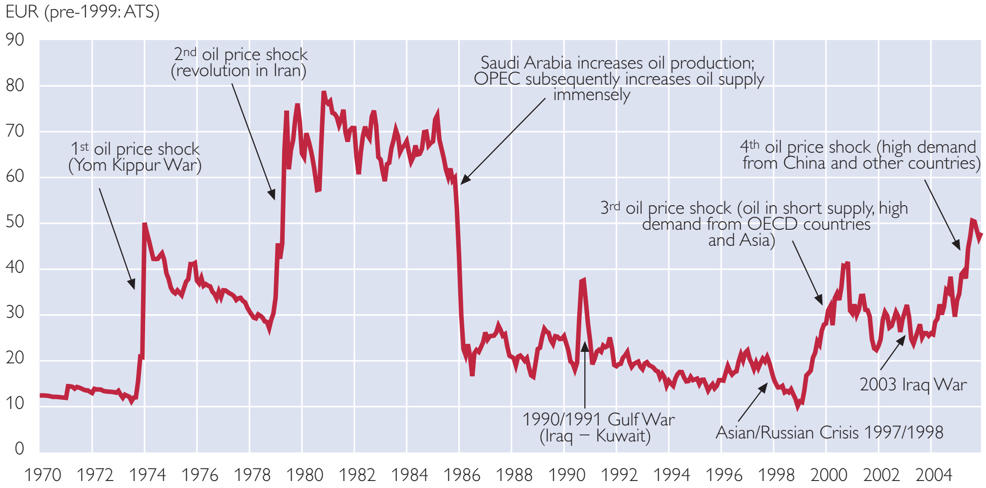
Chart 1

Real Price of Crude Oil in Austria

Real values calculated using the Austrian consumer price index (base value: December 2005)



Source: WIFO, Thomson Financial, OeNB.

The future of oil markets will be marked by growing regional imbalances: While the International Energy Agency (IEA, 2005) forecasts that demand for oil in OECD countries will continue to rise slowly until the year 2030, the supply of oil from that region will shrink steadily. Whereas European OECD countries were able to cover some 41% of their oil demand themselves in 2004 (mainly with oil from the North Sea), this coverage level will plummet to approximately 15% by the year 2030. In many emerging market economies (especially in Asia), the gap between oil supply and demand will also widen owing to markedly rising demand coupled with largely stagnant or shrinking production. Therefore, global dependence on major oil producers in the Organization of the Petroleum Exporting Countries (OPEC)[4] and the Commonwealth of Independent States (CIS)[5] will increase. Africa and Latin America (in particular Venezuela and Brazil) will also step up oil production. In the long term, non-conventional oil (e.g. tar sands in Canada) will gain greater importance. These growing regional imbalances will substantially intensify oil (and natural gas) trade among the regions of the world. The world's increasing dependence on crude oil from regions which are sometimes prone to crisis could point to persistently volatile oil prices.

[4] *Algeria, Indonesia, Iran, Iraq, Kuwait, Libya, Nigeria, Qatar, Saudi Arabia, United Arab Emirates, Venezuela.*
[5] *Armenia, Azerbaijan, Belarus, Georgia, Kazakhstan, Kyrgyzstan, Moldova, Russia, Tajikistan, Turkmenistan, Ukraine, Uzbekistan.*

Table 1

Global Oil Supply and Demand

	2004		2030		2004 to 2030[1]	
	Demand	Supply	Demand	Supply	Demand	Supply
	Millions of barrels (Brent) per day				%	
OECD	47.6	20.2	55.1	13.5	0.6	–1.5
OECD North America	24.9	13.6	30.6	10.8	0.8	–0.9
OECD Europe	14.5	6.0	15.7	2.3	0.3	–3.7
OECD Pacific	8.3	0.6	8.8	0.4	0.3	–1.4
Transition Economies (including Russia)	4.4	11.4	6.2	16.4	1.3	1.4
Developing Countries	27.0	15.2	50.9	16.3	2.5	0.3
China	6.2	3.5	13.1	2.4	2.9	–1.5
India	2.6	0.8	5.2	0.6	2.8	–1.2
Rest of Asia	5.4	1.9	9.9	1.3	2.3	–1.7
Latin America	4.7	3.8	7.5	6.1	1.9	1.8
Africa	2.6	3.3	5.7	4.7	3.0	1.4
OPEC	×	32.3	×	57.2	×	2.2
Non-conventional oil	×	2.2	×	10.2	×	6.1
World	82.1	82.1	115.4	115.4	1.3	1.3

Source: International Energy Agency.
[1] *Average annual growth.*

Refineries play a key role in pricing petroleum products such as gasoline and diesel fuel. Demand for higher-quality petroleum products (which has increased markedly in recent years) as well as persistently low levels of investment in refineries in the past (owing to relatively small profit margins at that time) have brought about diminished surplus capacities, low flexibility in production, as well as rising margins and prices for petroleum products. This can lead to substantial price hikes, especially in the case of unexpected refinery downtime (e.g. due to hurricanes in the U.S.A. or geopolitical events).

The worldwide capacity utilization of around 85% in the refining sector (2004) will probably remain at this high level until increased investments in refineries will help to mitigate the problem of refinery bottlenecks toward the end of this decade (IEA, 2005). This expansion of surplus capacity is only expected in the medium to long term for various reasons, such as higher environmental standards for refineries, rising demand for higher-quality petroleum products and the tendency of crude oil supplies (especially from the Middle East) to be heavier and have a higher sulphur content. This makes investments technically more complex and cost-intensive, as well as delaying them. Business-related uncertainties regarding the future profit margins of refineries are also making investors wary.

However, the future development of refinery investments will not only have an impact on profit margins for petroleum products, it will also affect the price of crude oil itself. On the one hand, the increasing demand for higher-quality petroleum products is accompanied by rising demand for light, higher-quality crude oils (such as Brent or West Texas Intermediate) which are easier to refine, and on the other hand it places increasing demands on refining technology, as more sophisticated refineries can produce high-quality petroleum products from all types of crude oil more efficiently. When the capacity available at modern, sophisticated refineries is low, this results in disproportionately high increases in demand and rising crude oil prices, especially for high-quality crude oils.

The IEA (2005) estimates that investments of nearly USD 500 billion will be necessary in the refining sector between 2004 and 2030; almost half of this amount would have to be invested by 2010 in order to upgrade existing refinery facilities and expand capacity to meet increasing demand. The largest investments are expected in emerging market economies (especially China), in the Middle East and in North America.

According to the IEA, the following trends in primary energy demands (oil, natural gas, hydropower, etc.) can be identified for the period leading up to 2030:

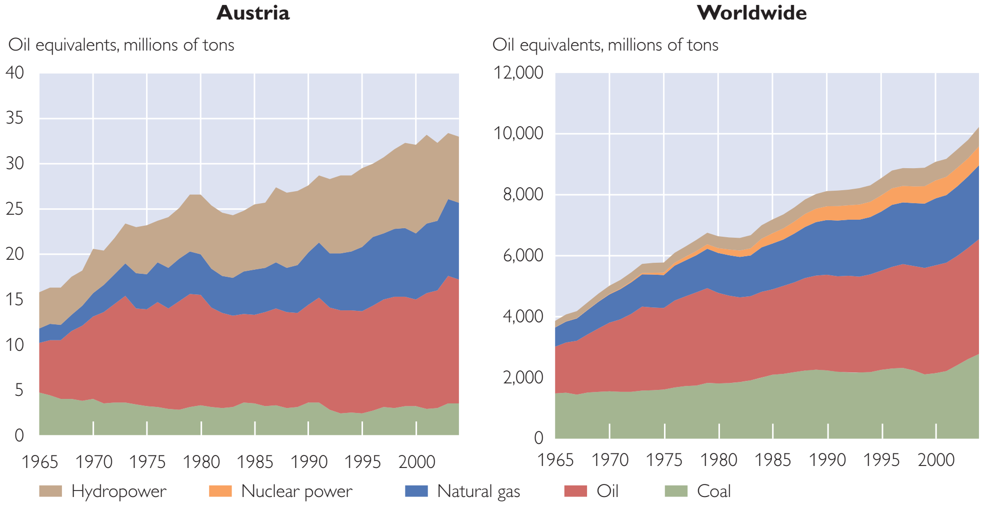
– Worldwide primary energy needs are predicted to continue rising by approximately 1.6% per year, with the demand for renewable energy forms[6] (especially considering their very low current basis) and for natural gas increasing most sharply. Oil will remain the main source of energy, and coal will only lose its place to natural gas as the second most important energy source by the end of the forecast period. The demand for hydropower is predicted to grow somewhat faster than global primary energy needs, while demand for energy from biomass and waste incineration will be somewhat weaker.
– The currently known and proven oil reserves exceed the oil demand forecast by the IEA until the year 2030. This surplus is even larger for known natural gas reserves. Nevertheless, significant investments will be necessary in the overall energy sector (IEA estimate: USD 17 trillion by 2030) in order to cover expanding energy requirements. While investments in OECD countries will mainly target the electricity and natural gas sectors, the largest investments in the oil sector can be expected in Asia (especially China), the Middle East, CIS countries as well as Latin America and Africa.

Regional differences in the composition of primary energy needs can be quite pronounced. For example, Austria shows a large share of hydropower, which is linked to the country's topography and abundant water resources. In contrast, the share of coal used in Austria remains stagnant at a low level. Oil and natural gas dominate primary energy needs worldwide – and in Austria – and are still gaining in importance.

[6] *Including geothermal, solar and wind energy.*

Chart 2

Consumption by Product



Source: BP Statistical Review of World Energy, June 2005.

The development of consumer prices for energy is significantly impacted by the factors mentioned above and in particular by national factors such as economic structures, tax systems and legal frameworks.

Energy intensity, which is an important factor in oil dependence, has exhibited a downward trend in OECD countries since the first oil price shock.[7] Within the OECD, there are relatively large (albeit decreasing) differences in energy intensity which can mainly be attributed to differing climatic conditions, (production) structures and incentive systems (e.g. taxes). Austria's energy intensity is relatively low, but – against the overall trend in the EU – it has increased since the 1990s.

Table 2

Energy Intensity of the Economy

Gross domestic consumption of energy as a share of GDP (at constant prices, 1995 = 100)

kg of oil equivalents per EUR 1,000

	AT	DE	IT	CZ	SK	HU	SI	EU-25	EU-12	US	JP
1993	146.44	183.36	193.92	1,134.12	1,289.74	758.84	391.39	239.89	203.62	381.52	117.11
2003	150.53	159.50	192.61	889.59	937.33	581.99	338.14	209.49	188.18	313.83	118.61
% change	+2.8	–13.0	–0.7	–21.6	–27.3	–23.3	–13.6	–12.7	–7.6	–17.7	+1.3

Source: Eurostat.

7 *In recent years, energy productivity has not made a great deal of progress in certain countries; Austria's energy intensity has even increased. To date, this development has only been researched to a limited extent.*

2 Considerable Differences in the Reactions of Motor Fuel and Heating Oil Prices to Crude Oil Prices Across EU Countries

2.1 Prices of Petroleum Products Show Only Partial and Delayed Reactions to Crude Oil Price Fluctuations

The development of crude oil prices is only transmitted in part and with a time lag to the prices of petroleum products such as gasoline, diesel or heating oil. The extent and speed of transmission varies from product to product and from country to country over time.

In general, the selling price of petroleum products consists of input costs (material input, labor and other production costs) and a profit markup. Input costs explain a majority of product-specific price differences. In the case of gasoline, the share of costs which can be attributed to crude oil (relative to other production costs) is lower than in the case of diesel or heating oil. Therefore, gasoline prices should be less sensitive to developments in crude oil prices. Bottlenecks in refinery capacities can accelerate the speed at which price fluctuations are transmitted. In view of internal production and sophisticated stock management, the daily spot prices of crude oil do not represent the actual operating costs of motor fuel or heating oil production. However, the raw materials costs are passed on quickly, as they serve as an indicator of future costs.

The intensity of competition in the energy sector as well as location factors (such as transport costs or commissions for filling station operators) determine the profit markup and can be responsible for product-specific as well as regional price differences. The higher the competitive pressure, the lower the extent to which oil price increases can be passed on to consumer prices, which reduces markups. A large share of non-oil components in the retail price of a petroleum product means that an increase in the final product's price in response to a rise in the crude oil price is lower than that of the raw material. Similarly, volume-based excise taxes (which are not proportional to the price) also dampen fluctuations in the retail prices of petroleum products.

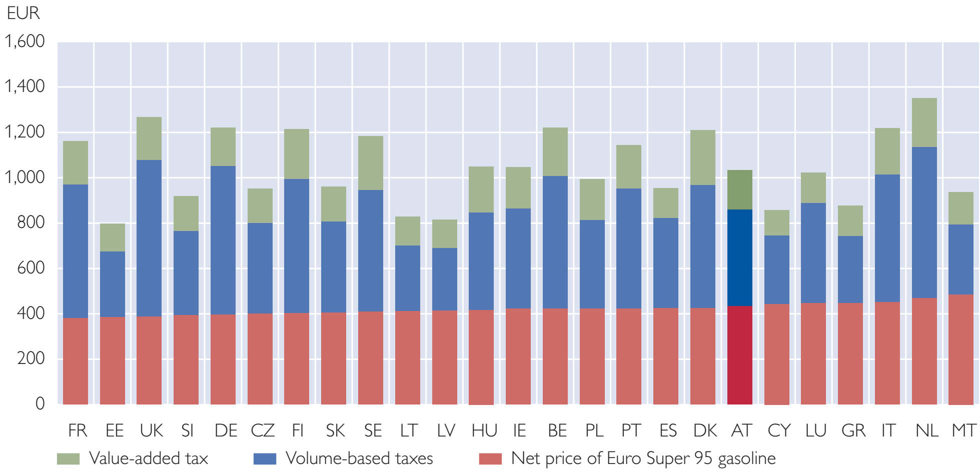
2.2 National Taxation Creates Differences in Retail Prices of Petroleum Products within the EU

This section presents an investigation of how strongly and quickly the prices of petroleum products in EU countries react to developments in crude oil prices on the basis of price data for gasoline, diesel and heating oil. This study is based on European Commission data collected from EU-15 countries on a weekly basis since the mid-1990s using a largely comparable method; for the new EU Member States, these figures are available from mid-2004 onward. Data are available on energy prices both including and excluding taxes.

Chart 3

Components of Gasoline Prices in the EU-25

Prices of 1,000 liters Euro Super 95 gasoline on average in 2005



Source: European Commission Oil Bulletin.

The net prices of Euro Super 95 gasoline are fairly homogeneous across EU countries (see chart 3). However, the deviations in gross prices are considerable. In France, Finland, Germany and the United Kingdom, energy taxes accounted for more than 67% of gross gasoline prices on average in 2005, whereas in Malta and Cyprus this share was only 48%. In general, the tax burden is especially low in the new EU Member States as well as in Greece and Spain. With taxes accounting for 58% of the price, Austria is slightly below EU-25 average.[8] In all countries, volume-based taxes account for the largest share of energy taxes.[9] The net gasoline price in Austria is rather high compared with the EU-25, but as a result of the country's relatively low motor fuel taxation, the gross prices are average compared with the other EU countries and thus slightly higher than in Austria's neighboring countries in Central Europe. A study by the oil brokers and consultants PVM (2005) identifies the following main reasons for the fact that the net gasoline price in Austria is in the top third of the EU-25 range: a relatively high concentration on the filling station market, legal restrictions such as the Trade Code (Gewerbeordnung, regulations on small business and trade) and comparatively strict environmental requirements (which both make filling stations more expensive to operate) as well as Austria's rather unfavorable location in terms of logistics (hardly any pipelines, low significance of transport by ship). Puwein and Wüger (1999) see location factors as partly responsible, but mainly regard competition – which focuses less on prices than on advertising, service quality, product design and new products – as the decisive pricing factor in Austria.

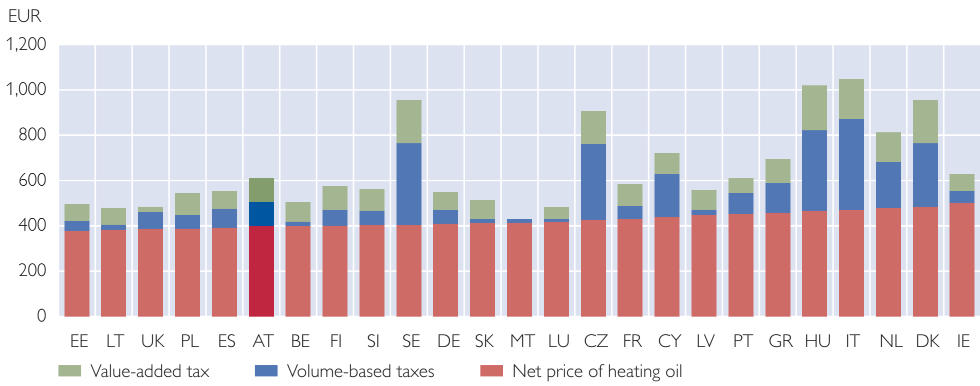
[8] *EU-25: 59% (unweighted average of national tax shares in gross gasoline prices).*

[9] *On the basis of the available data, the conjecture that higher taxation goes hand in hand with lower net prices (and vice versa) cannot be confirmed empirically in a country comparison for motor fuels or heating oil.*

Chart 4

Components of Heating Oil Prices in the EU-25

Prices of 1,000 liters of heating oil on average in 2005



Source: European Commission Oil Bulletin.

In the case of diesel, the situation is similar to that of gasoline: The tax share in the overall price is generally lower, but volume-based taxes account for the bulk of the price in this case as well. Net prices for diesel in Austria are again in the top third of the EU-25. The situation is different for heating oil: The EU-25 countries apply a wide range of reduced value-added tax (VAT) rates and lower duties to heating oil (see chart 4). For example, the VAT rate in Malta is 0%, and volume-based taxes are minimal in Luxembourg. In other countries, such as Italy, Hungary or the Czech Republic, the taxation of heating oil is quite similar to that of diesel. In Greece, the volume-based tax is approximately 50% higher in the summer months than in the winter. The net price of heating oil in Austria is very low, while the price including taxes is close to the EU average.

2.3 Heating Oil Prices React More Strongly to Oil Price Fluctuations than Diesel and Gasoline Prices

Our estimation of the long-term elasticities of motor fuel or heating oil prices to developments in crude oil prices is based on net prices. In the model used, the percentage changes in motor fuel and heating oil prices depend on their past rates of change, current and past rates of growth in the crude oil price as well as deviations from the long-run equilibrium.[10]

On the one hand, the estimation results reveal the long-term elasticity of motor fuel and heating oil prices in response to developments in crude oil prices. A value of 0.9, for example, means that an increase in the crude oil price by 1% will bring about a long-term rise of 0.9% in a country's motor fuel or heating oil price. In other

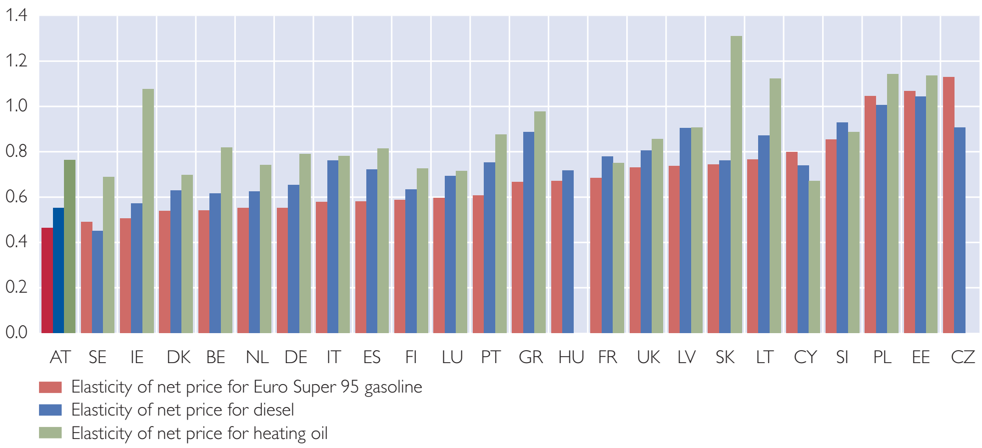
[10] *The model used is an autoregressive distributed lag model with an error-correction mechanism:* $\Delta p_{it} = \lambda_{i0} + \delta_i (p_{it-1} - \theta_i o_{t-1}) + \sum_{k=1}^{P} \beta_{ik} \Delta p_{it-k} + \sum_{k=0}^{Q} \varphi_{ik} \Delta o_{t-k} + \varepsilon_{it}$ *where* p_{it} *denotes the log of motor fuel or heating oil price,* o_t *is the log of crude oil price, and* ε_{it} *is an uncorrelated error term. The subindex* i *stands for the various crude oil products (gasoline, diesel and heating oil). The long-term elasticity of fuel and heating oil prices in response to developments in crude oil prices is* θ*, and* $-\delta$ *represents the speed of adjustment to the long-run equilibrium* $(p_{it-1} - \theta_i o_{t-1})$*.*$\theta$ *is estimated using a Bewley transformation (Bewley, 1979).*

words, 90% of the crude oil price increase is passed on to the final consumer. On the other hand, the results also indicate how quickly the motor fuel or heating oil price approaches the long-run equilibrium after a deviation. For instance, a value of –0.1 implies that the deviation from the long-run equilibrium is reduced by 10% per period (in this case per week).

The model is estimated separately for each EU country and each of the petroleum products in our sample. In almost all countries, the long-term elasticity of heating oil prices is highest, followed by the prices of diesel and Euro Super 95 gasoline (see chart 5).[11] Therefore, the elasticity is lowest for high-quality petroleum products, as crude oil accounts for a smaller share of their cost structure.[12]

Chart 5

Long-Term Elasticity of Net Prices for Euro Super 95 Gasoline, Diesel and Heating Oil to Changes in the Crude Oil Price (EU-25)



Source: European Commission Oil Bulletin, OeNB.

The elasticities tend to be especially high in the new EU Member States and in Portugal, Greece and – in the case of heating oil – Ireland. Different elasticities of energy prices to developments in crude oil prices may well be linked to location factors and varying regulatory regimes or the intensity of competition. However, the elasticity estimates for the new EU Member States should be interpreted with caution, as data on these countries have only been available since May 2004, and even in that period the weekly collection frequency was not always completely observed. This particular period has also been characterized by drastic increases in energy

[11] *Malta is not shown in the chart because price data have only been collected for that country three times since mid-2004.*

[12] *As is evident in chart 5, some countries show estimated elasticities above unity for certain petroleum products. This means that more than 100% of a change in crude oil prices is transmitted to the net prices of petroleum products. One explanation for such a scenario is presented in a Working Paper by National Resources Canada (2005). Its authors maintain that refineries cannot produce one barrel of gasoline directly from one barrel of crude oil because the production process generates numerous lower-quality byproducts (e.g. heavy fuel oil) which have to be sold at discounted prices. The refineries attempt to recover the losses incurred here by charging higher prices for gasoline, diesel and heating oil. In our sample, however, a t-test shows that the estimated elasticities do not deviate significantly from 1 in any of these cases.*

prices, which could also lead to biased results. If price reactions are asymmetric (i.e. different for increases in crude oil prices than for decreases), then a sample which is not representative over the long term can produce distorted results. These asymmetries in price adjustment are discussed in greater detail below. Last but not least, the new EU Member States have also exhibited dynamic economic growth. In stages of rapid growth, increases in input prices can be passed on to the final consumer more easily and rapidly. The catching-up process can, however, hardly be responsible for the high elasticity because – as shown in charts 3 and 4 – the net prices of motor fuels and heating oil are not systematically lower in the new Member States than in other EU countries.

2.4 Country Differences in the Speed of Price Adjustments Point to Low Market Integration

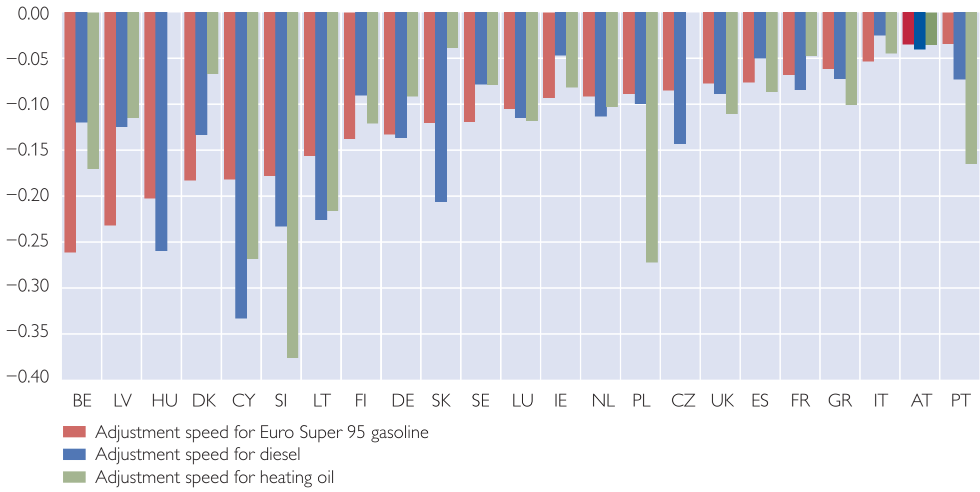
The new EU Member States also stand out in terms of their high adjustment speed to the long-run equilibrium (see chart 6); however, the above-mentioned qualifications regarding the short period of data availability still apply. The estimated speed of adjustment parameters exhibit very large differences among EU countries. In connection with the substantial price differences discussed above, we can regard this as another indication of these markets' low level of integration in the EU.

Austria's elasticity and adjustment speed are among the lowest by international comparison. At 0.46 for super gasoline and 0.55 for diesel, however, these elasticity estimates for Austria are markedly higher than those found by Puwein and Wüger (1999), who estimate the elasticities at around 0.3. The low elasticity and speed of adjustment in Austria, which are presumably linked to the temporary contraction/expansion of margins on the Austrian filling station market, may also be affected by the relatively high level of concentration on this market. According to PVM (2005), the four major chains of filling stations in Austria controlled almost 60% of the market in 2004, indicating that the concentration on this market "borders on a tight oligopoly".[13] At the same time, the menu costs can probably be disregarded as a justification for slow price adjustments: Price changes at filling stations have even been observed multiple times in a single day. As stock levels in Austria are relatively low compared with those of its neighboring countries (PVM, 2005), these stocks probably cannot serve as a buffer for price adjustments either.

[13] *Puwein and Wüger (1999) mention a "dominant oligopoly".*

Chart 6

Speed of Adjustment to Long-Run Equilibrium for Net Prices of Euro Super 95 Gasoline, Diesel and Heating Oil in the EU-25



Source: European Commission Oil Bulletin, OeNB.

2.5 Asymmetric Price Reactions to Increases and Decreases in Oil Prices as an Indicator of Pricing Latitude

One possible explanation for differences among various countries in both estimated elasticities and speed of adjustment parameters is the intensity of competition on petroleum product markets. The link between crude oil prices and those of petroleum products can be asymmetric. If competition on energy markets is intense, then retailers will lower motor fuel and heating oil prices quickly when crude oil prices fall. Likewise, under intense competition, an increase in crude oil prices will be absorbed in the short term by squeezing the (already tight) profit margins and delaying a hike in final retail prices. In this scenario, the downward adjustment speed is faster than its upward counterpart. If competition is weak, however, retailers can temporarily expand their profit margins when oil prices drop, while preventing margins from contracting temporarily when oil prices rise. In such cases, the speed of adjustment for an increase in crude oil prices is higher than for a decrease.

Box 1

Asymmetric Pricing Behavior on Motor Fuel Markets[14]

Why do motor fuel prices react more quickly or to a greater extent when crude oil prices rise than when they decline? In principle, prices should react symmetrically on competitive markets without distortions. However, menu costs and the definition of accounting valuation rules (e.g. LIFO or FIFO procedures) can delay price adjustments even in the case of perfect competition.

Most theoretical arguments for asymmetric pricing behavior are based on the market power of individual retailers. In this context, companies try to preserve their profit margins when prices increase and to retain the additional profits (at least temporarily) when prices decrease. On the one hand, this may be possible because comparing prices is time-consuming and cost-intensive for the consumer, so that competitive conditions are not restored until the end of the comparison stage.

On the other hand, such a situation can arise when a group of companies tacitly agree to maintain stable profit margins. When prices rise, the companies will then quickly pass on the increases in input prices, as delaying their reaction might signal a breach of the tacit agreement. When input prices decline, however, these companies will pass on the savings to the consumer as late as possible to avoid signalling that they are violating the agreement by narrowing their margins.

Another explanatory approach assumes that the refineries wish to keep production stable whenever possible. However, if the crude oil supply suddenly contracts, the refineries have to curtail production, thus causing gasoline prices to rise rapidly. In the reverse case, production would only be stepped up slowly and prices would only decline with a delay.

Galeotti et al. (2001) provide an overview of empirical investigations on asymmetries in pricing behavior. Most studies address the motor fuel markets in the U.S.A. and the United Kingdom, while a few works also deal with other European countries and Canada. They differ greatly in terms of methodology, statistical approaches, the time periods they cover and the type of asymmetries they address (adjustment speed, short-term and long-term elasticity). The studies also focus on different stages of the transmission process (i.e. from crude oil prices to refinery prices, from refinery prices to final consumer prices or the entire chain). The results of these studies are also highly varied.

Bacon (1991) and Manning (1991) find signs of asymmetric price reactions on the British motor fuel markets. Price increases are passed on more quickly and to a greater extent than price reductions. Similar findings are reached by Karrenbrock (1991), Duffy-Deno (1996) and Borenstein et al. (1997) for the U.S.A., by Lanza (1991) for Germany and by Galeotti et al. (2001) for five large EU countries. In contrast, Kirchgässner and Kübler (1992) find more rapid adjustments to falling input prices in Germany. The findings in Shin (1994) for the U.S.A. and in Berardi et al. (2000) for Italy provide no indications of asymmetries at all.

2.6 No Asymmetric Price Reactions to Rising/Falling Oil Prices in Austria

The hypothesis of asymmetric pricing behavior can be tested using our weekly data set on motor fuel and heating oil prices. Once again, we focus on net prices here, as companies only have direct control over this price component. We repeated the previously described regression analysis for EU-15 countries,[15] now drawing a distinction between the situations of rising and falling crude oil prices.[16]

[14] *For a more detailed summary of theoretical arguments, see Balke et al. (1998) or Galeotti et al. (2001).*

[15] *The new EU Member States are not investigated here, as the available data only go back to May 2004 and this period is almost exclusively characterized by rising crude oil prices.*

[16] *Specifically, the hypothesis of an asymmetric adjustment speed is tested on the basis of the following specification:* $\Delta p_{it} = \lambda_{i0} + \delta_{i1}(p_{it-1} - \theta_i o_{t-1}) I(\Delta o_{t-1} \leq 0) + \delta_{i2}(p_{it-1} - \theta_i o_{t-1}) I(\Delta o_{t-1} > 0) + \sum_{k=1}^{P} \beta_{ik} \Delta p_{it-k} + \sum_{k=0}^{Q} \varphi_{ik} \Delta o_{t-k} + \varepsilon_{it}$ *where the parameters for decreases in the crude oil price are associated with subindex 1 and those for increases are associated with subindex 2. If* $\delta_{i1} = \delta_{i2}$ *cannot be rejected using an F-test, the model is considered symmetric.*

In Belgium, Germany and Sweden, gasoline prices respond to crude oil prices significantly faster when oil prices rise than when they fall. The same pattern can be identified for diesel prices in Ireland. On these markets, competition may not be sufficiently developed in order to ensure symmetric pricing behavior. The differences in adjustment speed are statistically significant at the ten percent level, but they are extremely low (0.2% to 0.3%) and thus bear little economic relevance. In Finland, by contrast, decreases in crude oil prices are passed on to motor fuel consumers more quickly than increases. The difference is also very small in this case (approximately 0.2%). In Austria, there is no significant difference between the speed of adjustment to the long-run equilibrium in the case of rising and falling crude oil prices.[17]

3 Oil Price as Varied Impact on Other Energy Prices

Oil prices can also affect the prices of other forms of energy. This is possible through multiple channels.

Electricity, for example, is produced in part by means of oil or natural gas combustion, with vast differences among countries with regard to the share of electricity produced in this way. The price of oil thus affects the electricity price via production costs. Another channel is transport costs, which depend on oil prices and therefore affect the prices of solid fuels such as coal and wood.

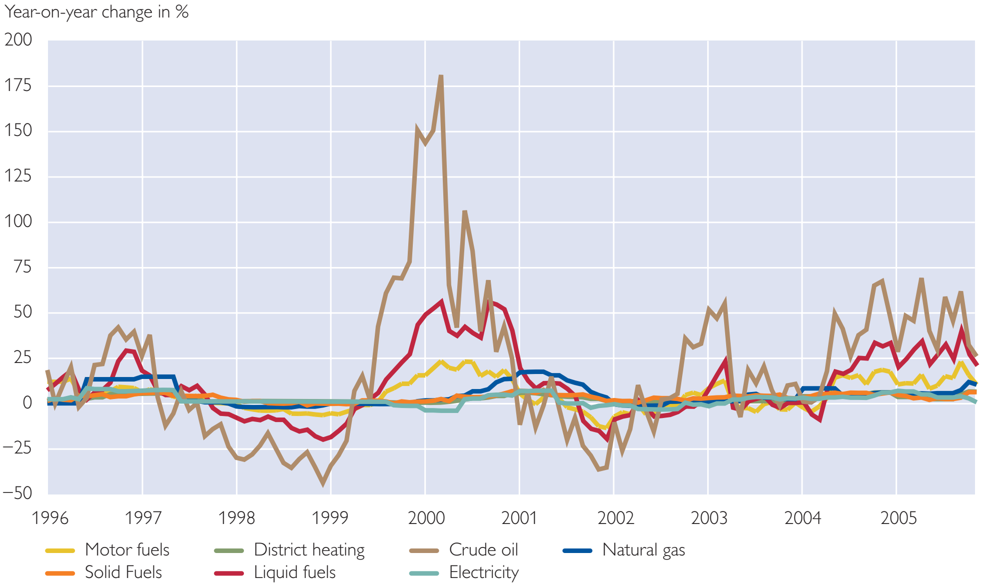
A third transmission channel arises in the possibility of substituting different energy sources. When oil becomes more expensive, other forms of energy become more attractive, which can increase demand for these forms of energy. Thus, crude oil prices can affect the prices of other energy sources, depending on how fierce competition is in these energy markets and how elastic the supply of these energy forms is in the short term. Natural gas was originally exploited in combination with oil and therefore has traditionally had a close connection with oil prices; in fact, many long-term supply contracts stipulate (partial) indexation of natural gas prices to oil prices, meaning that natural gas prices follow fluctuations in oil prices with a certain time lag.

However, it is also conceivable that a high oil price will help spur the advance of alternative energy sources by enabling them to reach lower, more competitive prices through technological innovation and mass production. In this special case, a negative price link between the oil price and that of alternative energy would also be thinkable in the medium to long term.

[17] *Using a different definition of asymmetry, PVM Vienna (2005) concludes that there are certain asymmetries in pricing behavior on the Austrian motor fuel markets. According to the PVM study, price decreases are passed on more quickly than increases in the case of diesel, which would indicate a high degree of competition among petroleum companies. No asymmetries were found for gasoline. Owing to the fundamentally different definition used in that study, however, its results are not directly comparable with the findings of this study.*

Chart 7

Energy Prices in Austria



Source: Statistics Austria, Thomson Financial.

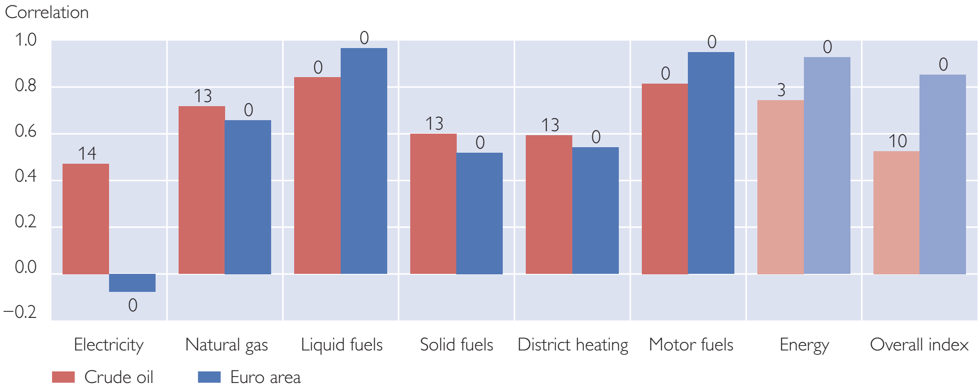
As shown in the rates of change in the subindices of the Harmonized Index of Consumer Prices (HICP) for various forms of energy compared with the development of crude oil prices (chart 7), the prices of liquid fuels and motor fuels are closely linked to the price of oil. As presumed, the price of natural gas tracks the crude oil price with a muted effect and a clear time lag. The prices of district heating, electricity and solid fuels only react relatively weakly to oil prices.[18]

For each energy subindex, the overall energy index and the HICP, chart 8 shows the relationship between annual inflation rates and the annual growth rate of crude oil prices, as well as the connection between annual inflation rates in Austria and annual inflation rates of the same index in the euro area. The prices of liquid fuels and motor fuels move very closely and largely simultaneously with the crude oil price (surveyed in the same monthly consumer price index). Natural gas and (to a lesser extent) solid fuels, district heating and electricity track the crude oil price with a delay of just over one year. The overall energy index shows a relatively high level of dependence on oil prices with a delay of one quarter.

[18] *In the EU, the lagged price fluctuations of natural gas are on average more pronounced. Similarly, the price index for district heating across the EU shows a largely similar development to that of natural gas, which points to different production sources and contractual price clauses to the ones in Austria.*

Chart 8

Correlation of Changes in Austria's HICP Subindices for Energy to Changes in Crude Oil Prices and HICP Subindices for Energy in the Euro Area



Source: OeNB.

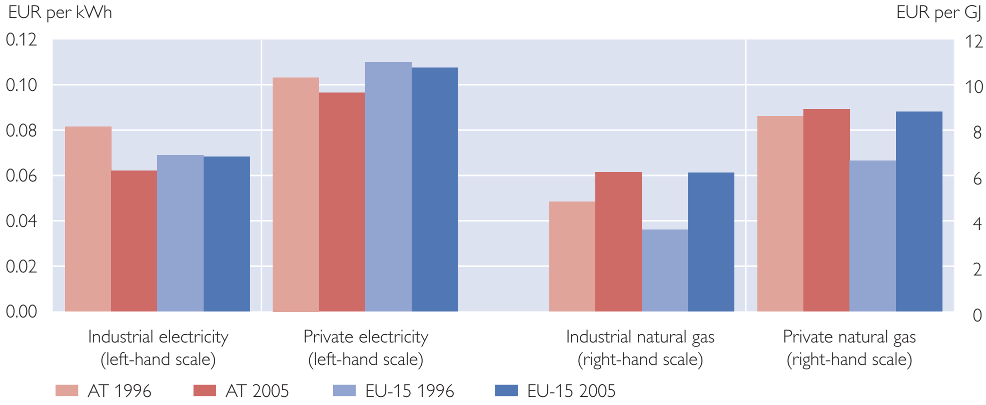
Note: The figures above the bars indicate the time lag in months for which the correlation coefficient is shown; in each case, the time lag with the highest correlation coefficient for the period January 1996 to November 2005 was selected.

The correlation between price developments in Austria and the average for euro area countries is very high (close to 1) for liquid fuels and motor fuels, followed by markedly weaker correlations for natural gas, district heating and solid fuels. While in the latter two cases this can be explained by transport costs and a possibly greater weight of biomass and wood products in Austria, the relatively moderate price link for the highly standardized product of natural gas reflects the continued existence of pricing latitude in this market segment and/or tax changes in individual countries over time. It is conspicuous that electricity prices in Austria show no connection to the (highly heterogeneous) electricity prices in other euro area countries. This may reflect the different energy sources used to generate electricity (i.e. the large share of hydropower in Austria) as well as the continued existence of national market segmentations.

A 10-year comparison of electricity and natural gas prices in Austria and the EU yields interesting results. Whereas the price of crude oil more than doubled in the period from January 1, 1996, to January 1, 2005, from just over USD 20 per barrel of Brent to more than USD 50, natural gas prices only rose slightly and electricity prices even declined (see chart 9).

Chart 9

10-Year Comparison of Electricity and Natural Gas Prices in Austria and the EU



Source: Eurostat.

Note: All prices shown without taxes.

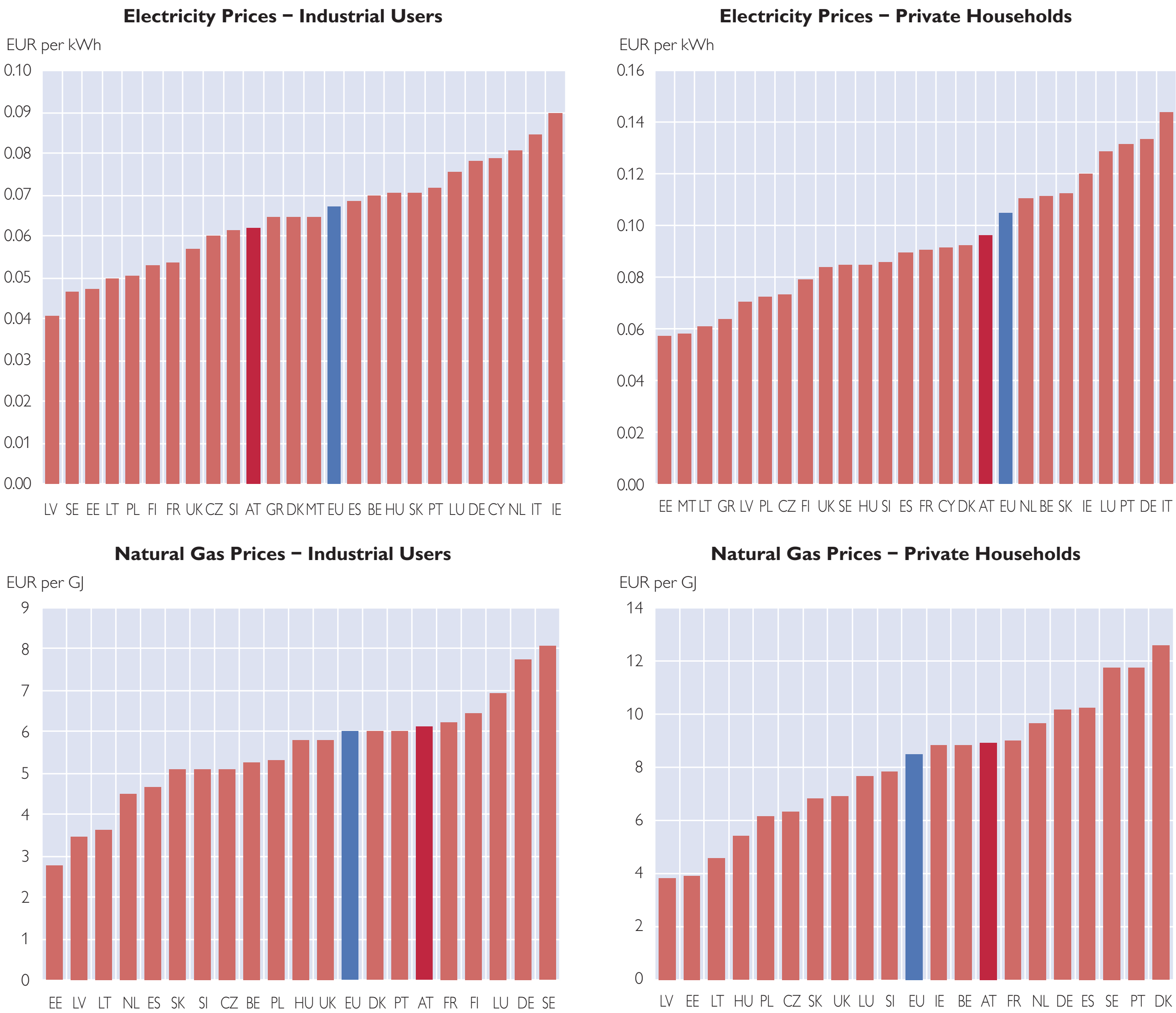
The decline in electricity prices in Austria was more distinct, while the increase in natural gas prices was lower compared with the EU-15. The liberalization of Austria's electricity market was especially favorable for industrial customers: While industrial electricity prices were far higher than the EU-15 average in 1996, they were markedly lower in 2005. Private electricity consumers in Austria have also benefited from prices falling below the EU-15 average. Natural gas prices for both industrial and private customers were well above the EU average in 1996. By 2005, however, Austria's natural gas providers had absorbed the effects of increases in international oil and natural gas prices to such an extent that natural gas prices in Austria and the EU were roughly at the same level. This favorable development in Austria may well be attributed to changes in the suppliers' pricing behavior owing to liberalization in network industries. Austria fully liberalized its electricity and natural gas markets in 2001 and 2002, ahead of the schedule prescribed by the EU.[19] As Kratena (2004) shows, the effects of liberalization offset the upward price pressure created by regulations, premiums and taxes on electricity and natural gas introduced in 1999.

Natural gas and electricity prices still show marked differences among EU countries (see chart 10). The highest price level is 2 to 2½ times the lowest price for electricity, and 3 times the lowest price for natural gas. Especially in several new EU Member States the price of natural gas for both industrial and private customers is as low as half the price in Austria, and electricity prices in some countries are more than one third lower than in Austria. In the countries with high prices, electricity is as much as 50% more expensive, and the price of natural gas is around one third higher than in Austria.

[19] *For more detailed information, see also Fluch and Rumler (2005) as well as Janger (2005).*

Chart 10

Electricity and Natural Gas Prices (EU Comparison) as of January 1, 2005



Source: Eurostat, Key indicators on EU policy – structural indicators.

Note: All prices shown without taxes.

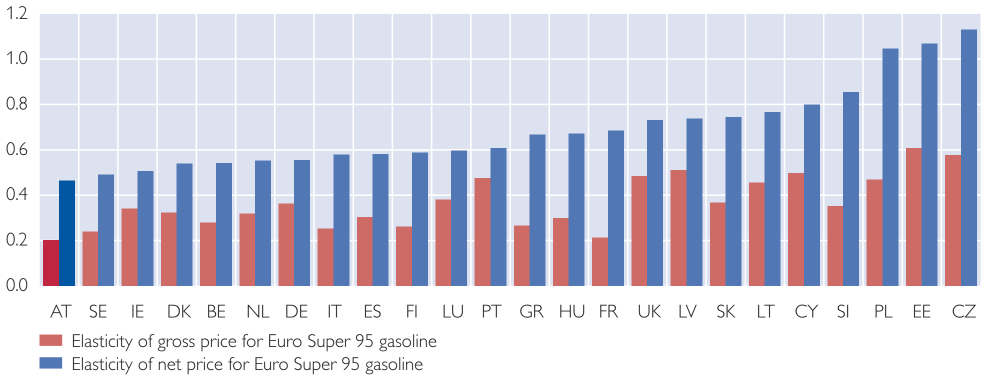
4 Energy Prices, Taxes and Government Policies

In many countries, energy is subject to high taxation. In addition to VAT, which is charged as a percentage of the price, most countries also levy volume-based taxes (such as the mineral oil tax in Austria). Energy taxes can pursue multiple goals: to generate tax revenues for the general budget, to collect at least partly consumption-based charges for transport activities, to cover part of the negative externalities (such as noise, exhaust, dangers) created by transport, to provide incentives to conserve energy and to finance the development of innovative, environmentally friendly forms of energy as well as means of public transportation. Energy taxes are also credited with the advantage of low administrative collection expenses, and – given certain government revenue requirements – their collection also makes it possible to reduce other, possibly more distorting taxes.[20]

Moreover, volume-based taxes dampen the percentage reaction of the relevant energy prices in response to oil price increases, as the fixed tax component is not affected by changes in the price of crude oil. This price-dampening effect can be illustrated by a simple comparison of the elasticity of gross and net prices for Euro Super 95 gasoline. As shown in chart 3, volume-based taxes account for most of the taxation of super gasoline, but the differences among EU countries are considerable. As expected, chart 11 shows that the net price of super gasoline in all EU countries is far more elastic to the development of crude oil prices than the gross price. Within the EU-25, Austria's net and gross prices for Euro Super 95 exhibit the second-lowest elasticity to oil prices after Malta, which is a special case as a small island country.

Chart 11

Long-Term Elasticity of Gross and Net Prices for Euro Super 95 Gasoline to Changes in the Crude Oil Price (EU-25)



Source: European Commission Oil Bulletin, OeNB.

Given the current high in oil prices, there have been discussions as to whether governments should cushion the effects of high energy prices through special measures, not least because VAT revenues also rise with energy prices – at least in the short term and as long as the demand for energy is rather price-inelastic.[21] Such discussions have addressed topics such as reducing energy taxation, providing financial relief for the needy or for companies, as well as measures with longer-term effects to reduce oil dependence (e.g. increasing energy efficiency, faster and larger-scale exploration of alternative energy sources). In recent months, the governments of certain EU countries (in particular France and Belgium) have taken measures to cushion the increase in energy prices.[22]

[20] *For a detailed description of current transport taxes and their steering control effects, see Puwein (2005).*

[21] *In the medium term, however, higher energy prices have a dampening effect on energy demand and economic growth, which in turn reduces revenues from various excise taxes as well as income tax and profit-based taxes. The net effect of an increase in energy prices on tax revenues is therefore uncertain.*

[22] *Many developing countries with less developed market economies also intervene directly in motor fuel pricing by way of government price regulations or energy distribution monopolies.*

Such measures may seem enticing in the short term, especially as they mitigate the acute effects of energy inflation (i.e. reduced purchasing power, increased costs and dampened growth and employment). However, they also have a number of drawbacks:

- First of all, these measures place a burden on the fiscal budget – be it through lost revenues or subsidies expenditures – if they are not offset by other fiscal measures; this can have negative effects on the sustainability of government budgets and on growth and inflation expectations. The political economy of fiscal budget decision-making processes suggests that measures to cushion increases in oil prices would generally increase the budget deficit.
- Second, it is unclear at the outset whether the rise in oil prices is temporary or permanent. At present, a great deal of evidence points to the latter. In such a case, it would be desirable for the economy to adapt to the changed price situation quickly in order to avoid resource misallocations. Measures to cushion prices delay the desirable transition to energy-saving technologies and prolong an excessive dependence on oil. In the long term, economic growth as well as the rate of inflation would then be more susceptible to future oil price shocks.
- Third, if many countries cushion oil price increases with government measures, this will reduce the price-induced dampening of global demand for oil, thus encouraging oil-exporting countries to increase prices even further.

If oil prices are high over an extended period of time, economic actors will show adaptive responses (energy-saving measures, substitution with other energy sources) that can be actively supported by economic policy (as has often happened in the past), for example by introducing stricter thermal insulation regulations, subsidizing energy-saving measures, increasingly scaling motor vehicle taxation by fuel consumption, etc. In any case, such measures should be planned with careful consideration of their effects in the short and long term (reduction of oil dependence, ecological effects, budgetary effects, complex effects on growth and employment in the short to long term).

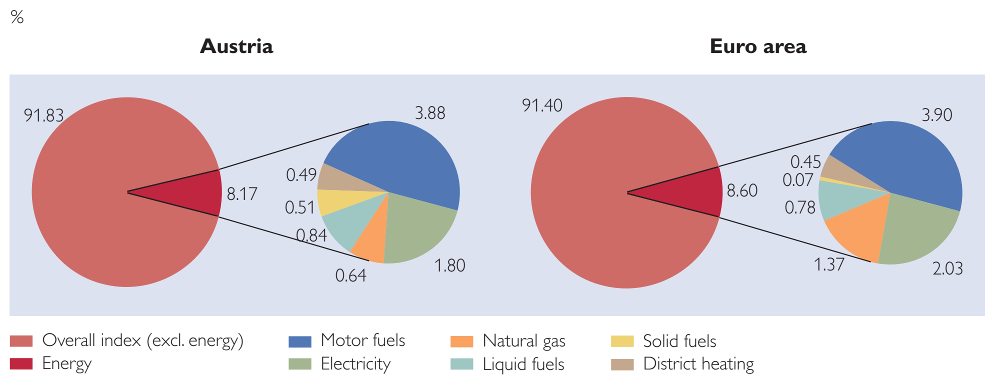
5 Oil Price Shock and HICP Inflation

A substantial part of the increased HICP inflation rate in Austria and the euro area in recent months can be attributed to energy prices. The HICP energy component (electricity, natural gas, liquid and solid fuels, heat energy as well as motor fuels and lubricants)[23] is assigned a weight of 8.17% in Austria's HICP and 8.60% in the HICP for the euro area (see chart 12).

[23] *The HICP does not include jet fuel, which depends heavily on oil prices and affects e.g. airline ticket prices.*

Chart 12

HICP Weights in 2005



Source: Eurostat.

Owing to the surge in this component, energy prices also have a strong effect on the overall HICP aggregate. Core inflation rates without energy prices have shown greater continuity.

In those countries where energy has shown especially drastic price increases since early 2002, the overall rate of inflation has also been high. In Austria, the inflation rate for energy prices as well as the overall rate of inflation were just below the EU average (see chart 13).

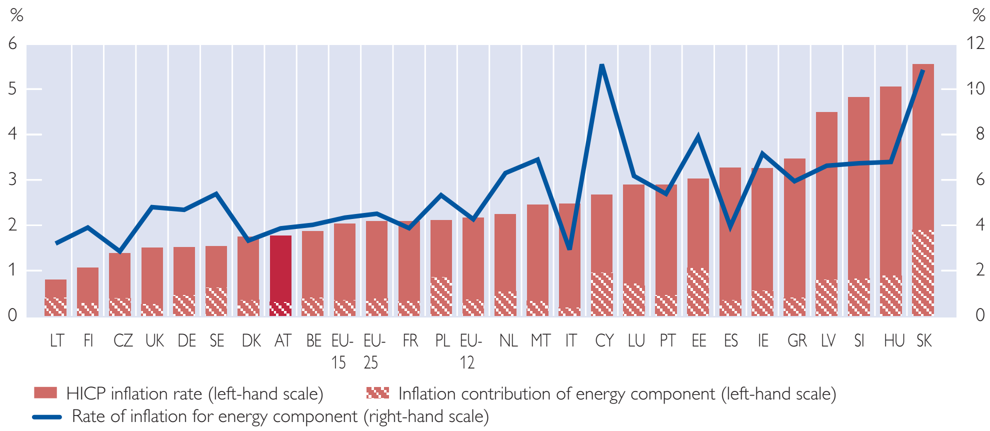
A comparison with the U.S.A. (chart 14) shows that the energy price component of the inflation rate has reacted to the increase in crude oil prices to a far greater extent than in the euro area and Austria. In principle, the development of the USD/EUR exchange rate could be of central importance here, but especially since 2004 the exchange rate has only played a minor role.

One of the main reasons for the stronger reaction of the energy price component is the markedly higher volatility of motor fuel prices in the U.S.A. compared with euro area countries; this can be put down to temporary regional events (e.g. natural disasters) and especially to the much lower level

Chart 13

Inflation Contribution of HICP Energy Component

Average from January 2002 to December 2005

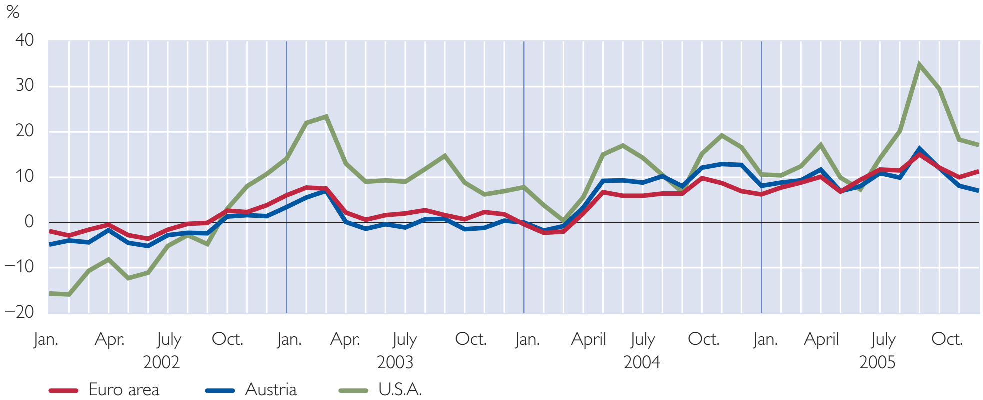


Source: Eurostat.

Chart 14

Energy Price Increases in the Euro Area, Austria and the U.S.A.

Annual rate of change of energy price component in HICP/CPI



Source: Eurostat, BLS.

of fixed, volume-based energy taxation in the U.S.A.[24] Moreover, natural gas and electricity markets in the U.S.A. are more competitive compared with those in euro area countries, and electrical power generation depends more heavily on combustion power plants (which account for 71% of overall electrical power generation in the U.S.A., compared with 52% in the euro area; IEA, 2005). Ultimately, this means that oil prices have a greater impact on consumer price inflation in the U.S.A. compared with the euro area, although the weights of motor fuel prices (approximately 4%) and the overall energy component (approximately 8%) are roughly the same in the U.S. Consumer Price Index as in euro area countries.

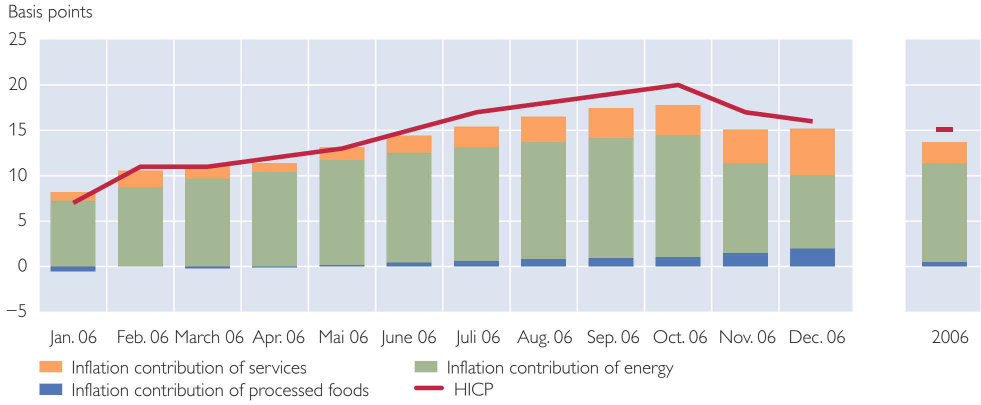
A simulation with the OeNB's short-term inflation forecasting model[25] shows that a 10% increase in the oil price in November 2005 would raise annual inflation for the energy component by 1.33 percentage points in 2006 and the inflation rates for processed foods and services by 0.05 percentage point each. Moreover, the model shows that – owing to delayed pass-through effects – an increase in the oil price would also continue to have effects far into the future. In the energy component, the inflationary effect would materialize more or less immediately, reach a peak after slightly less than one year and then begin to subside. For unprocessed foods and (to a lesser extent) services, the increase in oil prices would only bring about clear inflationary effects after approximately one year, but these effects would continue to intensify in the ensuing months. The effect on the overall HICP would reach its peak after nearly one year, and over the entire year 2006 Austria's rate of HICP inflation would climb by 0.15 percentage point as a result of the simulated shock.

[24] *The overall taxation of gasoline in the U.S.A. (including state taxes) is approximately 8 euro cents per liter, whereas taxes in euro area countries range from 40 to 65 euro cents per liter.*

[25] *The authors would like to thank Friedrich Fritzer for providing the simulation results.*

Chart 15

Effects of a 10% Increase in Oil Prices on the HICP and Its Subcomponents in Austria



Source: OeNB.

Note: In the simulation, oil prices in USD were raised by 10% starting in November 2005.

6 Summary and Conclusions

The latest oil price hike is mainly associated with robust world economic growth and surging demand for oil, especially in a number of emerging market economies (most notably China). In addition, further bottlenecks in crude oil production capacity may be expected to occur in the coming years. Therefore, *crude oil prices cannot be generally expected to decline markedly*. In addition, the future development of global supply and demand for oil will be characterized by increasing regional imbalances, which will intensify global oil trade – especially with OPEC, but also with CIS countries. Low refinery investments in the past have also diminished reserve capacities and sharply increased the susceptibility of world market prices for motor fuel and heating oil to natural disasters. In the next few years, very high investments will be necessary worldwide in order to cover the forecast continued growth in energy demands for oil and its derivative products as well as other forms of energy. With its large share of hydropower generation, Austria is in a more favorable situation; however, *Austria's dependence on oil and natural gas has also increased substantially* and continuously over the last few decades.

What is important for the development of the economy and inflation is not so much the price of crude oil itself, but rather the development of prices for motor fuels and heating oil produced from crude oil. The *price level for motor fuels* in EU countries is dominated by high excise taxes (mainly fixed, volume-based taxes and VAT); the substantial price differences within the EU are mainly attributable to different levels of taxation. In most countries, the tax burden on *heating oil* is considerably lower than that on other petroleum products, but there are also considerable differences within the EU. Austria's net gasoline prices are quite high compared with the other EU countries, but owing to the country's relatively low motor fuel taxation, the gross prices are average compared with other EU countries and thus slightly higher than in Austria's neighboring countries in Central Europe. According to a study by PVM (2005), the rather *high net gasoline price in Austria* could be related to the relatively high concentration on the filling station market,[26] to legal restrictions (e.g. the Trade Code) and relatively strict environmental requirements (which both make filling stations more expensive to operate) as well as to Austria's rather unfavorable location in terms of logistics (hardly any pipelines, low significance of transport by ship). Puwein and Wüger (1999) see these location factors as partly responsible but mainly regard competition – which focuses less on the price than on advertising, service quality, product design and new products – as the decisive pricing factor in Austria.

The extent and speed of the *transmission of crude oil price fluctuations to the prices of petroleum products* vary considerably from country to country and product to product. Various levels of competition intensity as well as location factors may also be responsible for this phenomenon. *Austria's elasticity and adjustment speed are among the lowest*, which may be attributable to the relatively high level of concentration on the filling station market. According to our estimates, there is *no significant difference between the speed of adjustment for rising and falling crude oil prices in Austria*.

Oil prices also impact the *prices of other energy sources*. The price of *natural gas* tracks that of crude oil with a muted effect and a pronounced time lag – which is the result of contractual clauses which index natural gas prices to the price of oil or oil products. In Austria, this pricing link is weaker than the EU average; the HICP for natural gas follows the price of crude oil with a delay of just over one year. The *prices of district heating, electricity and solid fuels in Austria react only rather weakly to the crude oil price*; in the EU, district heating prices track that of natural gas more closely, which indicates different generation sources and price clauses than in Austria as well as existing market segmentations. The relatively weak pricing link between Austria and the rest of the euro area with regard to natural gas (a highly standardized product which can be transported efficiently) points to the continued existence of pricing latitude and/or to tax changes in individual countries over time. *Electricity prices* do not display any discernible links among euro area countries. This may reflect the different energy sources used to generate electricity (i.e. the large share of hydropower in Austria) as well as the continued existence of national market segmentations.

Despite the doubling of the crude oil price, the price of natural gas in Austria has only increased slightly – and less distinctly than the EU-15 average – over the past ten years; the observed *drop in electricity prices in Austria was more pronounced than the EU-15 average*. Electricity prices for industrial consumers are now significantly lower in Austria than the EU-15 average, and prices for private consumers have also fallen below the EU-15 average. *The previously higher price of natural gas in Austria is now in line with the EU-15 average*. This favorable development is probably attributable to the liberalization of Austrian network industries, which was carried out fairly early compared with the rest of the EU.

In recent months, there have been discussions about whether the high energy prices should be cushioned by

26 According to PVM (2005), the four largest filling station chains in Austria dominated almost 60% of the market in 2004.

government measures such as reducing energy taxes or subsidizing energy expenses. As enticing as such measures may seem in the short term to ameliorate the problems of diminished purchasing power as well as reduced growth and employment resulting from increased oil prices, they also involve a number of drawbacks. Given the already precarious budget situation in many EU countries, they would endanger the sustainability of fiscal budgets. Moreover, as the increased oil prices are likely to endure, such measures would delay the inevitable transition to energy-saving technologies, prolong an excessive dependence on oil and increase susceptibility to future oil price shocks. At the global level, they would enhance the incentives for oil-exporting countries to raise prices even further. Governments should carefully consider the manifold short- and long-term effects when deciding whether to accelerate the long-term adaptive responses of economic actors toward energy-saving measures, substitution with other energy sources, etc., by means of legal regulations and/or subsidies.

The surges of the energy price component in the HICP have a strong short-term impact on the current inflation rate in the euro area, which reflects, among others, the close link between energy prices in the euro area countries. Still, as long as the inflation expectations of economic actors remain in line with price stability, the medium-term *monetary policy of the Eurosystem* need not immediately tighten in response to sudden, short-term transgressions of the definition of price stability resulting from energy price surges. By contrast, monetary policy action would be warranted in the case of an increase in inflation expectations and/or second-round effects of an inflation shock, for example in the development of wage levels.

The large portion of fixed, volume-based taxes in European energy prices means that motor fuel and heating oil prices – and thus also the overall rate of inflation – in the euro area react far more sluggishly to oil price fluctuations than in the U.S.A. Therefore, the euro area should not deviate from its low inflation rates as quickly as the U.S. economy, where prices are more flexible. At the same time, Eurosystem analyses indicate that after a shock, *inflation in the euro area returns to its previous level more slowly than in the U.S.A. Therefore, it is especially important for the Eurosystem's monetary policy to anchor inflation expectations at a low level which is in line with the ECB's goal of price stability.*

The distinct differences identified among euro area countries with regard to the pricing links between crude oil and petroleum products as well as other energy products (along with other factors, such as differing economic structures in individual countries) mean that an oil price shock may have asymmetric effects within the euro area. This can also lead to a *temporary expansion of inflation differentials within the euro area,* which may make it more difficult to communicate monetary policy.

The variables which influence the energy component's contribution to inflation are subject to change over time. *The further decoupling of oil consumption from GDP growth, among other things, will determine how sensitively the inflation rate, growth and employment react to future oil price shocks.* Factors which can contribute to a decoupling include the increasing tertiarization of the economy, technological advances and energy-saving measures. A country's energy mix can also be diversified by promoting alternative sources of energy. *Energy policy* thus *influences* strategic and structural policy relationships as well as the *macroeconomic functioning* of a country and currency area.

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