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# Staff Memo

Monetary Policy

## Factors driving consumer price inflation

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# Factors driving consumer price inflation

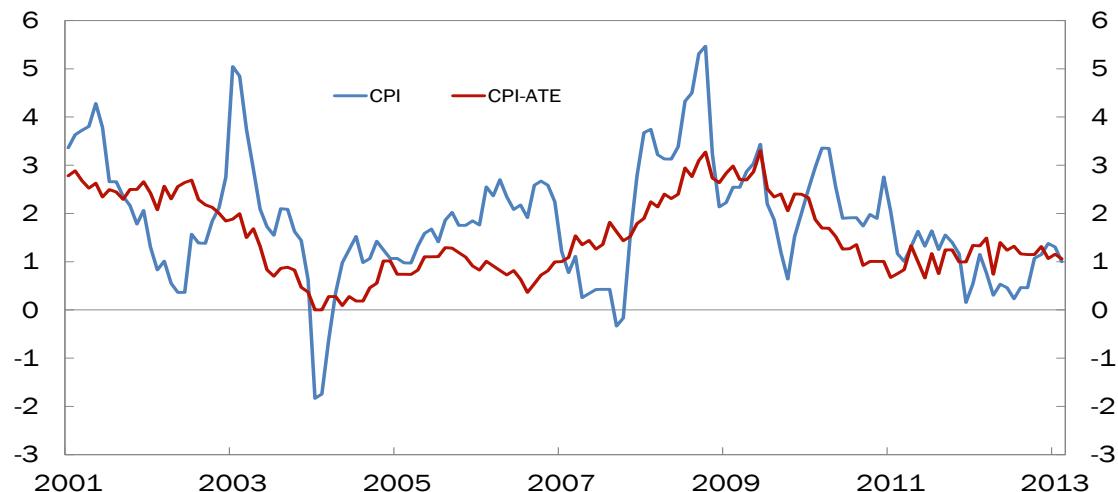
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*In this article, we explore how developments in key macroeconomic driving forces can explain developments in consumer price inflation since 2001. The relationships are analysed using empirical models. We find that prices for domestically produced goods and services excluding rent have moved in line with capacity utilisation and unit labour costs in household-oriented sectors. We also find that the rise in rental prices can, to a considerable extent, be explained by the general rise in consumer prices. A stronger krone and weak external price impulses have been the most important driving forces behind the decrease in prices for imported consumer goods since 2001.*

## 1. Introduction

Consumer price inflation (CPI) has on average been close to, but somewhat below, 2.5 percent since 2001 and has in periods varied considerably from month to month (see Chart 1). This variation can largely be attributed to fluctuations in prices for energy products. Consumer price inflation adjusted for tax changes and excluding energy products (CPI-ATE) has been more stable. This article presents an analysis of the factors driving consumer price inflation, as measured by the CPI-ATE. Our analysis is limited to the period after inflation targeting was introduced in 2001.

**Chart 1: CPI and CPI-ATE. 12-month change. Percent**



Sources: Statistics Norway and Norges Bank

CPI-ATE inflation has on average been somewhat lower than CPI inflation,<sup>2</sup> owing to a more rapid increase in energy prices than in other consumer prices. After remaining low for several years, CPI-ATE inflation picked up between 2007 and 2009 and has slowed since then. For the past two years, CPI-ATE inflation has been fairly stable at around 1 percent.

<sup>1</sup> Thanks to Kjetil Olsen, Leif Brubakk, Per Espen Lilleås and other colleagues at Norges Bank for useful input and comments. Any errors or omissions are responsibility of the authors.

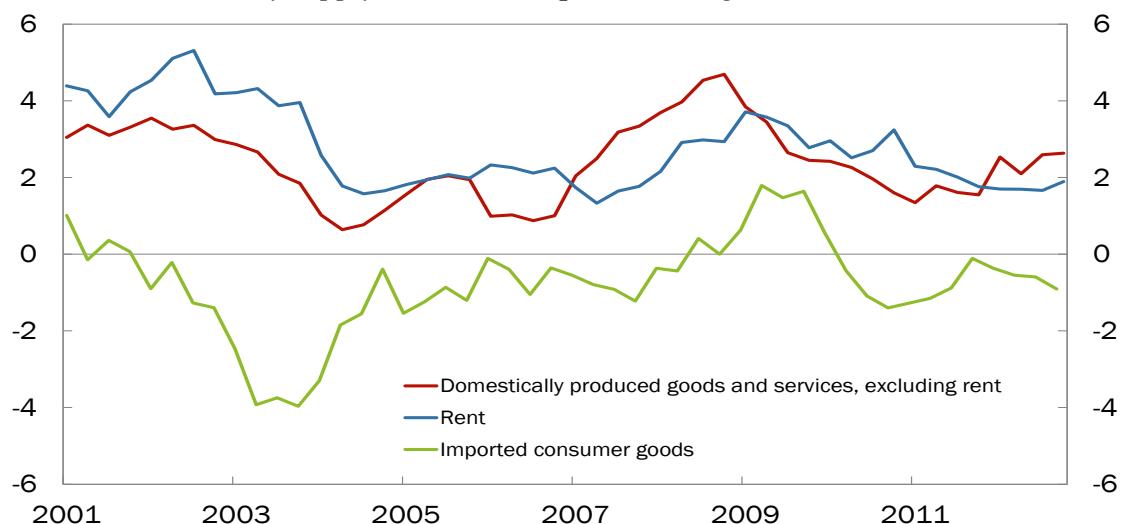
<sup>2</sup> CPI-ATE figures for the period preceding December 2002 are Norges Bank estimates.

The analyses in this article are based on the analyses in *Economic Commentaries* 11/2012, which discussed how developments in key subcomponents of the CPI-ATE have contributed to low consumer price inflation since 2009. This article considers how developments in key economic driving forces, such as labour costs, productivity, the krone exchange rate and international prices, can explain developments in consumer prices since 2001. These relationships are analysed using empirical models, which have been developed to provide a good description of historical price developments. If the historical relationships remain stable, the models could also be used to predict the future path of inflation.

We analyse developments in the CPI-ATE broken down into the following sub-groups: imported consumer goods, rent, and domestically produced goods and services excluding rent.<sup>3</sup> This breakdown is useful as the sub-groups are affected by different driving forces:

- *Imported consumer goods*: It is reasonable to assume that prices for imported consumer goods are largely determined by the krone exchange rate, producer prices for imported goods abroad and costs in the retail trade sector in Norway.
- *Rent*: Owing to a high degree of indexing, it is reasonable to assume that rental prices are influenced to a considerable extent by general consumer price inflation. Landlords' costs also play a role. These costs depend on factors such as borrowing and maintenance costs.
- *Domestically produced goods and services, excluding rent*: The rise in business sector costs is an important factor in the rise in prices for domestically produced goods and services. It can be assumed that the cost level and operating margins depends on capacity utilisation in the economy.

**Chart 2: CPI-ATE by supply sector. Four-quarter change. Percent**



Sources: Statistics Norway and Norges Bank

<sup>3</sup> The group *Imported consumer goods* accounts for about 32 percent of the weighting basis in the CPI-ATE. *Rent* accounts for about 20 percent of the index.

Prices for imported consumer goods have fallen for most of the period since 2001, pushing down overall consumer price inflation (see Chart 2). Rental prices have risen by an average 2.8 percent annually since 2001. The rise in prices for domestically produced goods and services excluding rent has averaged 2.4 percent.

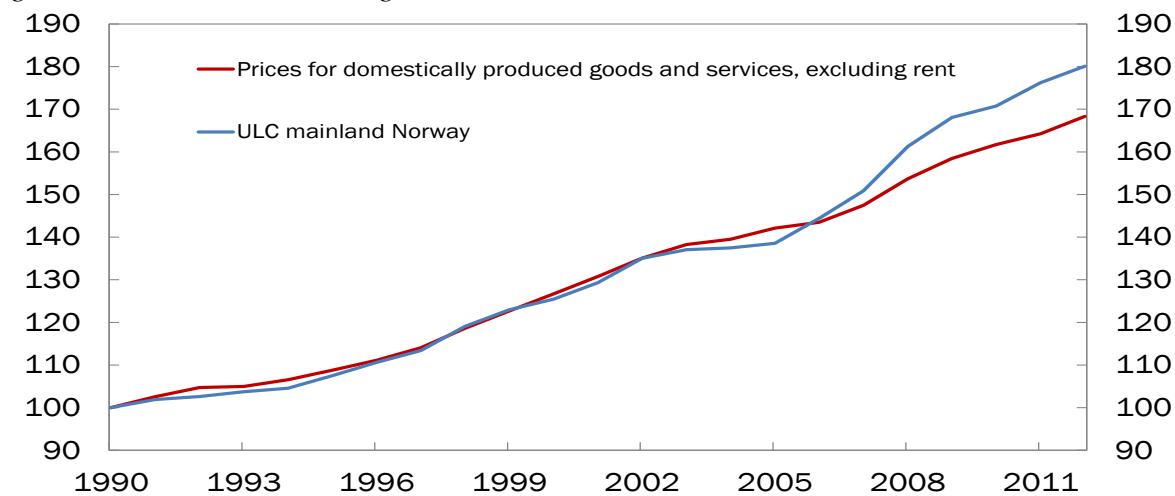
Section 2 explores the factors that have influenced prices for domestically produced goods and services excluding rent in the CPI-ATE. Sections 3 and 4 examine the driving forces behind developments in rental prices and prices for imported consumer goods. Section 5 concludes. The empirical models are presented in the appendices.

## **2. Prices for domestically produced goods and services excluding rent**

It is reasonable to assume that the rise in prices for domestically produced goods and services will, over time, be closely linked to cost developments in the Norwegian business sector. The most important cost component in production is labour costs. When labour costs rise more rapidly than productivity, unit labour costs (ULC) will increase. If this rise in costs is not matched by a corresponding rise in prices, businesses' operating margins will be reduced, increasing the share of income for compensation of employees (wage share). To restore profitability, businesses must either increase productivity or raise prices.

Chart 3 shows developments in mainland unit labour costs and prices for domestically produced goods and services excluding rent in the CPI-ATE. These two series tracked each other closely from 1990 to 2005. Since 2005, the rise in unit labour costs in the mainland economy as a whole has been clearly higher than the rise in prices for domestically produced goods and services excluding rent in the CPI-ATE. This may indicate reduced operating margins and thereby an increase in the wage share.

**Chart 3: Unit labour costs (ULC) mainland Norway and prices for domestically produced goods and services, excluding rent, in the CPI-ATE. Index. 1990 = 100**



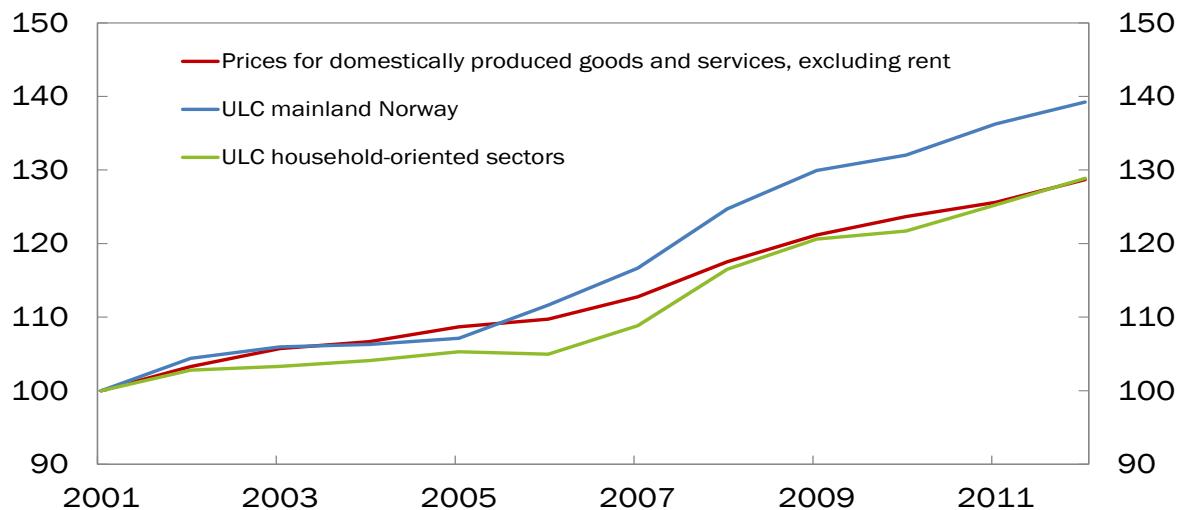
Sources: Statistics Norway and Norges Bank

The wide gap that has built up over time between unit labour costs in the mainland economy and prices for domestically produced goods and services excluding rent may also indicate that this definition of costs does not necessarily provide an accurate picture of cost developments in sectors producing consumer goods and services. If the rise in costs over time has been lower in household-oriented sectors than in the overall mainland economy, consumer price inflation in these industries may have been lower than overall cost inflation without having impaired profitability in businesses supplying the household sector.

There is no one who constructs a cost index reflecting producer costs of producing the goods and services included in the CPI. Norges Bank has therefore developed an index for unit labour costs in sectors assumed to be household-oriented. The index is based on a weighted average of cost developments in sectors primarily supplying the household sector. The weights are intended to reflect the relative importance of the different sectors for prices for domestically produced goods and services excluding rent in the CPI-ATE. See Appendix A for a further description of the index.

Prices for domestically produced goods and services excluding rent have moved roughly in line with the Bank's cost index since 2001 (see Chart 4). This implies that profitability has remained approximately unchanged in this period as a whole.

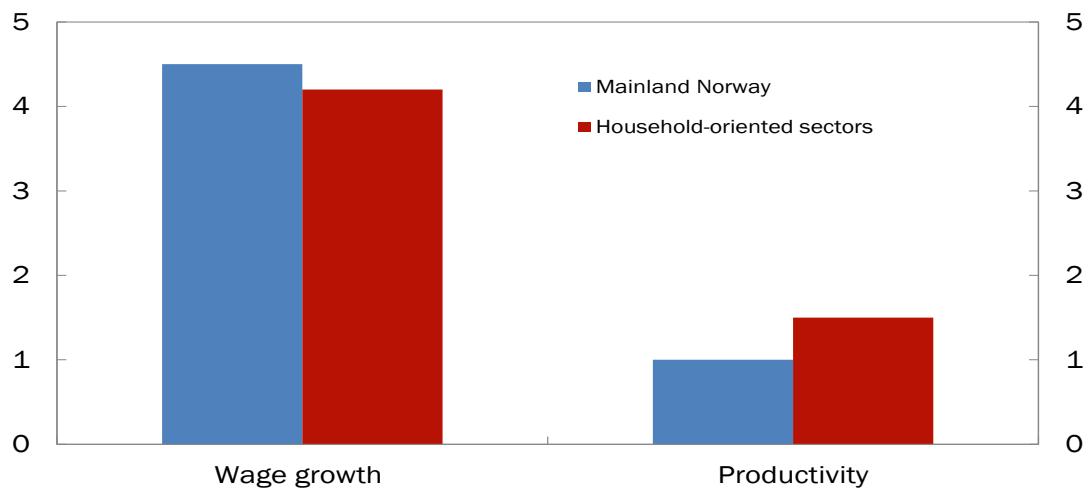
**Chart 4: Unit labour costs (ULC) and prices for domestically produced goods and services, excluding rent, in the CPI-ATE. Index. 2001 = 100**



Sources: Statistics Norway and Norges Bank

Chart 4 also illustrates that the cost index for household-oriented sectors has risen by much less than unit labour costs for mainland Norway since 2005. Wage growth has been lower and productivity growth higher in household-oriented sectors as a whole than in the wider mainland economy (see Chart 5). This has resulted in lower growth in unit labour costs.

**Chart 5: Hourly wages and labour productivity. Average 2005 – 2012. Annual change.**  
Percent



Sources: Statistics Norway and Norges Bank

Retail trade has made a substantial contribution to the lower rise in the estimated cost index than in unit labour costs in the mainland economy in recent years. Unit labour costs in this sector have increased by as little as 13 percent since 2001. Retail trade has been assigned a clearly higher weight in the cost index for household-oriented industries than in the index for unit labour costs for mainland Norway. Unit labour costs in the public sector have risen by 67 percent since 2001. The public sector has a far *lower* weight in the cost index for household-oriented industries than in the cost index for the mainland economy. The index for household-oriented industries also excludes a number of primarily corporate service sectors, where cost inflation has been relatively high.

#### *Empirical model*

A formalised relationship between developments in business costs and prices for domestically produced goods and services excluding rent has been explored using an empirical model. In the model, costs are expressed by the cost index for household-oriented sectors, as described above, and oil prices.<sup>4</sup> The model also includes significant, positive effects of Norges Bank's estimates for the output gap. This may reflect the following causal relationships: marginal costs increase more rapidly than average costs when capacity utilisation increases; other costs (such as rent) increase with rising pressures in the economy; and businesses raise prices when capacity utilisation rises. The model is estimated on quarterly figures from the first quarter of 2002 to the fourth quarter of 2012 and is described in more detail in Appendix B.

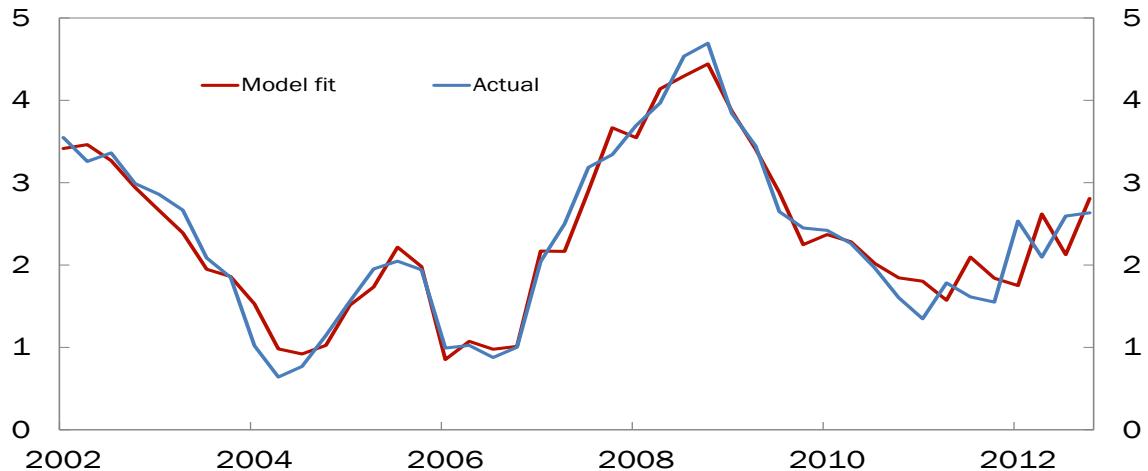
Chart 6 shows that the model fits to the data relatively well over the estimation period. The model indicates that costs are fully passed through to prices in the long term. Thus, prices track developments in unit labour costs in the long term. Prices are projected to rise by 1.6

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<sup>4</sup> Oil prices are intended to capture variations in energy and transport costs. We also tested for effects of prices for imported intermediate goods by including the krone exchange rate and producer prices for manufactured products among Norway's trading partners in the model. The effects of these variables were, however, far from being statistically significant.

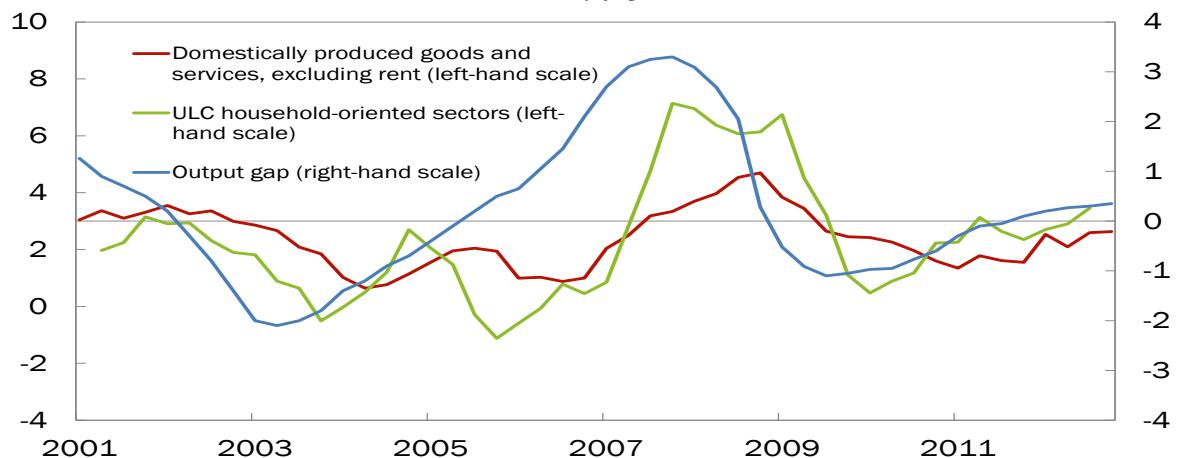
percent in the long term if the output gap increases by one percentage point and unit labour costs are constant. An increase in the output gap leads to higher prices both by pushing up prices for given costs and by contributing to higher labour costs as a result of increased labour market pressures.<sup>5</sup> Chart 7 illustrates that the rise in prices for domestically produced goods and services has been linked to developments in unit labour costs for household-oriented industries and the output gap in recent years.

**Chart 6:** Prices for domestically produced goods and services, excluding rent, in the CPI-ATE. Actual figures and model fit. Four-quarter change. Percent



Sources: Statistics Norway and Norges Bank

**Chart 7:** The output gap and four-quarter change in prices for domestically produced goods and services, excluding rent, in the CPI-ATE and three quarter centred moving average of ULC in household-oriented sectors. Quarterly figures. Percent



Sources: Statistics Norway and Norges Bank

<sup>5</sup> There is no appreciable change in the results if unemployment is used instead as an indicator of resource utilisation in the economy.

### 3. Rent

The rental price sub-index of the CPI-ATE comprises *actual rentals* and *imputed rentals*. *Actual rentals* refers to prices in the rental market, while *imputed rentals* represents the service value of owner-occupied housing. This value is assumed to track rental prices for similar dwellings in the rental market, as measured by the sub-index *actual rentals*. We model the aggregate index for rents in the CPI-ATE.

Rents in *existing* tenancy agreements are usually indexed to the CPI.<sup>6</sup> Price developments in new agreements may differ from those of existing agreements because a new agreement provides greater leeway for the landlord to change the rent. Rents in new agreements will depend on rental market demand and landlords' costs. These costs depend in turn on borrowing and maintenance costs. Demand for rental accommodation is determined by factors such as demographic conditions and house prices.

#### *Empirical model*

Our starting-point was a model specification containing the effects of the CPI, bank lending rates, demographic variables and unit labour costs in the construction industry (which include labour costs related to maintenance services).

The preferred model for rental prices is presented in Appendix C. It contains significant effects of the CPI, bank lending rates and unit labour costs in the construction industry. The model implies that rental prices in the CPI-ATE increase by 0.88 percent in the long term if the CPI rises by 1 percent and the other explanatory factors remain constant. A corresponding increase in labour costs leads to a 0.12 percent rise in rental prices over the long term for a given interest rate and CPI. Annual rental price inflation rises by 0.1–0.2 percentage points after three to six quarters if the interest rate increases by 1 percentage point, but we do not find significant long-term effects on rental prices. Nor do we find significant effects on rental prices of changes in house prices or demographic conditions over the estimation period from the first quarter of 2002 to the fourth quarter of 2012.<sup>7</sup>

The model fits well to actual data (see Chart 8).<sup>8</sup> As illustrated by Chart 9, rental price developments have been influenced by developments in the CPI and bank lending rates since 2001. The decline in rental price inflation between 2008 and 2012 primarily reflects the marked fall in general consumer price inflation. Lower electricity prices contributed to very low CPI inflation in much of 2012.

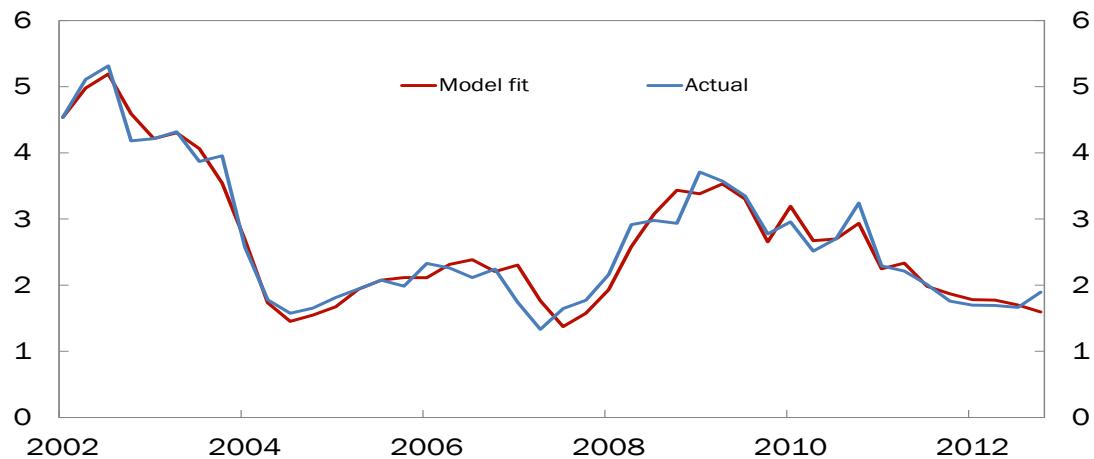
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<sup>6</sup> The Tenancy Act, Section 4-2a, states that "the revision [in the rent] must not correspond to a greater amount than the difference in the retail price index since the previous fixing of the rent". The rent may, however, be fixed to the "current level of rents" after three years (see Section § 4-3 of the Tenancy Act).

<sup>7</sup> A similar model for rental prices – estimated on data from 1986 to mid-2003 – was presented in Norges Bank's October 2003 *Inflation Report*. It contained the effects of the CPI, house prices, the interest rate level, the output gap, the unemployment rate, wages in private services, the share of the population in the 20-24 age group and the share of the 20-24 age group that are in education.

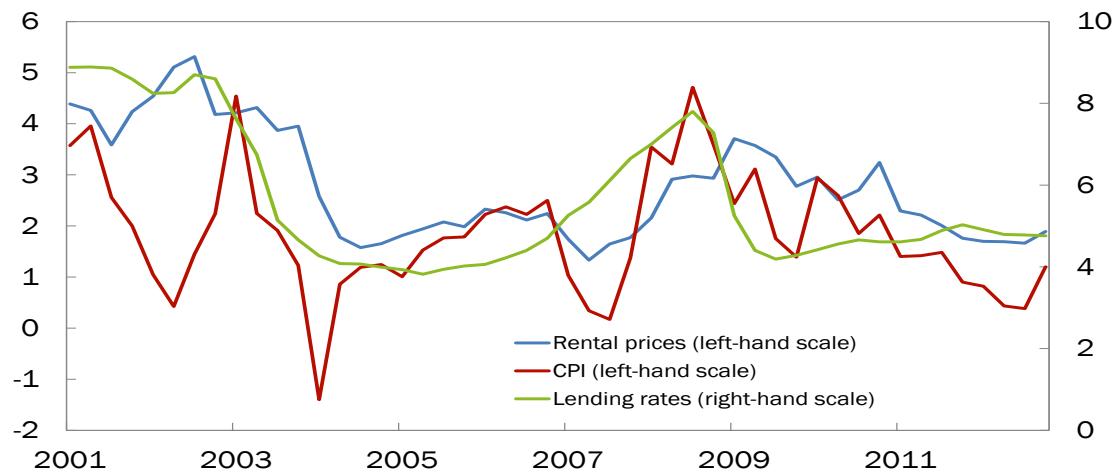
<sup>8</sup> The model contains dummy variables that capture the effects of rental market deregulation.

**Chart 8: Rental prices. Actual figures and model fit. Four-quarter change. Percent**



Sources: Statistics Norway and Norges Bank

**Chart 9: Lending rates, four-quarter change in the CPI and rental prices in the CPI-ATE. Quarterly figures. Percent**



Sources: Statistics Norway and Norges Bank

#### 4. Prices for imported consumer goods

Import prices are influenced to a considerable extent by the krone exchange rate and external price impulses. Norges Bank has constructed an indicator for external price impulses to imported consumer goods measured in foreign currency (see boxes in *Inflation Report* 1/2004 and 3/2005 and the article in *Economic Bulletin* 3/2004). The indicator is based on sub-indices for the various groups of imported goods included in the CPI-ATE broken down by country to ensure that the composition of both countries and goods in the index reflects actual imports of consumer goods over time. The indicator also takes account of the shift towards imports from low-cost countries, which has resulted in lower import prices.

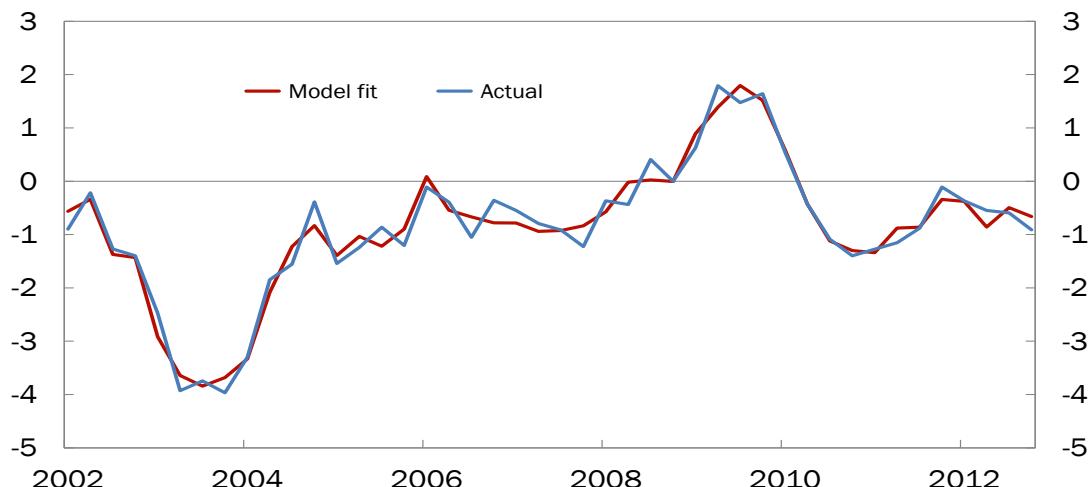
Shop prices for imported goods in Norway will also depend on retail trade costs and costs of transporting the goods to Norway. Transport costs will typically be closely linked to oil prices. In addition, retail trade margins may depend on resource utilisation in the economy.

### *Empirical model*

Our starting-point was a model specification containing effects of the krone exchange rate, the indicator for external price impulses, unit labour costs in the retail trade sector, oil prices measured in NOK and Norges Bank's estimates of the output gap.

The preferred model is presented in Appendix D. It contains significant effects of the krone exchange rate, external prices, oil prices and unit labour costs in the retail trade sector. The model implies that prices for imported goods included in the CPI-ATE increase by 0.79 percent in the long term if the krone exchange rate depreciates or external prices (excluding the oil price) rise by one percent and retail trade costs are constant. Retail trade costs have long-term elasticity of 0.19, while the oil price has long-term elasticity of 0.02. No significant effects of the output gap are found.

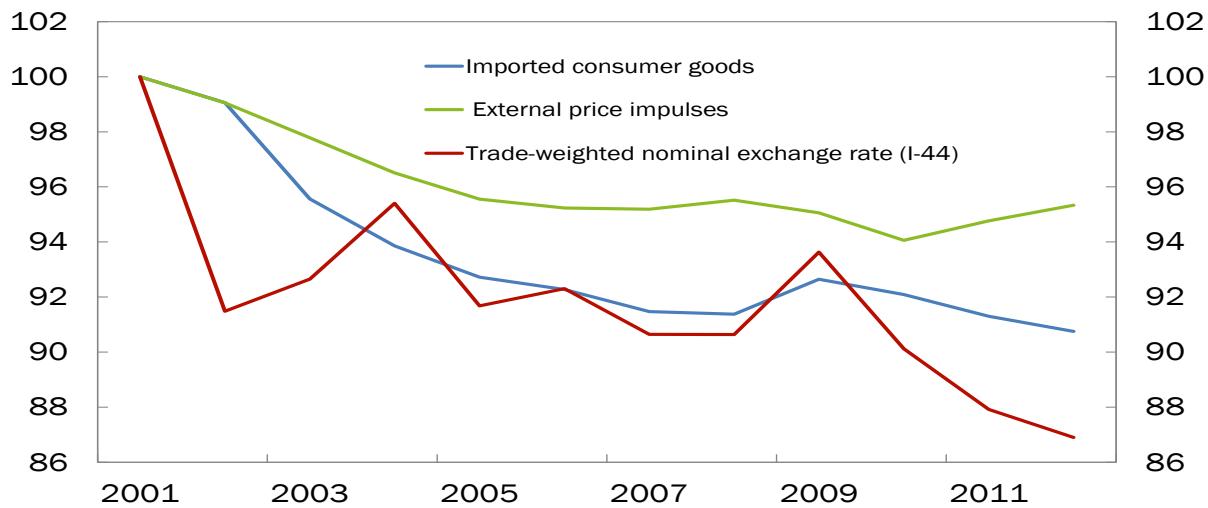
**Chart 10:** Prices for imported consumer goods in the CPI-ATE. Actual figures and model fit. Four-quarter change. Percent



Sources: Statistics Norway and Norges Bank

Chart 10 shows that the model fits well to the data. The model implies that a stronger krone exchange rate and weak external price impulses have been the most important driving forces behind the decrease in prices for imported consumer goods since 2001. External price impulses were weak or negative in most years in the estimation period (see Chart 11), reflecting moderate global inflation and a shift in trade patterns towards increased imports from low-cost countries. Prices for imported goods in the CPI-ATE have fallen more rapidly than implied by external price impulses, reflecting the considerable appreciation of the krone since 2001. The import-weighted exchange rate index (I-44) appreciated by 13 percent between 2001 and 2012. Oil prices and unit labour costs in retail trade increased through the estimation period. These variables have therefore contributed to limiting the decline in prices for imported goods.

**Chart 11: Exchange rate, prices for imported consumer goods in the CPI-ATE and the Norges Bank indicator of external price impulses to imported consumer goods. Index. 2001 = 100.**



Sources: Statistics Norway and Norges Bank

## 5. Conclusion

In this article, we have explored how developments in key macroeconomic driving forces can explain developments in consumer prices since 2001. We have analysed developments in the CPI-ATE broken down into three sub-groups: imported consumer goods, rent and domestically produced goods and services excluding rent. The main conclusions are as follows:

- *Domestically produced goods and services excluding rent:* The rise in prices has been lower than the rise in costs in the mainland economy since 2005, probably reflecting a considerably slower rise in costs in household-oriented sectors than in the mainland economy. Prices for domestically produced goods and services excluding rent have moved roughly in pace with unit labour costs in household-oriented sectors since 2001. Capacity utilisation in the economy has an effect on prices beyond that captured by developments in unit labour costs. This may reflect the following causal relationships: marginal costs rise faster than average costs when the gap increases; other costs (such as rent) increase with growing pressures in the economy; and businesses raise prices when capacity utilisation increases.
- *Rent:* Rental prices are influenced to a large extent by general consumer price inflation. Although higher interest rates result in higher annual rental price inflation after three to six quarters, we find no evidence to suggest that the interest rate level has a direct impact on rental prices in the long term.
- *Prices for imported consumer goods:* A stronger krone and weak external price impulses have been the main driving forces behind the decrease in prices for imported consumer goods since 2001. Higher labour costs in retail trade and higher oil prices have contributed to limiting the decline in prices for imported goods since 2001.

## APPENDIX A

### Construction of a cost index for household-oriented sectors

The cost index is constructed by weighing together separate cost indices for household-oriented sectors. *Wholesale and retail trade* has been selected to represent *domestically produced consumer goods* in the CPI-ATE basket. We have also included other service industries that may be relevant to prices for *services excluding rent*. Thus, the cost index contains costs from the following sectors in the national accounts:

- Wholesale and retail trade, repair of motor vehicles
- Transport activities excluding ocean transport
- Accommodation and food service activities
- Information and communications
- Education
- Health and social work activities
- Arts, entertainment and other service activities

The index is constructed as follows:

1. The costs for each sector is constructed as *unit labour costs (ULC)*

$$ULC_i = \frac{Wage\ costs_i / Hours\ worked,\ employees_i}{Value\ added_i / Hours\ worked,\ employees\ and\ self-employed_i}$$

Where  $i$  = the sectors mentioned above. All figures are from the quarterly national accounts.

2. In order to let the aggregate cost index include changes in the relative relationship between sectors, we have constructed *short-term indices* for each *cost index* mentioned in point (1).<sup>9</sup> When constructing the short-term indices, we have rebased the first quarter each year to 100.
3. Then the *short-term indices* in point (2) were weighted together. *Wholesale and retail trade* represents *domestically produced consumer goods* in the CPI-ATE basket, which constitutes around 18 percent of the CPI-ATE. The other sectors were given weights based on the weights of associated price indices in the CPI-ATE basket (see Table 1). Finally, the weights are normalised so that they add up to 100 percent.

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<sup>9</sup> Construction of short-term indices is explained in NOS D436. The Production Volume Index; Manufacturing, Mining and Quarrying, Oil and Gas Extraction and Electricity Supply 2009.

*Table 1: Weights (2013) used in the construction of the cost index for household-oriented sectors*

<b>Industries in the national accounts</b>	<b>Associated price indices</b>	<b>Associated supply sector/consumer group</b>	<b>Weight in the CPI-ATE 1)</b>
<b>Wholesale and retail trade, repair of motor vehicles</b>	Domestically produced consumer goods	Delivery sector 1–3	17.9
<b>Transport activities excluding ocean transport</b>	Transport services	Groups	3.1
<b>Accommodation and food service activities</b>	Restaurants and hotels	Divisions	5.6
<b>Information and communications</b>	Communications	Divisions	2.9
<b>Education</b>	Education	Divisions	0.3
<b>Health and social work</b>	Social protection	Groups	2.0
<b>Arts, entertainment and other service activities</b>	Recreational and cultural services	Groups	3.8

1) The weights are computed by Norges Bank

Sources: Statistics Norway and Norges Bank

4. Then we constructed a *chained index* based on the quarterly growth rates in the constructed *short-term index* in point (3).<sup>10</sup> The *chained index* expresses developments in the *weighted cost-index*, and thus represents the *cost index for household-oriented sectors*.
5. Finally, the *cost index for household-oriented sectors* was seasonally adjusted, using X-12 ARIMA.

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<sup>10</sup> Construction of chained indices is explained in NOS D436. The Production Volume Index; Manufacturing, Mining and Quarrying, Oil and Gas Extraction and Electricity Supply 2009.

## APPENDIX B

### An estimated model for prices for domestically produced goods and services, excluding rent, in the CPI-ATE

We started with a simple long-term relationship explaining prices:

$$1. \quad P_t = A * ULC_t^{\beta_1} * PF_t^{\beta_2}$$

$P$  is the price index for domestically produced goods and services, excluding rent.  $ULC$  (unit labour costs) is the weighted cost index as described in APPENDIX A and  $PF$  represents prices for energy products and imported intermediate goods expressed in NOK. It is common to assume that  $\beta_1 + \beta_2 = 1$ . Thus, equation (1) states that, in the long run, the price level is determined as a mark-up ( $A$ ) on production costs. The log-linear version of equation (1) is:

$$2. \quad p_t = \alpha + \beta_1 ulc_t + \beta_2 pf_t ,$$

where small letters represent logs. We have estimated different versions of equation (2), and they are estimated as *error-correction models*. The models also include effects of the output gap ( $GAP$ ), as estimated by Norges Bank, in order to allow cyclical movements in the mark-up on production costs. If the output gap has a positive effect in a price equation that also includes  $ULC$ , this may reflect the following causal relationships: marginal costs rise faster than average costs when capacity utilisation increases; other costs (such as rent) increase with rising pressures in the economy; and businesses raise prices when capacity utilisation increases.

The preferred model contains significant long-term effects of  $ULC$  and the output gap on the price level. We did not find significant effects of prices for imported intermediate goods expressed in NOK. However, the model contains short-term effects of the oil price, measured in NOK ( $OILPRICE$ ), as it reflects the effects of changes in transport and commodity costs. We have set long-term elasticity of  $ULC$  to unity. This restriction is not rejected by data.

The estimated model:

$$3. \quad \Delta p_t = \alpha + \beta_0(p_{t-1} - ulc_{t-2}) + \Delta \gamma_i \sum_{i=0}^1 ulc_{t-i} + \Delta \delta oilprice_{t-1} + \beta_2(GAP)_{t-1} + \sum_{i=1}^2 \alpha_i S_i + S_1 BR + \vartheta D061 + \varepsilon_t$$

$\Delta$  is the first difference ( $\Delta p_t = p_t - p_{t-1}$ ).  $S_i$  is a seasonal dummy variable for quarter  $i$ . The model also includes the variable  $BR$ , which is 1 up to 2006 Q4 and which is multiplicative with the seasonal dummies. To some extent this will capture changes in the seasonal pattern following new methods for calculating the prices for *air fares* and *books* introduced in 2007. We have also included a dummy variable for 2006 Q1 ( $D061$ ), in order to

capture the effect of lower daycare fees in that quarter. The estimation period is 2002 Q2–2012 Q4. The estimation results are shown in Table 2.

**Table 2:** An estimated model for prices for domestically produced goods and services excluding rent

Dependent Variable: DLOG(P)

Method: Least Squares

Date: 03/06/13 Time: 09:31

Sample: 2002Q1 2012Q4

Included observations: 44

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.000231	0.000931	0.247842	0.8057
DLOG(ULC)	0.034013	0.024667	1.378861	0.1769
DLOG(ULC(-1))	0.055091	0.028028	1.965551	0.0576
DLOG(OILPRICE(-1))	0.005477	0.003135	1.747063	0.0897
D061	-0.009286	0.002537	-3.660183	0.0008
S1	0.001273	0.001202	1.058483	0.2973
S2	0.004134	0.000836	4.942427	0.0000
S1*BR	0.005185	0.001495	3.468046	0.0014
LOG(P(-1)) -LOG(ULC(-2))	-0.110371	0.025547	-4.320353	0.0001
GAP(-1)	0.001796	0.000272	6.593368	0.0000
R-squared	0.757586	Mean dependent var	0.005648	
Adjusted R-squared	0.693417	S.D. dependent var	0.004013	
S.E. of regression	0.002222	Akaike info criterion	-9.184350	
Sum squared resid	0.000168	Schwarz criterion	-8.778852	
Log likelihood	212.0557	Hannan-Quinn criter.	-9.033972	
F-statistic	11.80620	Durbin-Watson stat	2.157464	
Prob(F-statistic)	0.000000			

## APPENDIX C

### An estimated model for rental prices in the CPI-ATE

The preferred model for rental prices is expressed in Table 3. The model is specified as an error-correction model. It contains significant long-run effects of CPI and unit labour costs in construction (*ULCC*). The long-run solution is given as:

$$1. \text{ rental price} = \text{constant} + 0,88 \text{ cpi} + 0,12 \text{ulcc},$$

where small letters represent logs. We have imposed that, in the long run, rental prices should be homogenous of degree one in CPI and ULCC. This restriction is not rejected by data. The equation contains positive effects in the medium run of an interest rate increase, but we do not find significant long-run effects. The model also includes seasonal dummy variables and dummy variables for each of the first quarters of 2002, 2003 and 2010. The latter variables capture effects of the gradual rolling back of the Rent Regulation Act over the period from 1 January 2000 to 1 January 2010 (the Tenancy Act came into effect on 1 January 2000). The deregulation meant that rental prices for pre-war residential in Oslo and Trondheim could increase significantly by 1 January 2002, 2003, 2008 and 2010.

**Table 3: An estimated model of rental prices in the CPI-ATE**

Dependent Variable: DLOG(HUSLEIE)  
 Method: Least Squares  
 Date: 03/08/13 Time: 17:55  
 Sample: 2002Q1 2012Q4  
 Included observations: 44

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.151513	0.039655	3.820798	0.0006
S1	0.002534	0.000900	2.815035	0.0082
S2	0.001723	0.000991	1.738391	0.0915
S3	-0.000699	0.000812	-0.861107	0.3954
D021	0.003311	0.002223	1.489492	0.1459
D031	0.005526	0.002212	2.498723	0.0176
D101	0.011979	0.002300	5.207769	0.0000
LOG(RENTAL PRICE(-1))-LOG(CPI(-1))	-0.188539	0.037647	-5.008122	0.0000
LOG(RENTAL PRICE(-1))-LOG(ULCC(-4))	-0.025372	0.007075	-3.586326	0.0011
DLOG(RENTAL PRICE(-1))	-0.093908	0.115012	-0.816508	0.4201
D(INTEREST RATE(-3),0,2)	0.001275	0.000363	3.508864	0.0013
R-squared	0.860191	Mean dependent var	0.006362	
Adjusted R-squared	0.817825	S.D. dependent var	0.004336	
S.E. of regression	0.001851	Akaike info criterion	-9.534096	
Sum squared resid	0.000113	Schwarz criterion	-9.088049	
Log likelihood	220.7501	Hannan-Quinn criter.	-9.368680	
F-statistic	20.30361	Durbin-Watson stat	1.833972	
Prob(F-statistic)	0.000000			

## APPENDIX D

### An estimated model for prices for imported consumer goods in the CPI-ATE

The preferred model is expressed in Table 4. The model is specified as an error-correction model. It contains significant long-term effects of the trade-weighted nominal exchange rate (*I-44*), external price impulses to imported consumer goods expressed in foreign currency (*IPK*), unit labour costs in wholesale and retail trade (*ULCW*) and the oil price expressed in NOK (*OILPRICE*). The long-term solution is given as:

$$2. \quad pi = \text{constant} + 0,79 (i44 + ipk) + 0,19 ulcw + 0,02 oilprice$$

where small letters represent logs. We have imposed prices for imported consumer goods are that are homogenous of degree one in international prices denominated in NOK and unit labour costs in wholesale and retail trade. This restriction is not rejected by data. The model also includes seasonal dummy variables and a dummy variable for 2005 Q1. The latter is supposed to capture the effect of an increase in VAT, from 24 to 25 percent, on 1 January 2005 that does not appear to have led to an immediate increase in the price level (thus, the measured prices in CPI-ATE decreased).

**Table 4:** An estimated model for prices on imported consumer goods in the CPI-ATE

Dependent Variable: DLOG(PI)  
 Method: Least Squares  
 Date: 03/11/13 Time: 08:38  
 Sample: 2002Q1 2012Q4  
 Included observations: 44

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-1.717871	0.208526	-8.238165	0.0000
S1	-0.018599	0.002311	-8.049257	0.0000
S2	-0.005419	0.001100	-4.927340	0.0000
S3	-0.016220	0.002205	-7.356631	0.0000
D051	-0.005844	0.002708	-2.158188	0.0403
DLOG(PI(-1))	-0.149630	0.080015	-1.870018	0.0728
DLOG(ULCW(-1))	0.052634	0.013650	3.855862	0.0007
DLOG(I44)	0.048415	0.015536	3.116359	0.0044
DLOG(I44(-1))	0.134513	0.018696	7.194908	0.0000
DLOG(44(-2))	0.171165	0.019364	8.839149	0.0000
DLOG(I44(-3))	0.191402	0.020609	9.287160	0.0000
DLOG(I44(-4))	0.223277	0.025261	8.838648	0.0000
DLOG(I44(-5))	0.307681	0.031281	9.835904	0.0000
DLOG(I44(-6),0,3)	0.348087	0.035482	9.810224	0.0000
DLOG(I44(-9))	0.406180	0.041000	9.906728	0.0000
LOG(PI(-1))-LOG(IPK(-4))-LOG(I44(-10))	-0.461338	0.049602	-9.300805	0.0000
LOG(PI(-1))-LOG(ULCW(-2))	-0.112650	0.015266	-7.379095	0.0000
LOG(PI(-1))-LOG(OILPRICE)	-0.009646	0.002059	-4.685616	0.0001
R-squared	0.987569	Mean dependent var	-0.002148	
Adjusted R-squared	0.979441	S.D. dependent var	0.014049	
S.E. of regression	0.002014	Akaike info criterion	-9.284877	
Sum squared resid	0.000106	Schwarz criterion	-8.554981	
Log likelihood	222.2673	Hannan-Quinn criter.	-9.014196	
F-statistic	121.5008	Durbin-Watson stat	2.817588	
Prob(F-statistic)	0.000000			