

Jan Lansky¹, David Mares²

THE INFLUENCE OF DIESEL PRICES ON INFLATION

The article provides an indepth analysis of the petrochemical industry and its effect on inflation as measured by the consumer price index. It includes a thorough examination of diesel pricing, with an emphasis on the final price for customers. The article is based on the Czech economy case study and evaluates statistical data using 2004–2014 statistics. The research results are also applicable to other economies.

Keywords: diesel; inflation; consumer price index.

JEL classification: E31; E58; Q41.

Peer-reviewed, approved and placed: 25.04.2016.

Ян Ланскі, Давід Мареш

ВПЛИВ ЦІН ПАЛИВА НА ІНФЛЯЦІЮ

У статті представлено детальний аналіз функціонування нафтохімічної галузі та її впливу на інфляцію, виміряну через індекс споживчих цін. Ціноутворення на паливо проаналізовано з акцентом на кінцевих цінах для споживачів. Аналіз проведено на прикладі економіки Чехії, використано статистичні дані за 2004–2014 роки. Однак аналогічне дослідження може бути застосоване і до інших економік.

Ключові слова: паливо; інфляція; індекс споживчих цін.

Форм. 3. Табл. 1. Літ. 24.

Ян Лански, Давид Мареш

ВЛИЯНИЕ ЦЕН ТОПЛИВА НА ИНФЛЯЦИЮ

В статье представлен подробный анализ функционирования нефтехимической отрасли и её влияния на инфляцию, измеренную через индекс потребительских цен. Ценообразование на топливо проанализировано с акцентом на конечных ценах для потребителей. Анализ проведён на примере экономики Чехии, использованы статистические данные за 2004–2014 годы. Однако аналогичное исследование может быть применимо и к другим экономикам.

Ключевые слова: топливо; инфляция; индекс потребительских цен.

Introduction. The article deals with the relationship between inflation and diesel prices, formed by the entire petrochemical industry along with external factors. Petrochemical industry cannot be analysed solely through exit prices of individual products in a sales chain; the effects to which exit prices are exposed also need to be taken into account. Exit price is influenced by the price of basic raw material, exchange rate, taxes and margins. However, previous research hasn't covered the topic comprehensively and was based on the importance of inflation and oil price research without interlinks in the petrochemical industry. H. Baghestani (2014) posited that: "The importance of oil in the world economy has long been recognised. A global oil market with reasonably stable price is essential for sound policy making in both oil-exporting and oil-importing countries". Q. He and C. Fan (2015), who study the importance of inflation monitoring, posited that: "The inflation rate is an important indicator reflecting the macroeconomic situation and people's life quality and is an important issue the should receive long-term attention from the government".

To measure inflation, this article uses the Consumer Price Index (CPI), which is also employed for measuring inflation in other papers, e.g. S. Sethi (2015), who inter

¹ University of Finance and Administration, Praha, Czech Republic.

² University of Finance and Administration, Praha, Czech Republic.

alia: "CPI is calculated as the weighted average of prices of a specified set of goods and services purchased by customers". I. Partachi and V. Motelica (2015) also prefer measuring inflation using CPI; they mentioned that: "CPI has several advantages such as the fact that it is known to the public, it is based on the expenditures made by the households and it is disseminated on a monthly basis just several days after the end of the reference period. Besides its advantages, CPI has several shortcomings. It doesn't repeal the growth of prices which is caused by monetary factors. In other words, some price changes might be some sectorial shocks. These have transitory effects on the general price level and are not considered a part of the inflationary process. In this way, food prices might grow due to some bad weather conditions which determined a bad harvest or the fuel prices might grow once the fiscal authority increases the excise taxes. The direct effect of these changes is temporary and is not a part of the general inflation trend". Our research eliminates frequent negative factors of using CPI owing to a long timeline of data used in our research.

Literature review. S. Rafiq (2014) can be seen as an important work that looks into the effects of oil price and inflation in the UK; they inter alia posited that: "adverse oil price shocks have precipitated a rise in unemployment and a transitory rise in domestic inflation. His results suggest that oil price shocks have acted like adverse supply-side shocks, and led to an upward movement along the short-run Philips curve". And also further: "Oil price shocks have historically acted as adverse supply shocks on the UK economy by worsening the inflation-unemployment trade-off". This paper, though limited to oil price shocks, proves the influence of oil prices on inflation and unemployment. Some other authors also studied the effects of oil prices on inflation through the Phillips curve but they drew the following conclusion. E.g., N. Catik and O. Onder (2011) posited that: "Our estimation results suggest that a linear backward-looking Philips curve may not be a convenient tool for measuring the effects of oil prices on inflation".

P. Korchagin et al. (2015) examine the factors that affect the efficiency of enterprises in telecommunications of Russian Federation, 2005–2013 on the example of 3 major telecommunication companies. Their results suggest that the success of Russian telecommunications companies is associated with the level of inflation in the country. I. Bilan and A. Roman (2014) analyzed specific interconnections established between public indebtedness and inflation as a result of public borrowing and of voluntarily promoting inflation to reduce the real value of public debt and to ease its burden. A. Miecinskiene and I. Lapinskaite (2014) investigate the influence of changes of commodity price level in the world commodity exchanges on variation of general price level index in Lithuania. M. Bratu (2012) evaluate the inflation rate, unemployment rate and interest rate as some of the most important indicators used at macroeconomic level. These variables present a significant interest for the central banks that establish the monetary policy, as well as for the government.

Model structure and calibration. The assumptions of the model and its application are based on the actual conditions of Czech economy, and may also be used in other countries if the defined assumptions are met.

The model assumptions are as follows:

- market economy;
- dirty floating exchange rate;

- large number of entities (fuel retailers) offering final fuel (diesel) prices for carriers who can include inputs (oil prices, exchange rate etc.) in the fuel prices for carriers, thus influencing goods prices and consequently inflation;
- open economy;
- export-oriented economy.

We use fuel (diesel) prices for carriers as the basis as we assume that goods (such as foodstuffs) are transported by carriers that use diesel and buy it at fuel stations. Thus, rising or falling price will influence the costs of transporting goods and these increased costs of transporting goods will be automatically reflected in increased prices for products to be bought by consumers in stores, for instance; this price growth under unchanged conditions will trigger inflation.

The model does not include (i.e., we disregard) other effects that may also trigger inflation, except diesel price; according to L. Bachmeier and I. Cha (2011), some of such effects include:

- changes in production technologies;
- monetary policy;
- changes at labour market.

This article deals with the development of mutual relationships between the selected economic indicators that influence petrol and diesel prices for end consumers, 2004 to 2014. We obtained the complete values of the selected indicators (inflation rate, consumer price index, diesel price for consumers, petrol price for consumers, price of Brent crude, exchange rate of USD against the Czech koruna, excise duty and VAT) for the monitored period. Refining margin data has been available since 2007 and retailer margin data – since 2006.

The average annual inflation rate expresses a percentage change of average price level in the last 12 months against the average level of the previous 12 months. We adopted the values of the average annual inflation rate published by Czech Statistical Office (2015a). In the monitored period, the average annual inflation rate ranged between 0.4% in 2014 up to 6.3% in 2008.

The consumer price index (*CPI*) expresses the inflation rate of the current year against the relevant base year. Czech Statistical Office (2015b) publishes *CPI* values against 2005 as the base year. At the beginning of our monitored period in 2004, *CPI* was 98.1%, as opposed 123.2% at the end of the monitored period in 2015. *CPI* was calculated using the Laspeyres Price Index, which systematically overvalues inflation rates, but figures are accurate enough for the purposes of this article. W.E. Diewert (1998) deals with various ways of calculating the *CPI* and how the calculations are affected by the error.

Czech Statistical Office (2015c) publishes the average fuel prices in individual years. For the purposes of this article, we will use the diesel price C_n and the petrol price C_p for lead-free Natural 95 (an equivalent of Eurosuper/Super 95 in other European countries). Natural 95 was selected as a representative of petrol because of its predominant market position, which exceeded 90% in the monitored period. The price of diesel ranged between the minimum of 24.92 CZK per litre in 2004 and the maximum of 36.46 CZK per litre in 2012. The price of petrol ranged between the minimum of 26.73 CZK per litre in 2004 and the maximum of 36.68 CZK per litre in 2012.

Now we need to ascertain the oil price Co expressed in Czech korunas per litre CZK/l in individual years. The US Energy Information Administration (2015) publishes daily prices for European Brent crude Co expressed in USD per barrel (one barrel is 158.987294928 litres). The Czech National Bank (2015) publishes daily exchange rates of the dollar against the Czech koruna $FX[CZK/USD]$. Price for oil in year Y expressed in Czech korunas per litre $Co_Y [CZK/l]$ is calculated by the formula:

$$Co_Y [CZK / l] = \frac{1}{\{d | d \in Y\}} \sum_{d \in Y} \frac{Co_d [USD / barrel] \times FX_d [CZK / USD]}{158.987294928 [l / barrel]} \quad (1)$$

Formula (1) could be updated in a more precise manner using the average based on traded quantity of oil instead of the currently used arithmetic mean. Given the inaccuracies of other indicators to be used for our calculations, such an update is not necessary. The price of oil ranges between the minimum of 6.16 CZK per litre in 2004 and the maximum of 13.72 CZK per litre in 2012.

Excise duties are set pursuant to Act No 353/2003 Coll. A historical overview of the excise duty rates applicable to diesel and petrol until 2011 is available in (Mincic, 2011) of the Ministry of Finance of Czech Republic. The current excise duty rates applicable to diesel and petrol since the rate was changed in 2010 until the present is published by the Customs Administration of Czech Republic (2015). The excise duty applicable to diesel had stood at 9.95 CZK per litre since 2004; it was raised by 1 CZK per litre to 10.95 CZK per litre in 2010 and this level was maintained until the end of the monitored period in 2014. The excise duty applicable to petrol had stood at 11.84 CZK per litre since 2004; it was raised by 1 CZK per litre to 12.84 CZK per litre in 2010 and this level was maintained until the end of the monitored period in 2014.

The value added tax (VAT) was introduced by Act No 588/1992 Coll. Since 1 April 2004, it has been governed by Act No 235/2004 Coll. R. Novakova (2013) gives a historical overview of VAT rates. At the beginning of our monitored period on 1 January 2004, the VAT rate stood at 22% and was reduced to 19% on 1 April 2004. It was raised to 20% in 2010 and to 21% in 2013. As the VAT rate change of 2004 was made during the year, we calculated its average value for the relevant year as the average of the original and new rates, weighted by the number of days when the relevant rates applied. The final VAT rate for 2004 is 19.99%.

Unipetrol a.s. is the largest oil refining company in Czech Republic. Its refining margin in $USD/barrel$ for 2008 to 2014 was published by Unipetrol a.s. (2015). We calculated its average annual refining margins as an arithmetic mean of the specified average quarterly values. For 2007, only the average margins for the first and the fourth quarters were available from Unipetrol a.s. (2008), and thus we calculated the annual value by an arithmetic mean of these values, being aware of the inaccuracy of this. We need to convert the average annual refining margins $GM_Y(refinery)$ in year Y expressed in $USD/barrel$ into CZK/l using the formula (2). The average annual exchange rate of USD against Czech koruna in year Y is referred to as $FX_Y[CZK/USD]$.

$$GM_Y(refinery)[CZK / l] = \frac{GM_Y(refinery)[USD / barrel] \times FX_Y[CZK / USD]}{158.987294928 [l / barrel]} \quad (2)$$

The refining margin of Unipetrol a.s. is calculated as the revenues for its products minus the price of Brent crude. Automotive petrol makes up 17% while automotive diesel makes up 40% of its products sold. The refining margin ranged between the maximum of 0.90 CZK per litre in 2007 and the minimum of 0.11 CZK per litre in 2011.

The retailer margins for diesel and petrol are specified by Forbes (2015) in its interactive graph with daily granularity. The graph provides values for any day but not for all days overall. Hence we only used the values as of 1 January, 1 April, 1 July, 1 October and 31 December of the relevant calendar years. We calculated the margin for the relevant year by the weighted average of these values. The weights of margins as of 1 January and 31 December were 1/8; the weights of margins as of 1 April, 1 July and 1 October were 1/4. The retailer margin for diesel ranged between the minimum of 2.21 CZK per litre in 2007 and the maximum of 3.15 CZK per litre in 2014. The retailer margin for petrol ranged between the minimum of 2.14 CZK per litre in 2007 and the maximum of 2.99 CZK per litre in 2010.

Results. The values of inflation, consumer price index, petrol and diesel prices for consumers, oil prices, excise duties applicable to petrol and diesel, VAT, refining margin and retailer margin for 2004 to 2014 are presented in Table 1. The data sources do not include data on refining margins from 2004 to 2006 and on retailer margins in 2004 and 2005. Data for 2015 was not available at the time of writing this article.

Using the correlation statistics tool according to D. Bilkova et al. (2009), we will unveil the existence of a linear dependence between the variables concerned. The correlation coefficient defined by formula (3) can equal the real values within the interval of $[-1, +1]$. Limit value $+1$ denotes a directly proportional dependence (rise in the consumer price index – rise in diesel prices for consumers). Limit value -1 denotes a strong indirect dependence (rise in the consumer price index – fall in diesel prices). Value 0 denotes that linear dependence does not exist between the variables concerned but this does not rule out a different form of dependence, e.g. quadratic one.

The correlation coefficient of the consumer price index and the diesel price for consumers $corr(CPI, Cn)$ from 2004 to 2014 is defined by formula (3), where $CPI(Y)$ denotes the consumer price index in year Y and $Cn(Y)$ denotes the diesel price for consumers in year Y .

$$corr(CPI, Cn) = \frac{11 \sum_{Y=2004}^{2014} CPI(Y)Cn(Y) - \sum_{Y=2004}^{2014} CPI(Y) \sum_{Y=2004}^{2014} Cn(Y)}{\sqrt{11 \sum_{Y=2004}^{2014} CPI(Y)^2 - (\sum_{Y=2004}^{2014} CPI(Y))^2} \sqrt{11 \sum_{Y=2004}^{2014} Cn(Y)^2 - (\sum_{Y=2004}^{2014} Cn(Y))^2}}. \quad (3)$$

After inserting values into formula (3), we obtain the correlation coefficient value of 0.863. According to (Bilkova et al., 2009), a value greater than 0.8 denotes a very strong dependence. The consumer price index and diesel prices for consumers from 2004 to 2014 rose in a very strong directly proportional dependence.

Discussion. The article deals with the subject matter which is very important for central banks. Inflation is analysed through many factors concerning the petrochemical industry. This industry is analysed through the sale chain, the effects to which the exit price is influenced by the price of basic raw material, exchange rate, taxes and

Table 1. Structure of fuel prices for consumers and inflation

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Inflation, %	2.80	1.90	2.50	2.80	6.30	1.00	1.50	1.90	3.30	1.40	0.40
Consumer price index	98.10	100.00	102.50	105.40	112.10	113.30	114.90	117.10	121.00	122.70	123.20
Petrol price for consumers, CZK/l	26.73	28.48	29.59	29.54	30.32	27.15	31.74	34.58	36.68	36.17	36.16
Diesel price for consumers, CZK/l	24.92	27.87	28.97	28.67	31.74	26.10	30.57	34.25	36.46	36.11	36.31
Oil price, USD/barrel	38.26	54.57	65.16	72.44	96.94	61.73	79.61	111.26	111.57	108.56	98.84
USD/CZK	25.70	23.94	22.60	20.30	17.03	19.06	19.60	17.69	19.58	19.56	20.75
Oil price, CZK/l	6.16	8.21	9.18	9.13	10.17	7.27	9.55	12.36	13.72	13.35	12.85
Excise duty on petrol, CZK/l	11.84	11.84	11.84	11.84	11.84	11.84	12.84	12.84	12.84	12.84	12.84
Excise duty on diesel, CZK/l	9.95	9.95	9.95	9.95	9.95	9.95	10.95	10.95	10.95	10.95	10.95
VAT, %	20	19	19	19	19	19	20	20	20	21	21
Refining margin, USD/barrel				7.08	5.68	2.05	3.42	0.95	3.63	1.00	1.35
Refining margin, CZK/l				0.90	0.61	0.25	0.42	0.11	0.45	0.12	0.18
Retailer margin for petrol, CZK/l			2.40	2.14	2.45	2.98	2.99	2.93	2.27	2.51	2.28
Retailer margin for diesel, CZK/l			2.50	2.21	2.24	3.01	2.83	2.82	2.60	2.89	3.15

Source: Authors' own calculation based on the following data: Czech Statistical Office (2015a), Czech Statistical Office (2015b), Czech Statistical Office (2015c), US Energy Information Administration (2015), Czech National Bank (2015), Customs Administration of Czech Republic (2015), L. Mincic (2011), Forbes (2015), Unipetrol a.s. (2008; 2015).

margins. For better understanding of the influence of diesel prices on inflation is used the model with calibration and assumptions (market economy, dirty floating exchange rate, open economy, export-oriented economy). The assumptions of the model and its application are based on the actual conditions of Czech economy, and may also be used in other countries if the defined assumptions are met.

This problem hasn't been sufficiently studied in Czech Republic and in other countries either. The inflation was analysed without wider context subject to the sale chain of the petrochemical industry. Our results could be used as well for measuring of living standards.

Measuring of these standards could be done through:

1. Situation in the petrochemical industry:
 - 1.1. Profitability (relation between margin and number of employees – social situation of employees in the petrochemical industry).
 - 1.2. Average wage of employees the industry.
2. Social situation of all citizens could be measured:
 - 2.1. Average wage.
 - 2.2. Inflation and average wage of a country given.
 - 2.3. Costumer price index.
 - 2.4. Petrol price for consumers (expending of citizens for personal transport).
 - 2.5. Citizens' personal transport is affected by oil prices.
3. We can consider oil price as a strategic source, because it is the basement for calculation of the final price for consumer (diesel and petrol prices):
 - 3.1. Diesel price for consumers (citizens using public transport).
 - 3.2. Diesel price for consumers (as reflected in food prices).

Also noteworthy:

1. Currency rate: We can see steady decrease.
2. Excise duty on petrol: We can see guile stable status but in year 2010 there was an increase by 1 CZK.
3. Excise duty on diesel: In year 2010 there was an increase by 1 CZK.
4. Value Added Tax: We can observe the increasing value of VAT.
5. Refining margin USD/barrel: Decreasing due to competition.
- 6 Refining margin CZK/l: Decreasing due to competition.
7. Retailer margin for petrol: Remains equal.
8. Retailer margin for diesel [CZK/l]: Remains equal.

Conclusion. We can conclude that inflation growth measured by the consumer price index (CPI) is primarily triggered by the rise of diesel prices for consumers. Given the high value of the correlation coefficient of 0.863, we can conclude that this dependence is very strong and dominant. Therefore, using the example of Czech economy, we can confirm that fuel (diesel) prices for consumers have a significant effect on CPI inflation. We can also resume that the final price for consumers is influenced not only by oil prices but also by exchange rate, excise duty, VAT, refining margin and retailer margin. The authors see the future direction of further research in analysing the relevance of individual factors, i.e. VAT, excise duty, refining margin, retailer margin, exchange rate, oil price in USD/barrel, consumer price elasticity, and price stability of individual elements of the petrochemical industry (refineries and fuel retailers), as well as inflation. Concerning further research into the relationship

between inflation and diesel prices for consumers, the authors believe that it may cover inflation expectations and energy price forecasting or the relationship between inflation and GDP growth.

Acknowledgement. *The article is covered by the "Institutional support for long-term strategic development of the research organization", University of Finance and Administration, 2015.*

References:

Bachmeier, L., Cha, I. (2011). Why Don't Oil Shocks Cause Inflation? Evidence from Disaggregate Inflation Data. *Journal of Money, Credit & Banking*, 43(6): 1165–1183 = DOI:10.1111/j.1538-4616.2011.00421.x.

Baghestani, H. (2014). Inflation expectation and energy price forecasting. *OPEC Energy Review*, 38: 21–35.

Bilan, I., Roman, A. (2014). Interconnections between Public Indebtedness and Inflation in Contemporary Economies. *Economics and Sociology*, 7(4): 59–70.

Bilkova, D., Budinsky, P., Vohanka, V. (2009). Pravdepodobnost a statistika. Vydavatelstvi a nakladatelstvi Ales Cenek, s.r.o. Plzen, Czech Republic.

Bratu, M. (2012). Accuracy Assesment of Short Run Macroeconomic Forecasts in Romania. *Economics and Sociology*, 5(1): 26–38.

Catik, N., Onder, O. (2011). Inflationary Effects of Oil Prices in Turkey: A Regime-Switching Approach. *Emerging Markets Finance & Trade*, 47(5): 125–140.

Customs Administration of Czech Republic (2015). Zmena sazeb spotrebnych dani // tinyurl.com.

Czech National Bank (2015). Kurzy devizoveho trhu // tinyurl.com.

Czech Statistical Office (2015a). Mira inflace vyjadrena prirustkem prumerneho rocnihho indexu spotrebitelskych cen // tinyurl.com.

Czech Statistical Office (2015b). Indexy spotrebitelskych cen – inflace – casove rady // tinyurl.com.

Czech Statistical Office (2015c). Indexy spotrebitelskych cen – zakladni cleneni // tinyurl.com.

Diewert, W.E. (1998). Index Number Issues in the Consumer Price Index. *Journal of Economic Perspectives*, 12(1): 47–58.

Forbes (2015). Marze pohonných hmot od roku 2006 // tinyurl.com.

He, Q., Fan, C. (2015). Forecasting Inflation in China. *Emerging Markets Finance & Trade*, 51: 689–700 = doi:10.1080/1540496X.2015.1039890.

Korchagin, P., Korneeva, E., Nikitina, N. (2015). Factors that Influence the Effectiveness of Russian Telecommunication Companies. *Economics and Sociology*, 8(3): 119–130.

Miecinskiene, A., Lapinskaite, I. (2014). The Research on the Impact of the Changes of Commodity Price Level in the World Commodity Exchanges on Variation of General Price Level. *Economics and Sociology*, 7(4): 71–88.

Mincic, L. (2011). Spotrební dan z mineralních oleju v Ceske republice. Liberalni institut – Praha // libinst.cz.

Novakova, R. (2013). Vyvoj sazeb DPH od roku 1993 // tinyurl.com.

Partachi, I., Motelica, V. (2015). Methods of measuring core inflation in inflation targeting countries. *Journal of Applied Quantitative Methods*, 10(1): 56–66.

Rafiq, S. (2014). What Do Energy Prices Tell Us About UK inflation? *Economica*, 81(322): 293–310 = doi:10.1111/ecca.12076.

Sethi, S. (2015). Inflation, Inflation Volatility and Economic Growth: The Case of India. *IUP Journal of Applied Economics*, 14: 25–44.

Unipetrol a.s. (2008). Prehled vybranych ukazatelu za 1. ctvrtletí 2008 // tinyurl.com.

Unipetrol a.s. (2015). Makroekonomické data – ctvrtletne roku 2008 az 2014 // tinyurl.com.

US Energy Information Administration (2015). Spot Prices for Crude Oil and Petroleum Products // tinyurl.com.